



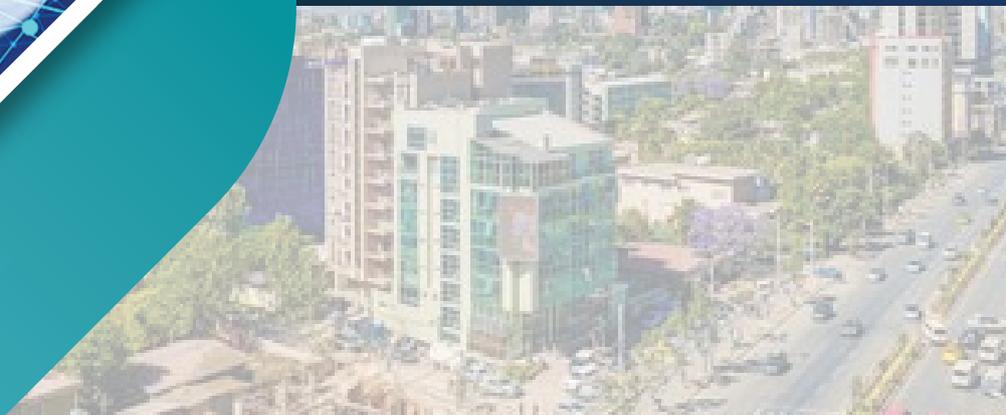
International Conference on Innovative Research in Science and Technology

Virtual Conference

ICIRST-2021



26th - 27th
November 2021



Organized By

Institute For Engineering Research and Publication (IFERP)

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**International Conference on Innovative
Research in Science and Technology**

(ICIRST-2021)

Virtual Conference

26th-27th November, 2021

Addis Ababa, Ethiopia

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IFERP-Explore

Editorial

We cordially invite you to attend the **International Conference on Innovative Research in Science and Technology (ICIRST-2021)-Virtual Conference** which will be held at **Addis Ababa, Ethiopia** on **26th-27th November, 2021**. The main objective of **ICIRST** is to provide a platform for researchers, students, academicians as well as industrial professionals from all over the world to present their research results and development activities in relevant fields of Science and Technology. This conference will provide opportunities for the delegates to exchange new ideas and experience face to face, to establish business or research relationship and to find global partners for future collaboration.

These proceedings collect the up-to-date, comprehensive and worldwide state-of-art knowledge on cutting edge development of academia as well as industries. All accepted papers were subjected to strict peer-reviewing by a panel of expert referees. The papers have been selected for these proceedings because of their quality and the relevance to the conference. We hope these proceedings will not only provide the readers a broad overview of the latest research results but also will provide the readers a valuable summary and reference in these fields.

The conference is supported by many universities, research institutes and colleges. Many professors played an important role in the successful holding of the conference, so we would like to take this opportunity to express our sincere gratitude and highest respects to them. They have worked very hard in reviewing papers and making valuable suggestions for the authors to improve their work. We also would like to express our gratitude to the external reviewers, for providing extra help in the review process, and to the authors for contributing their research result to the conference.

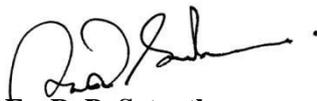
Since September 2021, the Organizing Committees have received more than 60 manuscript papers, and the papers cover all the aspects in Science and Technology. Finally, after review, about 13 papers were included to the proceedings of **ICIRST-2021**.

We would like to extend our appreciation to all participants in the conference for their great contribution to the success of **ICIRST-2021**. We would like to thank the keynote and individual speakers and all participating authors for their hard work and time. We also sincerely appreciate the work by the technical program committee and all reviewers, whose contributions made this conference possible. We would like to extend our thanks to all the referees for their constructive comments on all papers; especially, we would like to thank to organizing committee for their hard work.

Acknowledgement

IFERP is hosting the **International Conference on Innovative Research in Science and Technology (ICIRST-2021)** this year in month of November. The main objective of ICIRST-2021 is to grant the amazing opportunity to learn about groundbreaking developments in modern industry, talk through difficult workplace scenarios with peers who experience the same pain points, and experience enormous growth and development as a professional. There will be no shortage of continuous networking opportunities and informational sessions. The sessions serve as an excellent opportunity to soak up information from widely respected experts. Connecting with fellow professionals and sharing the success stories of your firm is an excellent way to build relations and become known as a thought leader.

I express my hearty gratitude to all my Colleagues, staffs, Professors, reviewers and members of organizing committee for their hearty and dedicated support to make this conference successful. I am also thankful to all our delegates for their pain staking effort to make this conference successful.



Er. R. B. Satpathy
Chief Executive Officer
Institute for Engineering Research and Publication (IFERP)

Keynote Speaker



Dr Tahmina Ajmal

Senior Lecturer in Engineering
Electronics, sensors, and data analytics
University of Bedfordshire Luton, United Kingdom



Dr. Sailesh Iyer

Professor and Dean
CSE/IT Department
Rai University, Ahmedabad, India



Mr. Deepak Shripat Mane

Senior Data Scientist/Enterprise Solution Architect
Tata Consultancy Services
Australia



Prof. Ir. Ts. Dr. Mohd Rizal Arshad

School of Electrical and Electronic Engineering
Engineering Campus, Universiti Sains Malaysia
Malaysia

Welcome Message



Nihad B. S. Baban, PhD, CEng

Associate Professor Of Geotechnical Engineering
Former Head Of Irrigation Eng. Dept., College Of Engineering
University Of Sulaimani, KRG, Iraq

It is a great pleasure and honor to welcome you to the “International Conference on Innovative Research in Science and Technology (ICIRST-21)” which will be held on 26th – 27th November 2021 in Ethiopia. This conference is a great opportunity to present and share your new ideas among the participants and global experts in various fields of science and technology. The aim of this conference is to deliberate and scientifically discuss various issues and problems facing science and technology projects which required to be identified in adapting and application of new innovations made in science and technology fields. Hence, it is a great opportunity for all global participants with different scientific backgrounds related to the fields of science and technology to share and collaborate on wide related knowledge. Participants from around the world are expected to actively participate in this event. In addition, I believe all delegates’ contributions will be unique and valuable for a better and more modern human life. Therefore, I am delighted to look forward to welcoming you to the International Conference on Innovative Research in Science and Technology (ICIRST-21).

Welcome Message



A.U. Ravi Shankar, Ph.D

Professor (HAG)

Department Of Civil Engineering

National Institute Of Technology Karnataka, India

It gives me immense pleasure and a great honor to Welcome all Delegates to the INTERNATIONAL CONFERENCE ON INNOVATIVE RESEARCH IN SCIENCE AND TECHNOLOGY (ICIRST-21) is being organized by Institute for Engineering Research and Publications (IFERP) from 26th -27th November 2021 in Ethiopia. This conference provides a platform for academia and Practicing Engineers and scientists to exchange their innovations in their respective fields. The main objective of this conference is to deliberate on important issues related to Science and Technology. I am very confident that the conference would serve as a useful platform for participants. I hope the Participants will get a chance to equip and update the knowledge of its respective fields. I wish all the very best to the conference organizers and contributors for a successful competition.

Welcome Message



Esmail Khalife

Lecturer

Mechanics AndMechatronics Engineering
Salahaddin University-Erbil

It's my pleasure to welcome you to the "International Conference on Innovative Research in Science and Technology (ICIRST-21)" which will be the host of several researchers from all around the world on 26th and 27th November 2021, as a Hybrid conference. This Conference is targeted to serve the academic society to provide an opportunity for everyone; who thinks our universe has just one key to unlock the questions and it is the science; to share their findings, results and their ideas to make more favorable world for everyone! Findings that could provide access to water, food, electricity, etc. millions of people all around the world. To be as a member of this academic community, I would be happy to invite you to participate in our conference, and I wish you success and pride.

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**International Conference on Innovative
Research in Science and Technology**

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26th-27th November, 2021

Addis Ababa, Ethiopia

(Virtual Conference)

ABSTRACTS

Organized by
Institute For Engineering Research and Publication (IFERP)

Security Enhanced Forward Compatible Integrated Asynchronous GPON and XGPON using Pseudo User Scheme

[1] **Karanvir Mangal**, [2] **Hardeep Singh**

[1] Department of Electronics and Communication Engineering, Thapar Institute of Engineering & Technology, Patiala, Punjab, India

[2] Department of Electronics and Communication Engineering, Thapar Institute of Engineering & Technology, Patiala, Punjab, India

Abstract—Security of the proposed Passive Optical Network is increased manifolds without any interference with the transmission line by co-transmitting Pseudo User Cross-Correlation based Diagonal Double Weight Codes, making detection obscure at eavesdropper receiver.

Index Terms—Passive optical networks (PON), Diagonal double weight (DDW), Pseudo user scheme (PUS), Continuous wave (CW), X Gigabit passive optical networks (XGPON), Optical network unit (ONU), Single mode fiber (SMF), Spectral amplitude coding optical code division multiple access (SAC-OCDMA), Optical line terminal (OLT), Bit error rate (BER), Downstream (DS), Upstream (US)

I. INTRODUCTION

Until today, most of the work has been reported for the improvement of capacity and transmission rate in PONs, although data confidentiality of available data is major work which needs to be addressed either. Eavesdropping seriously influences the performance of the system and exposes the confidential information of authorized user. In this paper, a novel security enhanced pseudo user scheme against eavesdropping in forward compatible asymmetrical GPON/XGPON is presented which is less complicated than techniques used in [1-2].

II. PSEUDO USER SCHEME PRINCIPLE IN FORWARD COMPATIBLE GPON/XGPON

In order to provide extra security to a system, pseudo random users are transmitted along with GPON and XGPON, hence it becomes extremely difficult for eavesdropper to get correct information. Therefore, DDW codes are incorporated in the system. Probability of GPON (P(GPON)) for ‘0’ and ‘1’ is 1/2 and if PUS at same data rate is employed in the system, then total cases become $P(\text{Total})=P(\text{GPON}) \times P(\text{PUS})=1/4$ while the data rate of XGPON is 4 times the data rate of GPON, so total number of cases at which 1s and 0s occur at same time is 1/16 (0000 to 1111). Thus, for XGPON with PUS, the total cases become $P(\text{XGPON}) \times P(\text{PUS})=1/16 \times 1/16$ (1/16 because PUS and XGPON are operated at 10 Gbps) = 1/256. Hence total number of cases including GPON, XGPON and PUSs becomes 1/1024. Hence, it is very hard for the eavesdropper to grasp correct information.

III. SIMULATION SETUP

A security enhanced forward compatible GPON/XGPON system is demonstrated under the existence of eavesdropper as depicted in Fig. 1. A CW laser at wavelength of 1490 nm is incorporated in the system for GPON transmitter.

Similarly, a laser at wavelength of 1577 nm is employed for XGPON transmitter. Bit streams are generated from pseudo random bit sequence generator and multiplexed signals are fed to bi-directional fiber (SMF-28). After transmission over SMF, signals are passed through two optical filters so that GPON and XGPON wavelengths get separated. Both the wavelengths are made to fall on photo-detectors and noise suppression is done with low pass filters. Decision of quality received and errors are observed from BER analyzer. Wavelengths 1270 nm (XGPON) and 1310 nm (GPON) are used for upstream. At downstream, two pumps at 1240 nm and 1206 nm are used to give Raman gain to upstream wavelengths. An upstream decoder with photo-detector, low pass filter and 3R generator is employed at receiver end.

For the integration of PUS scheme with aforementioned system, a spectral amplitude coded OCDMA system is incorporated. One SAC-OCDMA user is assigned for GPON and another for XGPON to boost the security of the system both in OLT and ONU. A system is proposed with DDW codes [3] having cross-correlation 1.

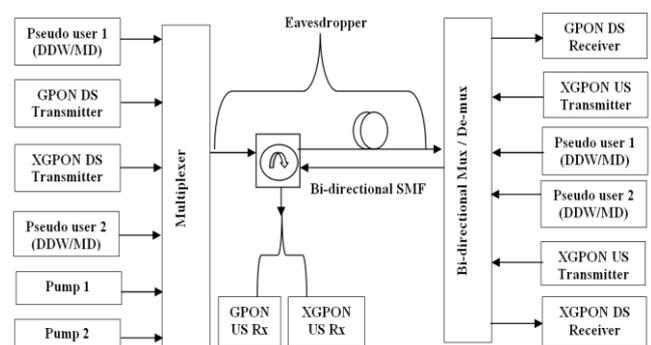


Fig. 1. Block diagram of security enhanced forward compatible co-existed GPON/XGPON system

IV. RESULTS AND DISCUSSIONS

Investigation of the proposed system has been done using simulation software Optiwaves's Optisystem™. Table I. shows values of the Q factor and Table II. shows BER with the variation of the launched power at the eavesdropper. Readings are observed in with and without pseudo random user scheme at eavesdropper's receiver.

Obviously, more Q factor and less BER are observed at the eavesdropper in the system where PUS is not used. This is due to less scrambling of data because no false user is there to minimize the probability of detection for the unauthentic user. However, less Q factor and more BER are seen at the eavesdropper when PUS is included.

TABLE I. VALUES OF Q FACTOR VERSUS LAUNCHED POWER AT EAVESDROPPER

Launched Power (dBm)	Q Factor (Eavesdropper in without PUS system)	Q Factor (Eavesdropper in with PUS system)
-2	5.55	3.16
0	6.03	3.60
2	6.64	4.03
4	7.41	4.37
6	8.38	4.57

Significantly, with increase in the input power of authentic users, probability of code word detection at eavesdropper's decoder increases. Presence of pseudo user does not compromise with quality of signal received by the authentic user. Therefore, for enhanced security, PUS should be included in the system.

TABLE II. VALUES OF BER VERSUS LAUNCHED POWER AT EAVESDROPPER

Launched Power (dBm)	BER (Eavesdropper in without PUS system)	BER (Eavesdropper in with PUS system)
-2	10^{-8}	10^{-4}
0	10^{-10}	10^{-4}
2	10^{-11}	10^{-5}
4	10^{-14}	10^{-6}
6	10^{-17}	10^{-6}

V. CONCLUSIONS

In this paper, an integrated novel security enhanced forward compatible GPON/XGPON is presented with pseudo random scheme to resolve the network breaking issue because of eavesdropping. The presence of pseudo user with false wavelength makes deciphering the information bits tedious for eavesdropper. Thus, proposed system is flexible, security enhanced and reliable for PON systems.

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Development of an Internet of Things - Based Fish Feeding Robot Prototype with a Water Level Monitoring System for Pond Use

^[1]Abdul Kadir Muhammad, ^[2]Dermawan

^{[1][2]} Center for Mechatronics and Control System, Mechanical Engineering Department, State Polytechnic of Ujung Pandang, Indonesia

Abstract—The purpose of this study is to develop an internet of things - based fish feeding robot prototype that equipped with a water level monitoring system for pond use. The robot prototype presented in this paper consists of a feed storeroom tank, a feed distribution mechanism, a feed ejection mechanism, an ejector position turning mechanism, a water level monitoring system, a base and a solar panel system for energy sources. The feed storage tank and the water monitoring system used an ultrasonic sensor, respectively. The three mechanisms used a DC motor actuator, respectively. An internet of things – based control and monitoring system was designed to control the robot and to monitor level of feed in the tank as well as water in the pond. Performances of the robot prototype were tested through laboratory scale experiments. The result of the conducted experiments are presented and discussed.

Index Terms—Aquaculture robot, Fish feeding robot, Internet of Things application, water level monitoring system

I. INTRODUCTION

One of the fastest-growing food sectors in the world is aquaculture [1] [2]. In aquaculture activities, the frequency of feeding fish is very important because it will affect the amount of feed consumed, feed efficiency and the possibility of environmental contamination. Environmental pollution will affect the health and survival of fish. However, the current feeding activity is still mostly done manually so it is not effective because the distribution of feed is uneven and sometimes not on time. Furthermore, monitoring of water level of pond is another important thing. Sometimes the water level rises after heavy rains which if handled too late can cause the pond to overflow, especially in tropical area.

In the last decade, a number of fish feeding automatic mechanism have been investigated by researchers [3 – 7]. Wei et al [3] and Osueke et al [4] designed automatic fish feeder machine that focused on design and construction. Nasir Uddin et al [5] investigated automatic fish feeder with water temperature monitoring whereas Balagi et al [6] investigate automatic fish feeding with pH and temperature monitoring. Karningsih et al [7] develop automatic fish feeding system for an offshore aquaculture unit.

The purpose of this study is to develop an internet of things - based fish feeding robot prototype that equipped with a water level monitoring system for pond use. Method to achieve the purpose was design and manufactures the robot as well as testing and robot prototype refinement.

The system used in this paper consists of a feed storage tank, a feed distribution mechanism, a feed ejection mechanism, an ejector position turning mechanism, a base and a solar panel system for energy sources. The three mechanisms used a DC motor actuator, respectively. Finally, the performances of the robot prototype were tested in a laboratory scale environment.

II. DEVELOPMENT OF AN INTERNET - BASED FISH FEEDING ROBOT PROTOTYPE WITH A WATER LEVEL MONITORING SYSTEM

A. Mechanisms Design

Figure 1 shows the model of the fish feeding robot prototype. The system of the robot consist of a feed storage tank, a feed distribution mechanism, a feed ejection mechanism, an ejector position turning mechanism, a water level monitoring system, a base and a solar panel system for energy sources, as shown in Fig.2.



Fig. 1. The 3-D model of the Fish Feeding Robot Prototype

Figure 3 shows the three mechanisms. The mechanisms used a DC motor actuator respectively. The feed storage tank made of water drums with diameter of 38[cm] and height of 65 [cm]. On the lid of the tank, an ultrasonic sensor was installed to measure percentage of feed in the tank.

The feed distribution mechanism functions to regulate the flow of feed from the tank to the feed thrower according to the desired portion. The feed distribution mechanism consists of a valve, two cylinders as feed channel with diameter of 9 [cm] and height of 7 [cm], and a DC motor. The motor moved the valve from the point of drop of the feed to the input of the feed ejector with a rotation angle of 360 degrees in a clockwise direction. The motor would stop shortly after turning 180 degrees and then would rotate again. The valve served to move feed from the tank on and off, measured the portion of

feed, and then led the feed to the ejector to be thrown into the pond. The quantity of feed can be set based on the number of rotations of 180°. The distribution mechanism also played a role in regulating the rhythm of the feed to be ejected so that there was no buildup in the ejection mechanism, and did not burden the ejector motor.

The feed ejection mechanism consists of a planetary gear DC motor and used a propeller connected directly to the motor shaft to eject the feed. At maximum speed the ejector be able to throw up to 9 [m] forward. Furthermore, the ejector position turning mechanism functions to change the direction of the ejector by an angle of 90 degrees. To the right 45 degrees and to the left 45 degrees so that the feed can reach a wider area and make feeding evenly distributed. The ejector position turning mechanism consists of a cylinder with diameter of 9 [cm], a sprocket and a DC servo motor. The sprocket attached to the side while the lower end of the turning mechanism was connected to the ejection mechanism. The turning mechanism and the driving motor were connected using a chain so that they move in the direction of rotation of the driving motor. At the base, a sliding device was added to reduce friction when changing the direction of the ejector. The mechanism was driven by the DC servo motor.

The charging process uses a 20 WP solar panel. A 12 [V] battery with a current of 7.5 [A] was used. The solar panel was connected to the charge controller. If the battery is fully charged then the solar panel charging automatically stops.



Fig.2. Experimental fish feeding robot prototype with a water level monitoring system developed in this research

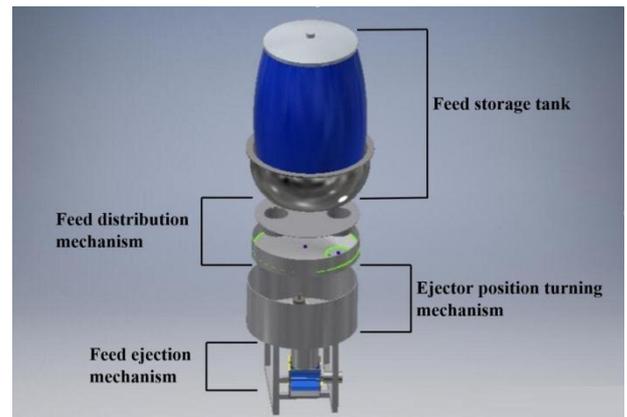


Fig.3. Feed storage tank and the three mechanisms of the fish feeding robot prototype

B. Water Level Monitoring System

Figure 4 shows the water level monitoring system developed in this research. The monitoring system consists of a tube that was dipped to water, and an ultrasonic sensor to measure the level of water in pond. Water level of the pond can be monitored through a smart phone by online.

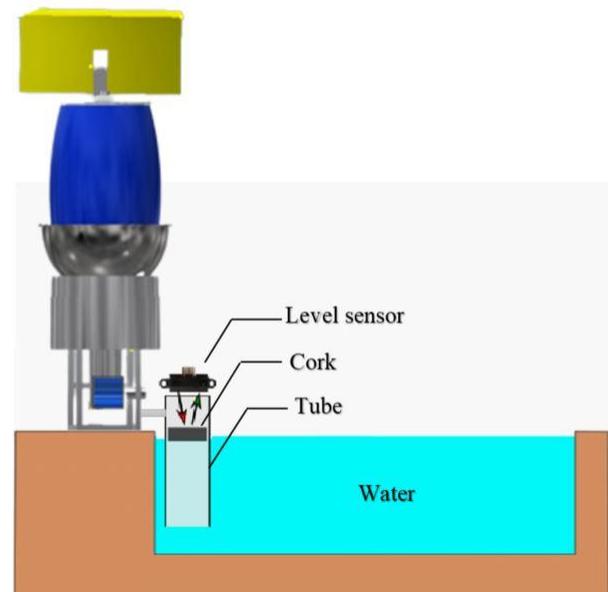


Fig.4. The water level monitoring system

C. Configuration of Control and Information Systems

Figure 5 shows system configuration of the internet of things – based fish feeding robot prototype with water level monitoring system. The robot was controlled by ESP32 Module based on set point that set in computer. Three motor drivers were used to drive three DC motor that rotated for the three mechanisms. A relay was used to switch on and off the driver. A solar panel and a solar charge controller were used as the energy source system. A battery of 12 [V] was used to store power generated by the solar panel system. An adaptor with outputs of 5 [V] and 5 [V] was used to step down the voltage from the battery. The ESP32 module is connected to a smart phone through

internet. Level of feed in the storage tank, level of water and level of battery can be monitored through the smart phone by online.

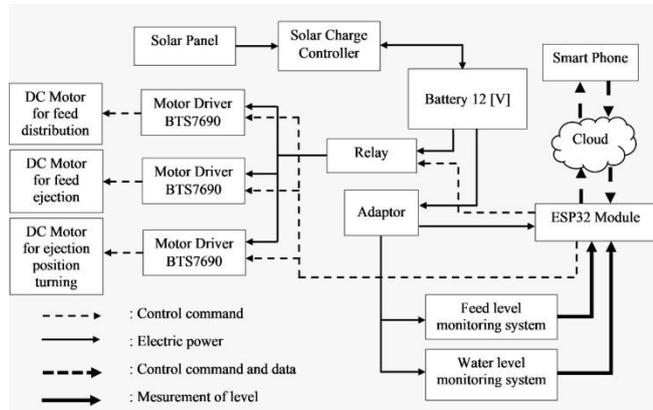


Fig.5. System configuration of the internet of things – based fish feeding robot prototype with a water level monitoring system developed in this research

III. EXPERIMENTS

A. Experimental Method

The experiment was conducted on a horizontal surface. The experiment goal was to test the performances of the robot in term of mass of ejected feed, feed throw distance and monitoring through information the information system. The first experiment was conducted to test performance of the robot in term of mass of ejected feed. Two containers were installed alternately under the distribution feed mechanism to accommodate the outgoing feed. The feed was then weighed to determine the mass of feed that comes out. This experiment was carried out for 1 [minute] with a sampling time of 10 [seconds]. Each sample taken was then weighed.

The second experiment was conducted to test the performance of the robot in terms of feed throw distance. The Robot prototype ejected the feed while rotating 45 degrees to the right and 45 degrees to the left. This experiment was carried out for 1 [minute] with a sampling time of 10 [seconds]. Feed throw distance was measured every 1 sample.

Level of feed in the storage tank, level of water and level of battery can be monitored through the smart phone by online during the experiments.

B. Experimental Results

Figure 6 shows the performance of the robot prototype in term of mass of ejected feed. It can be seen in Fig.6 that masses of ejected feed are consistence in range of 183 [g] to 185 [g]. Figure 7 shows the performance of the robot prototype in term of feed throw distance. It can be seen in Fig.6 that feed throw distances are consistence in range of 5.5 [m] to 5.8 [m]. The experimental results revealed that the robot can work consistently. A captured window of the smart phone showed the monitoring results can be seen in Fig.8.

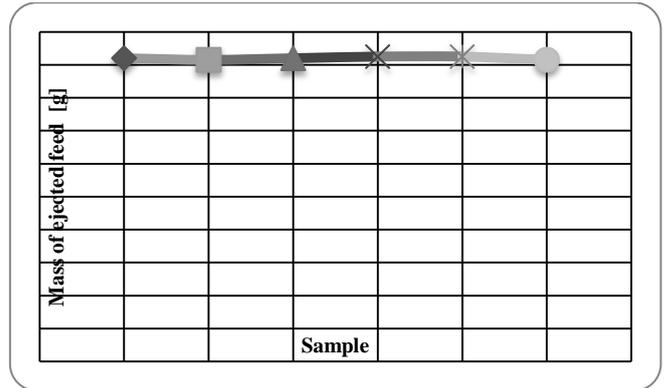


Fig.6. Mass of ejected feed experiment performance of the fish feeding robot prototype

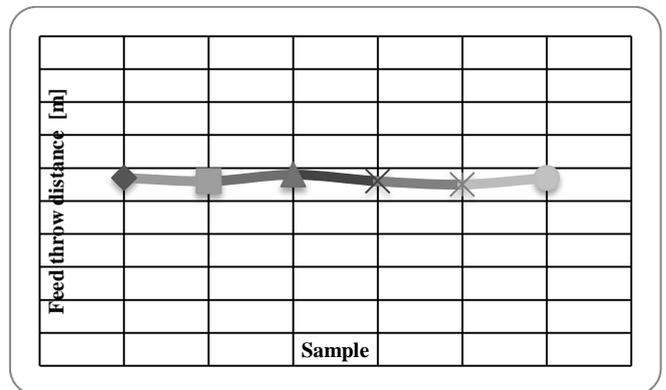


Fig.7. Feed throw distance experiment performance of the fish feeding robot prototype



Fig.8. Monitoring of the internet of things – based fish feeding robot prototype with a water level monitoring system captured from the used smart phone

IV. CONCLUSION

In this present study, the internet of things – based fish feeding robot prototype with the water level monitoring system and solar panel system was developed. Three mechanisms namely the feed distribution mechanism, the feed ejection mechanism and the ejector position turning mechanism which are main part of the feeding system were developed effectively. The monitoring systems of feed level in the storage tank, water level and battery level have been developed and equipped to the robot. Performances of the robot prototype were tested through laboratory scale experiments. The experimental results revealed that the robot can work consistently.

V. ACKNOWLEDGMENT

This work was supported by Ministry of Education, Culture, Research and Technology, Republic of Indonesia, with Grant Number of 099/E4.1/AK.PT/2021.

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Growth, Mortality and Recruitment Pattern of *Atrina Pectinata* (Linnaeus, 1767) in Sorsogon Bay, Philippines

[¹] Maria Aurea B. Guiriba, [²] Ma. Vivian C. Camacho

[¹] Bicol University Research Development and Management Division, Legazpi City, Philippines

[²] Institute of Biological Sciences, University of the Philippines Los Baños, Los Baños, Laguna, Philippines

Abstract— A stock assessment study of *Atrina pectinata* in Sorsogon Bay, Philippines was conducted to determine growth parameters of the species and the status of the fishery given the current harvesting efforts of this resources to the bay. Length-frequency of 1,200 individuals of *baluko* sampled for 12 months was analysed using FAO-ICLARM Statistical Analysis Tools. The growth estimates yielded mean L and K values of 36.90 cm and 1.1 year⁻¹, respectively. *A. pectinata* exhibits continuous maturation with peak month of spawning in September. Catch curve analysis showed total mortality (Z) value of 4.37 year⁻¹; fishing mortality (F) was 2.97 year⁻¹. The current exploitation level (E_{curr} 0.51) exceeded the optimum level ($E_{50} = 0.37$) by 37.84%, suggesting that *A. pectinata* is highly exploited. A closed season from August to November during breeding season of *baluko*, and a reduction in number of boats operating in Sorsogon Bay to decrease fishing effort are recommended to prevent its further decline.

Index Terms— *Atrina pectinata*, Population growth; Mortality; Recruitment pattern

I. INTRODUCTION

Atrina pectinata (Linnaeus, 1767), also known as comb pen shell, belongs to the Pinnidae family of order Ptenoidea, and Genus *Atrina*. The pen shell *Atrina pectinata* is one of the commercially important edible bivalves in East Asian countries including Korea, China, and Japan (Yoo, 1976; Kwon *et al.*, 1993; Chung *et al.*, 2006). Bivalves, specifically Pinnidae, are a popular food source and have high commercial value in a number of Asia-Pacific countries (Yu *et al.*, 2004). The meat of *A. pectinata* is eaten in Japan, Polynesia and a number of islands in the Indo-Pacific region (Rosewater *et al.*, 1961). This benthic species is widely distributed in the Indo-West Pacific, from south eastern Africa to Melanesia and New Zealand, north to Japan and South Wales (Rosewater 1961; FAO 1998; Liu *et al.* 2011). In the Philippines, *A. pectinata* is known to inhabit the waters of Panay, Puerto Galera, Palawan, Batangas, Bohol, Camarines Sur and Sorsogon and form part of commercially-exploited shellfishes in some fishing grounds of these provinces (FAO, 1998).

Sorsogon Bay fishing ground is endowed with rich fishery assets, such as small pelagics, demersal fishes, and shell fishes. An enclosed bay surrounded by five coastal municipalities; namely, Casiguran, Juban, Castilla, Magallanes, and Sorsogon. The resource and ecological assessment (REA) of Sorsogon Bay, conducted by Cinco *et al.*, (1995) estimated the fishery production of Sorsogon Bay at about 5,585.62 metric tons.

As early as 1972, Sorsogon Bay was already declared as biologically overfished in the study on relevance of the proposed trawl ban conducted by Ordoñez *et al.* (1972). The results of the REA conducted in the bay also showed high exploitation rates and high fishing mortalities of several dominant demersal species (Olaño *et al.*, 2003). With the decline of finfish catch along the bay, fisher folks

turned to shellfish collection including, *Placuna placenta*, *Paphia undulata*, and *Atrina pectinata*.

Many studies have been conducted on exploitation of bivalves along Sorsogon Bay (Del Mundo, 1992; Borbe and Soliman, 1999; Dioneda and Soliman, 2004;2008). However, research data for stock structure and reproductive biology of *A. pectinata* are extremely scarce. Available information is limited to distribution and phylogeography of Philippine Pinnids (Lemer *et al.*, 2016), and records of small population in Camarines Sur (Nieves, 2015).

The population of *A. pectinata* in Sorsogon Bay has not been adequately studied despite its economic importance of the species in the area. A baseline information that would generate yield predictions and the current fishing effort to developed a management strategy leading to the rational exploitation of this species. This should be complemented with other biological data relevant to the formulation of conservation measures applicable to the fishery. In this study we determined the growth parameters, recruitment patterns, mortality and exploitation rate of *A. pectinata*.

II. MATERIALS AND METHOD

Samples were collected from the three collection sites of *A. pectinata* along Sorsogon Bay; namely, Sorsogon City, Juban, and Casiguran municipal waters (Figure 2). The bivalves were found aggregated in muddy portion of the bay (dakal-dakal). Surface water temperature during the study period fluctuates from 27.00 to 31.75 °C with a mean of 29.33°C, and the salinity ranged from 29.75 to 35.00 psu.

III. COLLECTION OF SAMPLES

Monthly monitoring of landed *A. pectinata* catch was conducted twice a month for 12 months in major landing sites of Sorsogon City Pier site and Bitan-o. An analytic length-based fish stock assessment technique was used to obtain population growth and other stock assessment parameters using the software package FISAT II (FAO-

ICLARM Stock Assessment Tools) (Gayanilo et al., 1992). Length measurements were obtained from samples taken from unsorted catches from the identified major landing sites. Shell height (SH) were measured from the umbo to the anterior margin of the shell using a modified fish measuring board with a ruler (0.01 cm) while the total weight (TW) were measured using a portable electronic balance (0.01 g).



Figure 1. Size measurement of *Atrina pectinata* caught in Sorsogon Bay, Sorsogon, Philippines.

IV. DATA ANALYSIS

The relationship SH and TW were examined through the power regression analysis expressed as:

$$y = a * x^b$$

where, y = the dependent variable
 a = is the intercept
 x = is the independent variable (or covariate)
 b = is the slope of regression coefficient.

Estimation of growth rate

The growth rate of *A. pectinata* were determined using the von Bertalanffy Growth Function (VBGF) expressed as $L_t = L_{\infty}[1 - e^{-K(t-t_0)}]$ where L_{∞} is asymptotic length in millimetres, K is the growth constant, L_t is the length at age t in years, and t_0 is the theoretical age of the animal at a length equal to zero if it had grown according to the VBGF (Pauly, 1982). The parameters in the VBGF have biological meaning although the specific physiological derivation of the equation may not exactly be fulfilled in practice (Gulland, 1983). Here, L_{∞} is the maximum size that the animal would reach if it were not caught by a fishing gear, did not fall prey to a predator, or die of a disease. K describes the constant rate per year at which it approaches this limiting size and may therefore be considered a measure of the rate at which the animal grows. The von Bertalanffy growth model has found wide application in fisheries science, most notably in the analysis of fish growth. It has also found application in bivalve and other invertebrate studies (Pauly and Calumpong, 1984; de l Norte, 1988; Vakily, 1989, Vakily, 1992). The best combination of L_{∞} , and K was derived using the Powell-Wetherall plot to obtain the initial estimates of L_{∞} whereas preliminary estimates of K were obtained using the combination of ELEFAN I and Shepherd's method of scanning for K values (Gayanilo et al., 1992). By varying

the parameters of the VBGF the growth curve in ELEFAN I is iteratively fitted to the restructured length-frequency data set such that it passes through most peaks (positive points) and avoids most troughs (negative points) until it accumulates the highest numbers of points (R_n value) that best explain the specific structure of the length-frequency samples (Pauly, 1987).

Estimation of mortality and exploitation rate

Total mortality (Z) of bivalve population was estimated from the length-frequency data. Z corresponds to the negative slope of the linear regression of the descending arm of the catch curve (Gayanilo and Pauly, 1997). Natural mortality (M) is the instantaneous natural mortality coefficient or death caused by predation, old age, or pollution. Fishing mortality (F) was estimated by subtracting M from Z . Exploitation rate (E) was estimated by dividing the F by Z (Gayanilo and Pauly, 1997).

V. RESULTS AND DISCUSSION

Growth

A total of 1,200 *A. pectinata* were measured for length analysis. Mean shell height SH (\pm SD) of *A. pectinata* was 22.9 ± 5 cm (combined sexes) ranging from 12.2 to 35 cm. Noticeably, juvenile *A. pectinata* was captured during the *baluko* fishing, suggesting over fishing (Ingles, 2004 and Nieves et al 2013). The power regression between SH and total weight (TW) is shown in Figure 2.

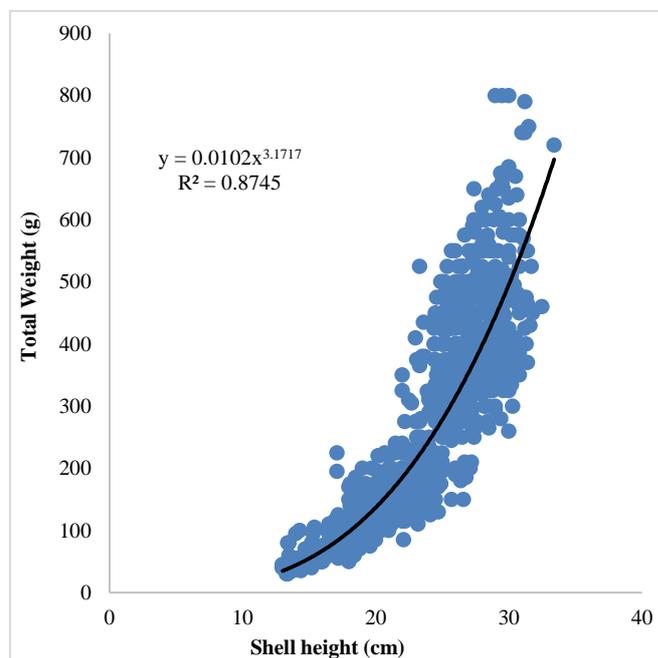


Figure 2. Relationship between shell height and total weight of *Atrina pectinata* in Sorsogon Bay.

Regression analysis between shell height and total weight of *A. pectinata* showed positive power regression with a high correlation coefficient value (R^2) of 0.87. The results implied that the weight of the species was positively correlated with shell height. All allometric relationships were computed between sizes – wet weight measurements of pen shell, *A. pectinata* caught in Sorsogon Bay. The

slope of height – weight regression was found less than 3 (negative allometry). This result means that the bivalve weight increase at a comparatively lesser rate than the height. Similar results were reported for the scallop species in a previous study in Gulf of Gerence, Aegean Sea (Ozvarol and Gokoglu, 2013) and in Lanveoc, Bay of Brest, France, (Shafee *et al.* 1981). In fisheries management, length frequency is used in determining size-at-age, catch-at-age and other analyses for marine organisms. It is easily measured and existing program package developed is mainly for the analysis of length-based data such as FAO-ICLARM Fish Stock Assessment Tools (FiSAT II).

Figure 3 shows the size distribution of *A. pectinata* measured from August 2015 to July 2016. It can be noted that majority of the catch from August to December 2015 had sizes ranging from 23 cm to 32 cm while sizes ranging from 12.2 cm to 22 cm were mostly caught from January to May 2016. Moreover, sizes less than 15 cm were caught in the months of November 2015, January-June 2016. These show that *A. pectinata* are harvested right after they reach a year old (14 cm) (Ryu, *et al.*, 2001), which suggest that the collected or harvested *baluko* may have not yet contributed to spawning to increase recruits before they have been caught (Ryu *et al.*, 2001; Dioneda *et al.*, 2008).

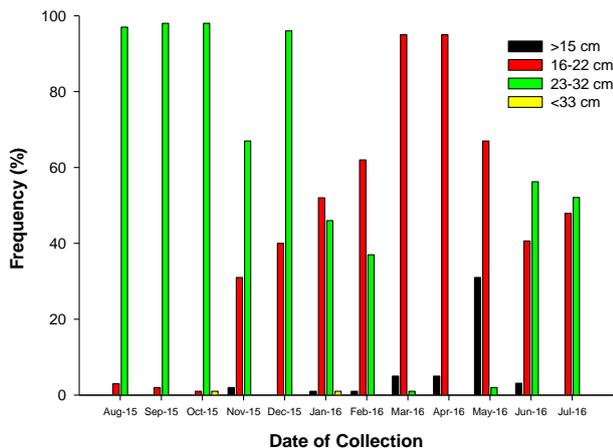


Figure 3. Size distribution of *Atrina pectinata* collected from Sorsogon Bay, Philippines from August 2015 to July 2016.

Growth Parameter

The growth parameters were estimated using the FAO ICLARM Stock Assessment Tools, (Gayanilo *et al.*, 1996). The length frequency data were inputted to the program followed by the estimation and optimization of growth parameters L_{∞} (Maximum attainable length of the species) and the K (growth constant) under the ELEFAN 1 routines.

The resulting growth and population decay models fitted for the data of *A. pectinata* are, $L = 36.90\text{cm} (1 - e^{-1.1(t)})$ and $N_t = N_0 e^{-3.73(t)}$, respectively. The L_{∞} value (36.90 cm) is close to the maximum observed lengths (35.00 cm) during the sampling, confirming that samples collected are representatives of the stocks studied. Likewise, the progression of the modes or peaks in the length-frequencies

can be reasonably traced with a smooth growth curve (Figure 6) that vouches for the suitability of the length frequencies for the analysis. It is a crucial aspect in the use of length-based assessment method for finfish and shellfish, but more particularly for the latter as their growth is stepwise rather than a smooth curve (Dioneda and Soliman, 2008).

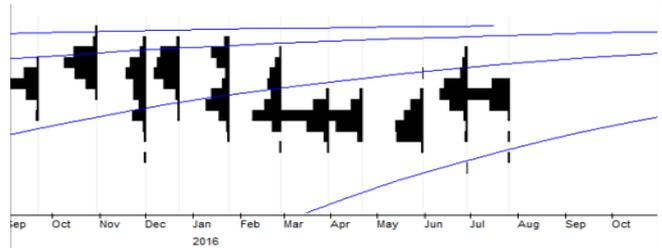


Figure 4. Growth curves traceable onto the length frequencies.

The $L_{\infty}=36.90$ cm computed in this study represents the average maximum attainable length of the bivalve stock if it is allowed to grow to its very old age. The growth constant ($K=1.1$) is typical of a fast growing species such as bivalves. The K value of 1.1 represents a steep slope in a length-age profile. This indicates that the pen shell could reach the L_{∞} faster, hence fast growing. There were no stock assessment study specifically reporting estimates of biological and mortality parameters for *A. pectinata*. Population genetics of the species in the waters of Japan and China were worked out by Liu *et al* (2011) and in Korean waters by An *et al* (2012). Likewise, the diversity and reproductive accounts of distant species *Pinna* species in Malaysian waters were studied by Idris *et al.*, (2008).

Mortality

Using the estimates of Growth parameters L_{∞} and K, mortality parameters were determined under the ASSESS menu through the Length-Converted Catch Curve (Figure 7).

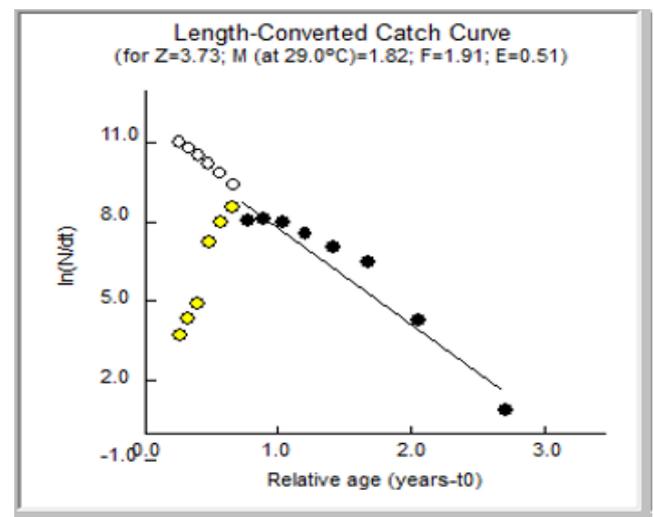


Figure 5. The length-converted catch curve analysis for *Atrina pectinata*.

The estimated total mortality (Z) was estimated to be at 3.73. Natural mortality was estimated at 1.82, based on Pauly's equation (Pauly 1980), relating natural mortality to von Bertalanffy growth parameters (L_{∞} and K) and mean environmental temperature (29°C). Conceptually, M and F combines to form Z ($Z=M+F$). Fishing mortality then can be computed via $F=Z-M$ which yields $F=1.91$.

From the mortality parameter estimates, exploitation level (E) was computed at 0.51 from the equation $E=F/Z$. Conventional Stock Assessment concepts for tropical species considers E range of 0.3 to 0.5 to be optimum and within the sustainable level (Beddington and Cooke, 1983 and Gulland, 1971). Exploitation values below or exceeding this optimum range may mean under exploitation and overexploitation, respectively. Since the computed E (0.51) exceeds 0.50, the bivalve is clearly subjected to intense fishing pressure. The tendency to maximally harvest the bivalves practiced in Sorsogon Bay whenever pen shell population rebound appear in the Bay is consistent to this high E value estimated.

Length at first capture and recruitment pattern

As an extension routine of the mortality parameters-estimating catch curve analysis, probability of capture analysis was carried-out to establish selection patterns of fisheries based on length sizes. From here, the shell height at first capture (SH_{50}) was estimated to be 19.44 cm. At this length, 50% of a given pen shell population would be caught by the fisheries and the remaining 50% would remain as surviving segment of the population. The computed SH_{50} was 19.44 cm, which is considered sexually mature based from histological analysis. This is smaller than the reported length at first maturity of 20.10 cm (Chung *et al.*, 2012). This means that the pen shell stock in the Bay is subjected to intense fishing pressure, that even the smaller segments of the population, at smaller sizes are harvested even before they have contributed to spawning. A harvest scheme like this is unsustainable as it operates beyond the regenerative capacity.

The Relative Yield-Per-Recruit ($Y'-PR$) shows the resulting relative yield at a given level of effort and also the impact of such level of effort to the overall standing stock biomass. Figure 10 shows the result of the $Y'-PR$ analysis, yielding the three exploitation level indices (E_{10} , E_{50} and E_{max}). These are options to fine-tune the computed exploitation rate (E_{curr} or E_{50}). The current exploitation level ($E_{curr}=0.51$) exceeded the optimum E ($E_{50} = 0.37$) by 37.84%. This can be thought of as an excess exploitation rate (i.e., fishing effort) relative to the optimum (E_{50}) to produce sustained yield. In essence, this is excess fishing intensity will be eased-up in the fisheries management plans. Table 3 shows the impacts to yield per recruit and biomass per recruit of the pen shell when E_{curr} is adjusted to any of the three exploitation indices. It is interesting to note that yield per recruit from the E_{curr} produces around 21% increase from the E_{50} . Relative biomass per recruit however would be reduced to 37% if E_{curr} is maintained. This translates to significant reduction of surviving biomass, hence reducing the capacity of the pen shell to support a viable population

that would support the fisheries on a year to year basis. Opting to adjust the E_{curr} to either E_{10} or E_{max} would be more unwise. Although it will generate 13-15.79% increase in Yield per recruit, it would further reduce the surviving biomass to just 24 and 12%, respectively. From the stand point of sustainability, it is then imperative for the fisheries of pen shell in Sorsogon Bay to reduce effort relative to excess and opt for the E_{50} option or optimum level of exploitation.

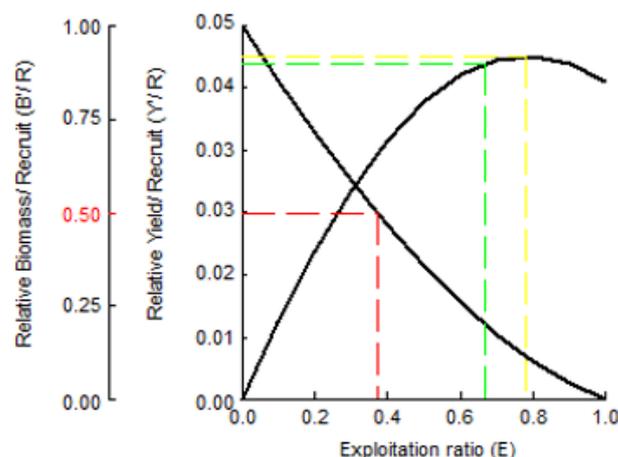


Figure 6. Yield and biomass per recruit of the *Atrina pectinata*.

Table 1. Impact of changes in E level to relative $Y'-PR$ of *Atrina pectinata* stock.

Reference	E value	$Y'-PR$	Percent Difference	Relative 'B-PR	
E_{curr}	0.51	0.038		0.37	
E_{50}	0.372	0.03	-0.008	-21.053	0.5
E_{10}	0.668	0.043	0.005	13.158	0.24
E_{max}	0.778	0.044	0.006	15.789	0.12

VI. SUMMARY AND CONCLUSIONS

Regression analysis between shell height and total weight showed positive linear regression with a high correlation coefficient (r^2) of 0.87. The results implied that the weight of the bivalve was positively correlated with the increase of its shell height. Meanwhile, the average catch size distribution revealed that from August to December 2015, matured bivalves are caught on their two-year life cycle, thus, *A. pectinata* caught during the months of January to July 2016 were mostly on their first year life cycle since their shell height sizes ranged from 12.2 to 20 cm. According to this study, length at first capture (L_{50}) is 19.44 cm, larger than the reported size at first maturity which is at 15.81 cm in shell height (SH) in females and 15.72 cm SH in males. The downtrend in average catch sizes revealed that the bivalves were caught at the onset of their reproductive maturity, thus, can no longer contribute to stock replenishment of *A. pectinata* in the bay. This can be attributed to the open access scheme of "hookah" fishers from Sorsogon Bay and other compressor-fishers from Masbate and Visayas. Institutional arrangements and

stakeholders' consensus is of paramount importance to manage the critical *A. pectinata* fisheries in Sorsogon Bay.

Corollarily to this, *A. pectinata* stocks in Sorsogon Bay is subjected to intense fishing, with high exploitation rate beyond the sustainable level. Considering the findings of the negative exploitation experienced in the bivalve bed as evidenced by high exploitation rate ($E_{curr} = 0.51$) and from the observed declining average catch size of *A. pectinata* in the study, it is evidenced by the activity of the "hookah" fishers that they were at harvesting frenzy in the months of August–November when the pen shells were at spawning stage. In Sorsogon Bay, two forms of biological overfishing are observed, these are; (1) "recruitment overfishing" where potential breeders are being fished, thus affecting the future population of the animal and (2) "growth overfishing" occurring when pen shell are caught before they have a chance to grow or when immature individuals are caught as reflected in the January to May catch sizes.

VII. RECOMMENDATIONS

Given the present status of the *A. pectinata* fisheries along Sorsogon Bay, the general inadequacy of law enforcement to protect it and the lack of local management mechanisms to protect important resources in the bay, it is imperative that immediate measures should be implemented. Based on the reproductive seasonality of *baluko*, analytical length-based stock assessment and gear inventory revealed in this study, the following are recommended as specific management mechanisms:

1. Reduction of excess fishing effort to 21% following the prescribed harvestable size of 22.5 cm, granting preferential use right to the registered resident fishers of Sorsogon to exploit the bivalve and establishment of common landing/buying station.

The size limit of 22.5 cm set by the City is sustainable as it allows 2-3 spawning period for the bivalve, contributing to the recruits. This in effect highlights fishing productivity within the regenerative capacity of the species. The size limit shall be strictly enforced alongside the reduction of fishing effort proportional to the excess. The exploitation of resident fishers to demarcated fishing areas, as stipulated in the Amended Fishery Code (RA 10654) shall be invoked in giving the locals priority in exploiting its own fishery resources.

2. Establishment of Closed Season from August to December when most of the bivalves are in breeding season. This will ensure the future stock and prevent depletion of the parent stock.

3. Activation of the established reserve area/sanctuary

Marine reserve area/ sanctuary is a recognized effective strategy in protecting and enhancing coastal productivity. Portion of Sorsogon City, Juban, and Casiguran where the *Baluko* is known to thrive shall also be declared. Establishment of physical markers such as buoys and floaters should be implemented. Prohibition of gathering inside the sanctuary shall be strictly implemented.

4. Mariculture trials

To lessen the fishing pressure on the *A. pectinata* beds, mariculture trials shall be explored in many accessible areas in the bay. This is a form of assisting nature to meet the increasing demand for the bivalve. Hatchery techniques shall also be explored to provide readily available seeds.

5. Address water quality deterioration of Sorsogon Bay

Major issue regarding pollution includes deterioration of the water quality due to lack of adequate sanitary facilities and poor implementation of Ecological Solid Waste Management Act of 2000 (RA 9003). Review the Environmental clearances of business industries surrounding the bay should be conducted.

6. Creation of non-fishery extractive livelihood among coastal Barangays such as tapping the resources coming from NGOs, civic groups and various governmental agencies in creating a lucrative livelihood for the misplaced fisher folks during closed season.

Continued research and monitoring shall be undertaken especially in human component of the fishery, reproductive biology, lifecycle and feeding biology of *A. pectinata* to fully understand the potential of this species and other vital aspects that would enable holistic approach in rationally exploiting and managing the bivalve.

VIII. ACKNOWLEDGEMENT

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Establishing a Quality and Processes System for Portable Air Conditioner SMAC

[¹] G. Shesha Sai, [²] Dr. Suresh Akella, [³] Mr. P. Vishwak Parth Reddy, [⁴] Palla Vishal Reddy

[¹] Junior Design Engineer, Puzzolona Machinery Fabricators, Hyderabad, India

[²] Professor, Sreyas Institute of Engineering and Technology, Hyderabad, India

[³] Intermediate Student & Research Scholar, Sreyas Institute of Engineering and Technology, Hyderabad, India

[⁴] Mechanical Engineer, Sreyas Institute of Engineering and Technology, Hyderabad, India

Abstract— A mobile air conditioner, SMAC is being manufactured at Akella systems operating at Sreyas institute of engineering and technology. The trial production was successfully done with 25 numbers in the year 2018-19 successfully. The processes of building a SMAC contained several manufacturing jobs like brazing, fabrication tube bending drilling etc., The quality and processes system should be established and configured with some quality assurance to make the product a perfect and comfortable to use with proper guidance. Several processes carried out are established in a sequential order and the processes time is evaluated. Every process is carried out with inspection and quality check. In the first stage receiving inspection of the BOM items is made for each and incoming material like evaporator, condenser, capillary, compressor etc., In the second stage the inspection is done for the elements like bended tubes copper pipes using the receiver gauges. Here the alignment issues are also resolved if present. The assembling of the portable air conditioner is done with the help of machining process like brazing and defects are checked using soap solution test in order to avoid leakages. In the third stage the tests like online tests psychrometric tests are conducted, the refrigeration cycle performance and customer evaluation are checked. This whole process is done for 5 portable air conditioners. After completing the whole processes, the detailed catalogue is setup and this consists of how to operate the remote and steps of installation.

Index Terms— Manufacturing jobs, quality and processes system, receiver gauges, catalogue

I. INTRODUCTION

A culture of quality should be cultivated in an organization which establishes a continuous improvement in the organization. It helps to deliver the products continuously with some standard operating procedure [1,6]. The production processes should be continuously monitored while assembling and setting the product to a well-established manner with all the detailed sketch and layout. The quality management systems are widely applied in construction industry, companies handling big and small projects, food processing industries and several service sectors. A quality management system established by construction system improved the quality of performance of the organization in the sector [2]. The lean production which is based on the Toyota system which is being adapted into other sectors also is profitable and reduces the over burden of the production [3]. The initial step to be taken care of is pointing out the production waste i.e., Overproduction,

Waiting, Transport, Processing, Inventory, Motion, and Defects [4]. For carrying out all these there are some elements to be implemented for lean production processes to happen and the elements are scheduling, employee perceptions, value stream mapping etc. The inspection techniques play a wider role in earning a good quality of the system. Once production has started for any product or a production system is established there must be a conformation that is given by the inspection done. The quality inspection is an important aspect of quality control processes. This also ensures the service and the lifetime of the product [5]. Tasks are performed like testing gauging

measuring are the attributes are reasonable for comparing with standard results of the model [6]. The customers get satisfied and show interest in buying a product when it is a well-controlled quality. The product tends to satisfy the desirable characteristics when it is coincided with the features of the standard product. This means that some of the parameters should be satisfying for example, in the portable air conditioner the product that is being manufactured in Akella systems is compared with a standard model called Croma which is another product that used to be sold in the market so frequently [7]. All these are important aspects that need to be taken care of to achieve a better quality. The product tends to fail when the inspection techniques are not conducted properly also there might be a chance that the production process might not be maintained properly. Most of the manual production processes will lead the defects and the flaws should be investigated properly with keen observation and inspection techniques. There are broadly categorized into two and one of them among them is general characteristics [8].

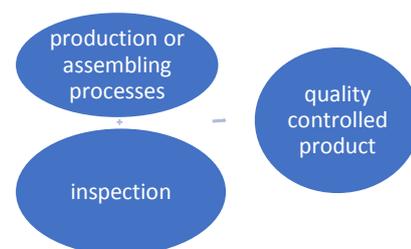


Fig.1: Brief representation of the quality management process and how it is leading to a controlled process

II. SETTING UP THE PROCESSES SYSTEM

It should be generally constrained that while manufacturing a product the system and the environment where all the manufacturing is done with some parameters and standard values. The product that is being manufactured here is a portable air conditioner the reliability and repeatability tests that are followed. DMAIC (define measure analyse improve control) plays a vital role in setting up the processes in a right way for as the steps should be practiced. Defining the production problem is the first and foremost step that should be followed. Problem that came across while setting up the assembly process of portable air conditioner was defects and motion. The process here are being managed by manpower the critical processes like brazing, extra surface removal (grinding) and drilling. It also involves other fabrication processes. Every process is manufactured manually by human skilled labour. In this process the defects are most commonly arising problems and there might not be accuracy of the finished good. Inspection is a compulsory process that should be conducted while manufacturing and after manufacturing.

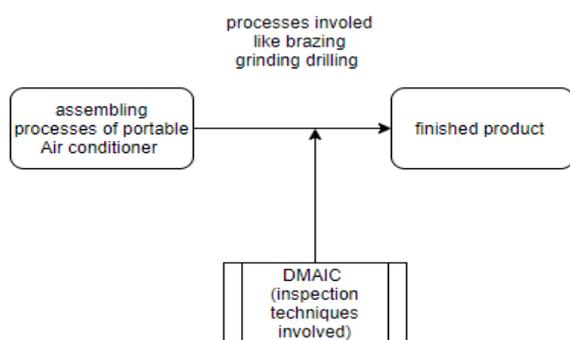


Fig .2: detailed view of how DMAIC is helping to define a production problem

following the first step of DMAIC it is to determine the problem. The problem here is defined as defects caused while manufacturing. The defects might be raised while brazing like blow holes surface leaks and over melting of metal. Before doing processes inspection the incoming material should be done and compared with a standard element or model. The coming materials like condenser, evaporator, compressor, frame, outer body, blowers, motors are checked out for flaws and defects.

INSPECTION OF THE INCOMING MATERIAL

a. Compressor

Compressor is a device in which work is done on the system thereby increasing the pressure and temperature of the refrigerant. It leads the refrigerant to the superheated state from the saturated state. Compressors used in air conditioning and refrigeration are hermetic[9].The “common, start, run” readings give the decision whether the compressor is going to run or not. The internal load acts in the common terminal which gives the indication whether the compressor is getting heated. The resistance between common and run will read to infinity and prevents the

compressor from running if the system is getting tripped. In the above table inspection has been done to the compressors which has R22 and R134 a working fluid. Three categories of errors are formed they are 0.1, 0.2, 0.6. The compressors showing 0.6 as the as the error were tripped off.

STATIC BALANCING OF THE BLOWER

The blower which is used to manage heat transfer processes should rotate without any wobbling and misalignment. The wobbling effect caused to the blower may displace the blower from the shaft. Sometimes the blower can even get separated from the shaft which is dangerous and can be accidental. To avoid phenomena like that a tight closure seal is set up. The seal looks like a cap that is attached to the threads joined. A brief tabular format is made listing the specifications of the perfect standard model.

Table1: specification of the blower

specifications of the blower	
material:	Fibre
motor attachment type	bush fitting
speed of the motor that blower can be rotated:	1500RPM



fig.3: attaching a bush for perfect alignment of the motor shaft



Fig.4: covering the blower front portion with a cap so that the blower will not move axially

S.NO	Compressor Model	Refrigerant Used	CR reading Ω	CS reading Ω	SR reading Ω	Error= SR-(CS+CR) Ω
1	PH150G1C-4DZH	R22	4.3	5.3	9.0	0.6
2	PH210M2A-4FTL1	R22	2.4	3.3	5.6	0.1
3	PH210M2A-4FTL1	R22	2.8	2.9	5.6	0.1
4	PJ250M2C-4FT	R134A	1.8	2.5	4.1	0.2
5	BSA645CV-RIEN	R134A	3.1	4.1	7.1	0.1
6	PH210M2C-4FT2	R22	3.3	3.2	6.3	0.2
7	PH210M2C-4FT2	R22	2.4	3.8	5.6	0.6

The specifications to be defined for the condenser	
fin and tube condenser	3row
Dimensions:	14" * 14" (l*b)
Diagonal length:	20"
Tube diameter:	1.25cm outer dia.
Fin spacing:	1.2mm
Horizontal distance between two tubes:	8mm
Vertical distance between two tubes:	10mm
Thickness of the support:	2.04cm
Thickness of the condenser:	6.5cm
Total number of condensers inspected:	5

Table 3

The specifications to be defined for the condenser	
fin and tube condenser	2row
Dimensions:	12" * 12" (l*b)
Diagonal length:	17"
Tube diameter:	1.25cm outer dia.
Fin spacing:	1.2mm
Horizontal distance between two tubes:	8mm
Vertical distance between two tubes:	10mm
Thickness of the support:	2.0cm
Thickness of the condenser:	4.0cm
Total number of condensers inspected:	5

Table 4

B. INSPECTION OF HEAT EXCHANGER

The nitrogen present inside the tubes has a constant pressure, when there is a leakage the pressure might get reduced due to punctures on the tubes. The pressure of nitrogen might vary when it is removed from the tubes of condenser which are sealed. Punctures on the tubes can be visualized by a human naked eye, and variation in the sound of the released nitrogen can be sensed due to leaks in the tube. The nitrogen present inside the tubes has a

constant pressure, when there is a leakage the pressure might get reduced due to punctures on the tubes. The pressure of nitrogen might vary when it is removed from the tubes of condenser which are sealed. Punctures on the tubes can be visualized by a human naked eye, and variation in the sound of the released nitrogen can be sensed due to leaks in the tube.



fig.5: Releasing nitrogen gas from the tubes for the inspection

C. SURFACE INSPECTION OF CONDENSER

The condenser should be aligned on the frame and attached to the blower and the enclosure of the condenser should be perfectly aligning with the blower casing so that there is no exchange of air or loss of the air to the atmosphere while the heat exchanging process takes place. The spirit level is used to inspect any surface irregularities and other alignment issues.

After checking the flaw and alignment issues the standard sizes and dimension are noted don for further inspection.

The dimension and specification of the heat exchangers are mentioned in the tabular form above.

There were no rejections found in the inspected 10 heat exchangers and all the inspected models are thereby approved for assembly.

III. INSPECTION OF THE FIXTURE'S ATTACHMENTS

A. INSPECTING THE BENDED TUBES

The tubes are bended and the bending's should be accurately bent and properly set up in order to connect the tubes with condenser, compressor, evaporator, and expansion valve. To find out if the tubes are bended or not gauges must be employed. The simple way to approach these gauges are making them with paper pulp and binders and they can be called as low-cost receiver gauges.

The process used to prepare the receiver gauge is listed below

- Take waste papers or newspapers or any other papers, make those paper into small pieces with different methods like paper grinding etc., take a bucket, pour water into it and soak the paper in that water for two days,
- Take a box of required dimensions and with only one side open, pour the water and fevicol (adhesive) into the cup with 80 percent of fevicol and 20 percent of water and mix that mixture in that cup.
- Place the standard copper tube into the box, now fill the box with the paper pulp mixture and ram the pulp mixture so that the pulp fits accurately in the box without any air gaps.

After filling the box with the paper pulp, apply fevicol on the outer surface of the paper pulp and let it dry for two to three days and remove the paper pulp from the box.



Fig.9: Gauge ready for drying

B. BRAZING AND SOAP LEAK TEST

The brazing operation is performed in the joints of the elements where copper tubes are connected to the other elements of the refrigeration circuit. There might be leakage of refrigerant at the joints the leakage should be checked with the soap bubble test after charging the refrigerant.



fig.10: brazing operation performed

C. CIRCUIT TESTING

The circuit testing is a part of online inspection where the whole refrigeration circuit is tested at all the points and consistency of the system is found out. The circuit is tested by setting up thermocouples at the points given in the below table and the temperatures are taken by setting up a constant dry bulb temperature and wet bulb temperature. The time until the compressor gets tripped off is noted.

The room where the unit of portable air conditioner was being placed maintained a constant temperature of 39 °C Dry bulb temperature and 37.6 wet bulb temperature. The system was able to perform consistently up to 40 min and the compressor tripped off. This means that the compressor can constantly do work on the system up to 40 minutes when the heat load is maintained at 39°C. The heat transfer can take place and cooling effect be produced and served in the room when a constant temperature is maintained as mentioned above. The thermal load bearing capacity was decided by referring the observations in Table.5.

Product SMAC125					
Test duration: 40 min			condenser type: 14" *14"*3 row		
capillary: 0.090" *51"* 1unit			evaporator coil: 12"*12"*2 row		
S.no	environment	10min	20min	30 min	40min
1	RETURN GAS	19	20	17	16
2	DISCHARGE GAS	101	114	117	123
3	LIQUID LINE	65	68	68	68
4	SHELL TOP	103	119	123	125
5	SHELL MIDDLE	104	119	125	128
6	EVAPORATOR IN	11	12	12	11
7	EVAPORATOR OUT	17	17	18	12
9	CONDENSER MIDDLE	63	67	67	67
10	AIR IN	32	34	31	31
11	AIR OUT	18	19	18	18
Power Consumption Parameters					
1	current	7.65	8.35	8.4	8.43
2	voltage	220	220	220	220
3	power	1683	1837	1848	1854.6

Table.5 temperature readings under constant load and DBT and WBT

IV. PSYCHROMETRIC ESTIMATIONS

The psychrometric estimation is done for the portable air conditioner to find out the effect of cooling in a room as the processes is cooling and dehumidification. The psychrometric readings were taken out from a graph through an online psychrometric property plotting software [10]. The result and other parameters are shown below in graph. The input parameters are given initial conditions as 30°C DBT and 27°C WBT and the final condition for the portable AC were 26°C DBT and 22°C WBT which reached after the processes. The entire unit was tested in the offline mode i.e., in an ambient room and found how temperature was decreasing. The enthalpy, humidity, humidity ratios were found out from this graph fig.12. The above-mentioned parameter values are given in fig.11 which are extracted from the software

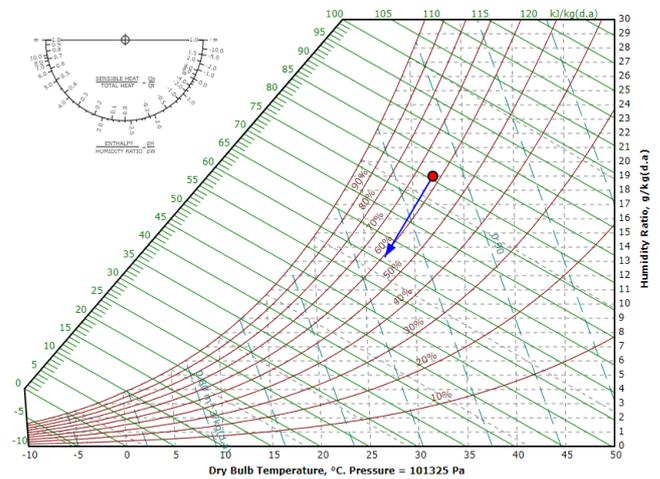


Fig.12: Psychrometric Plotting of the Parameters

V. TEMPERATURE CHANGE WITH RESPECT TO TIME AND SET TEMPERATURE

The temperature of the system is set to 16 degrees but the room is gradually cooling from 30 degrees and it is recorded that the temperature is decreasing very slowly the temperature readings are taken and noted down and graphically the values are plotted the temperature was recorded from a distance of 1.7 meters.

Table.6 The readings were taken from the distance of 1.7 meters of the unit and temperature effect was recorded

distance 1.7m model 1		
time	room ambient temperature	Set temp.
11:46	30	16
11:51	30	16
11:56	30	16
12:02	29	16

State changes from point A to B	
Dry air flow:	1000 kg/h
Delt.H/Delt.d	3.464 kJ/g
Heating load	0.000 kW
Cooling load	5.472 kW
Humidifying	-1.580 g/s
Sensible heat	-1.424 kW
Latent heat	-4.048 kW
Mixed air from state A and B	
Point A percent:	15 %
T.Dry.Bulb	27.750 °C
T.Wet.Bulb	21.758 °C
T.Dew.Point	19.235 °C
Rel.Humidity	59.827 %
Spec.Humidity	14.054 g/kg(d.a)
Enthalpy	63.764 kJ/kg(d.a)

Fig.11: Finding Parameter

12:07	29	16
12:12	28	16
12:18	27	16
12:22	26	16
12:28	26	16
12:34	26	16
12:40	26	16

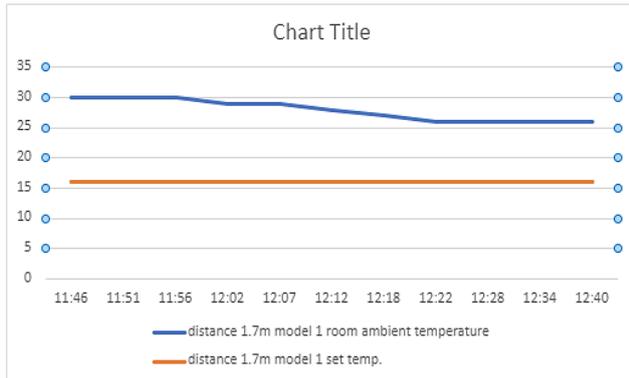


fig.13: graph between time and set temperature, and ambient

VI. CONCLUSION

- The final product is ready after getting involved in several inspection techniques
- The DMAIC rule was helpful in developing the production problem's solution
- After testing the refrigeration circuit, the outcome was found that it could retain in the circuit 40 min at a constant DBT and WBT. Through this the maximum heat that can be sustained is found out through psychrometric chart.
- Ambient temperature was changing with a difference of 4⁰C from the initial value when the set temperature is 16⁰C
- By conducting such type of inspection techniques, the defects were resolved.

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Experimentation on Mechanical Properties of Al 7075 Reinforced with Hafnium Carbide, Silicon Nitride, and Molybdenum Disulfide Hybrid Composites

^[1] N. Ummal Salmaan, ^[2] D. S. Robinson Smart, ^[3] S. Antony Raja

^[1] Research Scholar, Department of Mechanical Engineering, Karunya Institute of Technology and Sciences, India

^[2] Professor, Department of Mechanical Engineering, Karunya Institute of Technology and Sciences, India

^[3] Associate Professor, Department of Mechanical Engineering, Karunya Institute of Technology and Sciences, India

Abstract— The objective of the present research is to investigate the Mechanical properties of Hafnium carbide (HfC), Silicon Nitride (Si_3N_4) and Molybdenum Disulfide (MoS_2) reinforced with Al 7075. The secondary particles like Si_3N_4 (2 to 8) wt.% increase in the step of 3%, HfC (0.5 to 2) wt.% increase in the step of 0.75% and MoS_2 (2 to 5) wt.% increase in the step of 1.5 % are reinforced in base material Al7075 alloy using stir casting methodology. The casted specimen is machined using wire cut EDM as per the ASTM standards. Vickers's microhardness test and Ultimate tensile strength were performed; the result indicates Al7075 with 5wt.% Si_3N_4 , 1.25wt.% HfC, 3.5wt.% MoS_2 increases the hardness and tensile strength by indicating excellent mechanical properties, however, adding more reinforcements decreases hardness and tensile strength. The fatigue tests were performed on different specimens based upon the tension-compression cyclic loading, calculated the endurance limit, stress and no failure mode of each specimen by predicting the cut off value at 10^4 cycles; the Al7075 with 5wt.% Si_3N_4 , 1.25wt.% HfC, 3.5wt.% MoS_2 shows maximum stress at 1.6×10^4 Cycles. The SEM analysis after casting shows the disperse of reinforcements with the base alloy, and the fractography analysis of tensile test shows the fracture behaviour of the specimens that show the changes of behaviour from ductile to brittle by adding more reinforcements. The EDS shows the presence of materials based upon the wt.% added.

Index Terms— Al7075, HfC, Si_3N_4 , MoS_2 , Mechanical Properties

I. INTRODUCTION

The old conventional engineering materials are replaced by aluminium composite materials [1]. The Al7075 is a matrix material used in various applications. The researchers are mainly developing the aluminium matrix composites, which have to be light in weight, high strength, and good in wear and corrosion resistance, especially in Automobile and Aerospace applications [2]. The Al7075 matrix material has some disadvantages while used in this automotive application without adding any reinforcements. A substantial improvement in mechanical properties if just 30% of the reinforcements are added to Al7075 metal matrix composites [3]. Adding the hybrid reinforcements has a positive effect on improving the hardness and wear resistance of the alloy composites and improving microhardness and tensile strength while increasing particulate content [4], [5]. Some of the ceramic materials that some researchers have suggested improving the properties of Al7075 are Silicon carbide, Titanium carbide, zirconium carbide, B_4C , and TiB_2 . The Experiment conducted on Al7075 as a base MMC and SiC and B_4C have particulate materials the tensile strength, yield strength increases as the wt.% of SiC and B_4C increases, and the ductile and brittle fracture behaviour shown in the fractographic analysis [6]. To offer high elastic modulus, hardness, low density, the TiC is the most attractive reinforcement with Al7075. The hardness and tensile strength increased as the Experiment with Al7075, and different wt.% of TiC has added [7]. The ZrO_2 plays a significant role as reinforcements and Aluminium alloy as a base alloy. The Al7075 is fabricated by adding different

wt.% of ZrO_2 and shows an immense increase in microhardness, tensile strength and impact strength. Still, the decrease in ductility and fracture toughness [8].

The B_4C and MoS_2 reinforcements with various wt.% is added with Al7075 around 81%, and 4% of hardness and tensile strength is increased based on the particulates added. The Coefficient of friction was also reduced to 63%. It is due to the presence of solid lubricant MoS_2 [9]. When the hard ceramic particle TiB_2 wt.% is kept constant, and Gr wt.% is changed from 2 wt.% to 8 wt.% on the difference of 2%, the hardness and ultimate tensile strength are increased up to 74% and 68% by increasing the Gr, but there is a decrease in ductility due to the inclusion of TiB_2 and Gr [10]. The various manufacturing technique is used to fabricate the Al7075 based alloy matrix along with the reinforcements such as stir casting technique [11], powder metallurgy technique [12], Friction stir casting [13], squeeze casting [14] are the most commonly used manufacturing techniques for fabricating MMC's. The most attractive technique is the powder metallurgy technique due to its advantages in uniform distribution and reduced processing temperature but PM techniques is best for large scale manufacturing. However, stir casting is less expensive. By the stir casting technique, the Al7075 with SiC nanoparticles are heated up to 750°C . The nanoparticles are injected at the preheated stage at 200°C , and then the mechanical stirrer is used to stir up at 250 rpm in the presence of argon gas inert atmosphere shows an increase in the mechanical properties if the densities of the reinforcement and the base alloy have significant differences [15].

So, it is clear that adding up the reinforcements shows good positive results in increasing the mechanical properties and good bonding between matrix and reinforcement material [16]. The present objective of the research work is the preparation of Al7075/Si₃N₄/HfC/MoS₂ Hybrid composite fabricated using stir casting technique, there is a lot of research gap on the hard ceramic particle Hafnium carbide and so, the experiments were performed to investigate the Hardness, Ultimate tensile strength, Fatigue limit and understanding the microstructure formation of the hybrid composite to know the distribution of the reinforcements in the Al7075 base matrix.

II. EXPERIMENT PROCEDURE

The base matrix metal is Al 7075 purchased at (Coimbatore Metal Mart, Coimbatore) which have different chemical compositions, as shown in Table 1. The properties of the reinforcements are given in Table 2. The reinforcements have the particle size of micrometre purchased from (Alpha Aesar, USA). The total amount of the matrix base material and the reinforcements is selected by measuring the volume percentages in Table

Table 1. Chemical Compositions of Al 7075

Element	Zn	Fe	Mn	Cu	Cr	Si	Ti	Mg	Al
Wt.%	2.1	0.4	0.3	1.9	2.9	0.5	0.2	6.2	Bal.

Table 2. Properties of Reinforcements

Properties	HfC	Si ₃ N ₄	MoS ₂
Molar Mass	190.54 g/mol	140.28 g/mol	160.07 g/mol
Density	12.7 g/cm ³	3.17 g/cm ³	5.06 g/cm ³
Melting Point	3890°C	1900°C	1185°C
Boiling Point	4600°C	N/A	450°C
Hardness	2300 kg/mm ²	1450 kg/mm ²	900 kg/mm ²



Fig 1. a) Micro Hardness Tester; b) Universal Testing Machine; c) Fatigue Testing Machine; d) Fatigue test specimen holder

Table 3. wt.% of the Reinforcements

Specimen	Al7075	Si ₃ N ₄	HfC	MoS ₂
C1	100%	-	-	-
C2	-	2 %	0.5 %	2 %
C3	-	5 %	1.25 %	3.5 %
C4	-	8 %	2 %	5 %

*C1- Al7075, C2- Al7075+2wt.% Si₃N₄+0.5wt.% HfC+2wt.% MoS₂, C3- Al7075+5wt.% Si₃N₄+1.25wt.% HfC+3.5wt.% MoS₂, C4- Al7075+8wt.% Si₃N₄+2wt.% HfC+5wt.% MoS₂

2.1. Stir Casting Method:

The composites are all fabricated by the stir casting method. The Al 7075 is a 5mm round rod, and 100mm in length is cut into a small piece to be easy to add inside the furnace. First, the base metal matrix was heated up to 800°C, the reinforcements were added by using the mechanical stirrer; it stirred up manually at a maximum of 200 rpm. Then finally, the melted composite material was transferred to mild steel die 100mm×100mm×10 mm [17].

2.2 Wire cut Electrical Discharge Machining

Then by using the wire EDM machine, the fabricated samples are machined for the required testing as per the ASTM E8 standard guidelines. The distance between the specimen and molybdenum wire is 0.02 mm at a constant controlled by a servo control system having a wire diameter of 18mm and wire feed rate at 4 mm/min [18].

2.3 Hardness

By using the micro hardness tester (Mitutoyo, Japan – HM113) shown in Fig.1a, the Vickers hardness were measured at ten different points using diamond indenter for each ASTM E92 standard specimen at load 0.05 HV the interminable dwell time between every test is 5 secs to avoid the repeatability of the results.

2.4 Tensile Test

The tensile tests were conducted on ASTM E8M04 standard specimen by regulating the tensile strength through Computerized Universal Testing Machine (TMC, Chennai – CUTM) shown in Fig.1b with a strain rate of 1mm/min at a maximum load of 50 kN Fig.2 & Fig.3 shows the standard specimen for hardness and tensile strength.

2.5 Fatigue Test

The computerized fatigue testing machine at (Karunya Institute of Technology, Coimbatore) is used to conduct the fatigue test for the specimens shown in the fig.1c, prepared according to the ASTM E606 standard having a gauge length of 40mm. The gauge point of the fatigue test specimens will undergo a constant surface finish to reduce the bending conditions during testing. The prepared specimens are loaded axially, as shown in Fig.1d with tension-compression cyclic loading to a maximum of 50-60 cycles /min and maximum load of 60 kN with a ratio of stress as R=0.2 repeatedly at maximum load until there is a failure in the cycle at the room temperature. maximum 6

samples are used for each specimen from higher stress to lower stress until it exceeds the predetermined number of cycles (10^4).

2.6 SEM

The Scanning Electron Microscopy is used to analyse the distribution of the reinforcements with the base alloy. The SEM fractography of tensile test specimens was studied to understand the nature and cause of the fracture. The Electron Dispersive Spectroscopy (EDS) show the wt.% of the material in each specimen according to the composition (PSGIAS, Coimbatore).

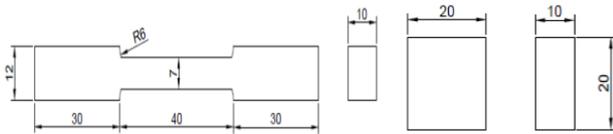


Fig. 2a) Standard specimen for Tensile test;
b) Standard specimen for Hardness test

III. RESULTS & DISCUSSION

3.1 Density and porosity

The theoretical and actual density was calculated by the role of mixture and Archimedes' principle. The addition of reinforcement increases the density of composite materials, and also, there will be an increase in the porosity due to the pore nucleation on the particulate surface of the reinforcements. The porosity level should be limited to 4.0 % is acceptable [19]. The porosity percentage of Theoretical and Experimental density is calculated by the given Equation.1 and values shown in Table.4 and the comparison of Theoretical and Experimental density shown in Fig.3

$$\% \text{ of porosity} = \frac{\text{Theoretical Density} \frac{g}{cm^3}}{\text{Experimental Density} \frac{g}{cm^3}} \times 100 \quad (1)$$

Table 4. Comparison of Theoretical, Experimental density and percentage of Porosity

Specimen Composition	Theoretical density (g/cm ³)	Experimental Density (g/cm ³)	% of porosity
Al7075	2.72	2.69	1.102
Al7075+2% Si ₃ N ₄ +0.5% HfC +2% MoS ₂	2.83	2.81	0.70
Al7075+5% Si ₃ N ₄ +1.25% HfC+3.5% MoS ₂	2.89	2.86	1.03
Al7075+8% Si ₃ N ₄ +2% HfC+5% MoS ₂	2.96	2.91	1.68

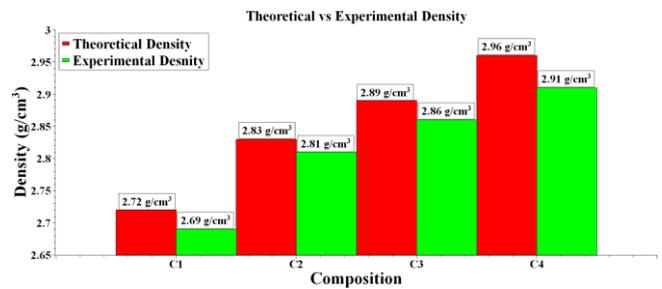


Fig 3. Comparison of Theoretical and Experimental Density

3.2 Evaluation of Hardness Test

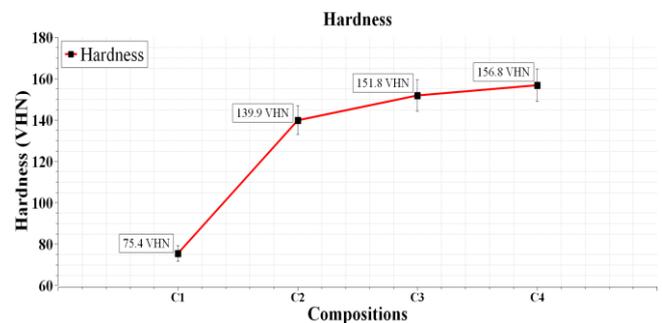


Fig 4. Variation of hardness with different specimen

Fig.4 shows the hardness variation with the different specimens as we can see that the wt.% of the reinforcements increased the hardness value. The pure base metal Al7075 has the lowest hardness value of 75.4 VHN due to the absence of reinforcements; as the reinforcements are added in specimens C2 to C4, the hardness value is increased according to the reinforcement wt. % [20]. It indicates that the Si₃N₄ and HfC ceramic particles are evenly distributed throughout the base metal matrix because the reinforcement particle size (45μm) is large when compared to the base matrix particles size (20μm) as we can see a 90% increase in hardness as the reinforcements added [21].

3.3 Evaluation of Tensile Strength

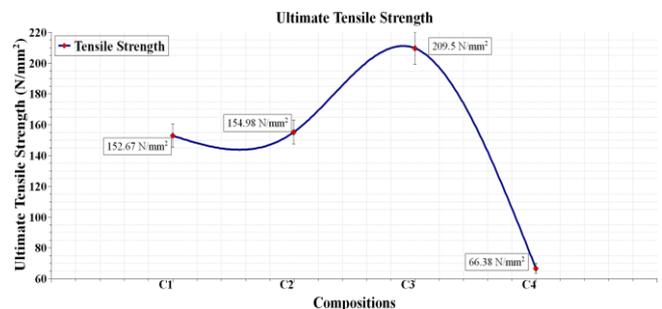


Fig.5 Variation of Tensile Strength with different Specimen

The Fig.5 and Fig.6 show the variation of Tensile strength and % of elongation with the different specimens as we can see that increasing the wt.% of the reinforcement with the base alloy increases the tensile strength from 152.67 N/mm² to 209.5 N/mm² at room temperature. It shows that

the properties and structures of the reinforcements control the mechanical properties of the composites where the load distributes and transfers from the matrix, which result in increased elastic modulus and strength [22]. As the reinforcement wt., % is further increased, the Tensile strength is decreased to the 66.38 N/mm² due to the improper bonding between the base alloy and reinforcements which causes dislocation at the interface. It will also decrease if there is a difference in the coefficient of thermal expansion of base alloy and reinforcements, leading to the diffusion of alloying elements and creating crack nucleation. Furthermore, due to the clustering of reinforcement particles with the matrix [23], to overcome this dislocation between the interfaces, the Orowan mechanism which used in strengthening the dislocation by creating an agglomeration between particles/matrix interface, creates a dislocation loop to overcome the

obstacles between the interfaces by that it increases the characteristic of tensile which leads to dispersion strengthening of the reinforcement particles with the base alloy [24], [25].

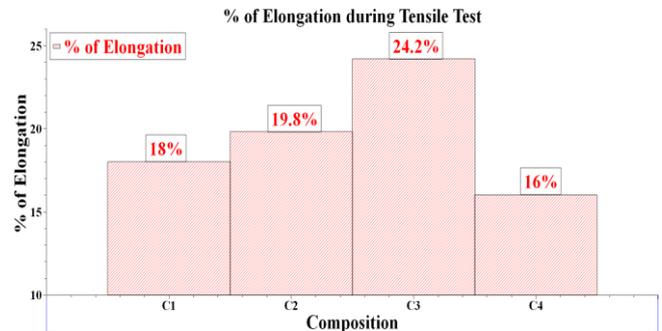


Fig 6. Percentage of Elongation with different Specimen

3.4 Evaluation of Fatigue behaviour:

Table.5 Fatigue Test Data

Composition	Specimen No.	load (kg)	No of Cycles (N)	No of cycles completed	Stress in MPa	Failure Mode
Pure AA7075	1	70	10 ⁵	15468	44.114	No Failure
	2	80		12456	44.267	No Failure
	3	90		8546	48.257	Failed
	4	100		3658	52.492	Failed
	5	110		524	53.657	Failed
	6	120		97	54.785	Failed
AA7075+2 wt.% Si ₃ N ₄ +0.5 wt.% HfC+2 wt.% MoS ₂	1	70	10 ⁵	15986	51.480	No Failure
	2	80		14680	51.697	No Failure
	3	90		7850	57.824	Failed
	4	100		4320	59.372	Failed
	5	110		758	59.878	Failed
	6	120		104	60.874	Failed
AA7075+5 wt.% Si ₃ N ₄ +1.25 wt.% HfC+3.5 wt.% MoS ₂	1	70	10 ⁵	17653	52.421	No Failure
	2	80		15784	52.652	No Failure
	3	90		7523	57.890	Failed
	4	100		4658	62.652	Failed
	5	110		948	63.669	Failed
	6	120		121	64.587	Failed
AA7075+8 wt.% Si ₃ N ₄ +2 wt.% HfC+5 wt.% MoS ₂	1	70	10 ⁵	9240	51.890	Failed
	2	80		5420	54.690	Failed
	3	90		958	59.301	Failed
	4	100		452	60.623	Failed
	5	110		112	61.785	Failed
	6	120		79	62.440	Failed

Fig.7 shows the S-N curve of low cycle fatigue behaviour. The fatigue life results are shown in Table.5; the results are conjoint with the tensile behaviour results, as the reinforcement wt.% increases, there is an increase in stress value, and the predetermined cycles (10⁴) are reached if the load for each composition is changed from higher to lower. Specimen 1 & 2 of composition AA7075+5 wt.% Si₃N₄+1.25 wt.% HfC+3.5 wt.% MoS₂ shows the full life cycles than the other composition specimens; however, the

specimens of compositions AA7075+8 wt.% Si₃N₄+2 wt.% HfC+5 wt.% MoS₂ has not reached the maximum Number of cycles due to the arrangement of the interface particles where the load is not transferred correctly to the reinforcements which increase the plastic deformation of the matrix material [26]. As the stress decreases, the fatigue life of the specimen increases. This stress limit is one of the material properties, which shows the fatigue or endurance limit of the material. The S-N curve in Fig.7 indicates the

endurance limit of each specimen between the stress and the Number of cycles. The fatigue life is decreased in other specimens and results in failure mode due to the fatigue cracks are developed on the specimen surface; most commonly, the crack initiation initially happens on the subsurface of the interior [27].

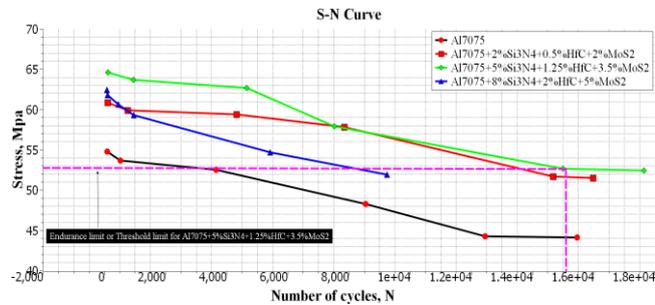


Fig 7. S-N curve of Fatigue Test

3.5 Evaluation of Scanning Electron Microscopy:

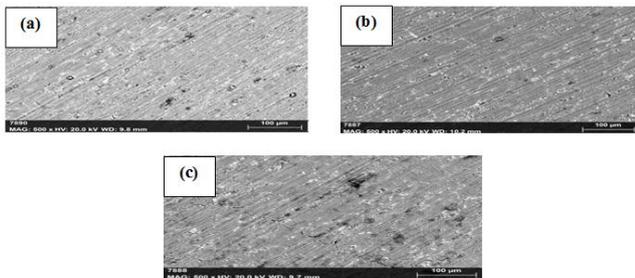


Fig 8. SEM of sintered samples a) Al7075-0wt.% b) Al7075+2wt.% Si_3N_4 +0.5 wt.% HfC+ 2 wt.% MoS_2 , c) Al7075+5 wt.% Si_3N_4 +1.25 wt.% HfC+3.5 wt.% MoS_2 and d) Al7075+8 wt.% Si_3N_4 +2 wt.% HfC+ 5 wt.% MoS_2

Generally, the casting defects can be seen in the Al7075 Composites, such as cracks and porosity. However, adding the reinforcements, the SEM image shows that at 2 Si_3N_4 -0.5 HfC- 2 MoS_2 wt.% and Al-5 Si_3N_4 -1.25 HfC- 3.5 MoS_2 wt.% the particles were uniformly distributed and almost

Table.6 C3 - Composition Element percentage

Element	C K	N K	O K	Fe L	Cu L	Zn L	Mg K	Al K	Hf M	Si K	S K
Weight %	20.49	1.51	15.14	0.41	1.97	4.15	4.06	50.06	0.62	1.27	0.32
Atomic %	34.51	2.18	19.15	0.15	0.63	1.28	3.38	37.53	0.07	0.92	0.2

3.6 Evaluation of Fractography:

The SEM fractography images after tensile tests are shown in Fig 11 (a-d). The fracture surface of base alloy Al 7075 without adding reinforcements shows a large size dimple, which indicates the ductile fracture. In contrast, the dimple sizes are getting finer while adding the reinforcements, so it has a mixed fracture mode, whereas during the Al-5 Si_3N_4 -1.25 HfC- 3.5 MoS_2 wt.% the dimple formation is less and interfacial bonding between the base alloy and the reinforcements are very good. However, in the Al-8 Si_3N_4 -2 HfC- 5 MoS_2 , the composites have produced more particulate cracks, and it has a large amount of brittle nature, which result in less mechanical properties and also

homogeneously in the matrix, this is due to the presence of the ceramic particles with the base alloy which are thermodynamically stable and produce pure interfaces which increase the load and bearing capabilities shown in Fig. 8a & 8b, whereas in the Al-8 Si_3N_4 -2 HfC- 5 MoS_2 wt.% in Fig. 8c shows some porosity and cracks due to the thermodynamically unstable ceramic particles, which results in unpleasant compounds [25]. The (EDS) spectrum analysis in Fig 9 & Fig 10 shows the presence of Silicon nitride, Hafnium carbide, and molybdenum Disulphide reinforcements with the base alloy wt.% added for the composition 2 Si_3N_4 -0.5 HfC- 2 MoS_2 wt.% and Al-5 Si_3N_4 -1.25 HfC- 3.5 MoS_2 wt.%. Table 6 shows the weight percentage of the elements present in the MMC's for the composition C3.



Fig 9. EDS Spectrum of the hybrid composites (Al7075 with 2wt.% Si_3N_4 , 0.5wt.% HfC, 2wt.% MoS_2)



Fig 10. EDS Spectrum of the hybrid composites (Al7075 with 5wt.% Si_3N_4 , 1.25wt.% HfC, 3.5wt.% MoS_2)

due to the presence of more hard ceramic particles in the Al7075 matrix.

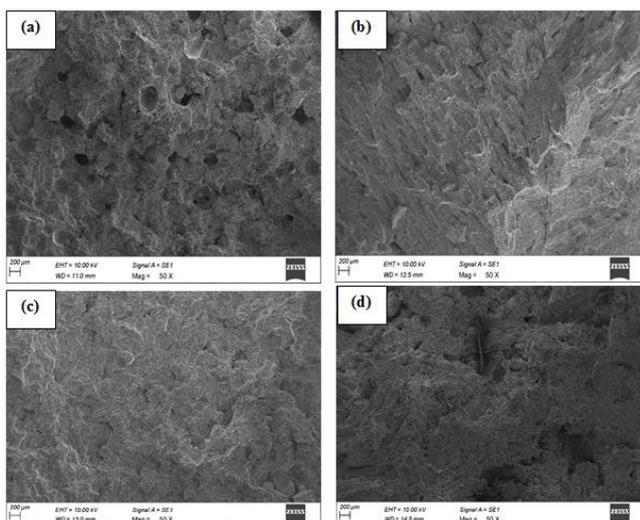


Fig 11. SEM fractography images Tensile Fracture samples a) Al7075-0wt.% b) Al7075+2wt.% Si_3N_4 +0.5 wt.% HfC+ 2 wt.% MoS_2 , c) Al7075+5 wt.% Si_3N_4 +1.25 wt.% HfC+3.5 wt.% MoS_2 and d) Al7075+8 wt.% Si_3N_4 +2 wt.% HfC+ 5 wt.% MoS_2

IV. CONCLUSION

The mechanical behaviour testing results of AL7075 reinforced with Si_3N_4 , HfC, and MoS_2 provide the following conclusions.

The microhardness of the hybrid composites materials is increased from 75.4 VHN to 156.8 VHN with an increase of reinforcements from 2 wt.% Si_3N_4 , 0.5 wt.% HfC, 2wt.% MoS_2 to 8 wt.% Si_3N_4 , 2 wt.% HfC, 5 wt.% MoS_2 .

The tensile test of the hybrid composites materials having reinforcements of 5wt.% Si_3N_4 , 1.25wt.%HfC, 3.5wt.% MoS_2 shows a higher value than the base alloy. However, more reinforcements added will result in brittle fracture due to the dislocation of the particles at the interface.

The fatigue test is found to be increasing as the wt.% of the reinforcements increases. The following results show that the composition 5wt.% Si_3N_4 , 1.25wt.%HfC, and 3.5wt.% MoS_2 have higher stress values than other specimens due to the fine grain size for better resistance.

The SEM analysis of the fabricated samples shows the uniform distribution of the reinforcements. when the reinforcements are exceeded above 5wt.% Si_3N_4 , 1.25wt.% HfC, 3.5wt.% MoS_2 , there occurs thermal instability between the base alloy and reinforcements, which results in cracks and porosity.

The Fractography SEM of tensile tests showed minor dimples and porosity when the reinforcements were added, resulting in ductile and brittle. However, when the reinforcements exceed above 5wt.% Si_3N_4 , 1.25wt.% HfC, 3.5wt.% MoS_2 , the crack propagation happens due to the sharp edges of heavy ceramic particles.

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Intelligent Wire Fence Monitoring System (IWFMS)

Vidalyn C. Geronimo

Bicol State College of Applied Sciences and Technology, Philippines

Abstract— Monitoring system plays a significant role in its safety and precautions in any establishment with the utilization of the new advancement in technology. The study is about the alarm and security defense system device used to monitor the intruders in the perimeter area using the microcontroller unit and sensor-based technology applied in detecting any intrusion. The objective of the study is to develop an Intelligent Wire Fence Monitoring System and to determine at what condition the alarm will be activated. The researcher utilized both the descriptive, product and development method to describe the step-by-step in the development of the device. An ultrasonic sensor was used for the detection of any intrusions. Once an intrusion is detected, the LED bulb lits. The siren will sound if the intruder is exposed for ten seconds within the range of 35 inches. The siren will continue to alarm unless the reset button at the panel board is pressed. When one area is activated, it measures 205V. When two, three, and four areas were detected, the voltage measured was 230V, 260V, and 306V, respectively. It integrates the object detection, alarm signal, LED lights, and voltage in the wire fence to present a proactive device that prevents any casualty. The IWFMS proved to be a reliable security solution for a wide variety of applications and gave a proper signal that warns the occupants and neighbors of any detected intrusions.

Index Terms— alarm, security, sensor, wire fence monitoring system

I. INTRODUCTION

Throughout the 21st Century, modern technologies, as well as people's awareness of prevention and improvement of preventive measures in a variety of security technologies, have emerged. Among them, perimeter security with a variety of cable-style perimeter to provide security was discovered [2].

With the advent of modern technologies, new innovations can be more advanced. One significant breakthrough in making more advanced innovations is the use of a monitoring system. According to Pritchard [15], there have been at least 268 perimeter security breaches at 31 major U.S. airports. Some involved fence-jumpers are taking shortcuts or looking to hop flights, others intoxicated drivers crashing through barriers. None was deemed terrorism-related. Usually, the airports security measures include fences, surveillance cameras, and patrols, but there are gaps. Not all of the miles of fences are routinely patrolled or covered by video surveillance.

Growing concerns over safety in some important areas such as airports, farms, private companies, private houses, correctional institutions, and factories have led people to consider the implementation of new, more stringent security measures through the use of fencing to bolster perimeter security [16].

The ever growing risks of crime, disorder, and victimization in our country are very alarming. It's high time to consider the safety and security of every individuals. In Europe, Closed-Circuit Television (CCTV) is viewed as "an essential part of daily life". CCTV is used to monitor crime, suspicious behavior, accidents, etc. The six capitals of European nations showed that 29% of them use CCTV which were most common in areas associated with transportation and government. According to the 2002 European survey, 86% of CCTV users cite the deterrence of theft, and 39% cite deterrence of violence [9].

In the Philippines, national or local, the most common security monitoring device is also CCTV or Closed-Circuit Television. CCTV is commonly applied in areas that may need monitoring such as airports, farms, private companies, private houses, correctional institutions and factories. This device can deter crime, monitor the scenarios and activities, and gather evidence. This enables the users to record the footage for later viewing and to help snitch criminals, and receive justice from the law. However, the crime cannot be stopped when it is in progress. Using CCTV is a great help in order to know the identity of the intruders or to monitor the illegal activities. However, CCTV does not alert the neighbors or the police like an alarm system would. This means that using CCTV will incur losses when victims run to the court and make insurance claims [3].

To address the most convenient, safe, and comfortable way to monitor security in the area, the researcher aimed to develop a perimeter monitoring system that will serve as an alarm and defense system as well.

II. OBJECTIVES OF THE STUDY

The objectives of the study are to (1) develop an Intelligent Wire Fence Monitoring System (IWFMS); (2) illustrate the step-by-step process on the different phases of creating IWFMS; (3) determine at what condition will the alarm be activated; and (4) test the efficiency of the device along: (a) sensitivity; (b) sounding of alarm; and (c) voltage injected in the wire fence.

III. MATERIALS AND METHODS

The researcher utilized both descriptive and product development method. It is descriptive because the efficiency and the internal consistency of the device was tested. There were different phases was considered in completing this study. The product and development method was also utilized to describe the step-by-step process made during the development of the device. The materials and components used in the development of the

prototype were: ultrasonic sensor, microcontroller unit, alarm, and other peripherals, and manual control system. The C language was used by the researcher as a programming language of the device because it produces code that runs nearly as fast as the code written in assembly language.

IV. RESULTS AND DISCUSSION

Planning and Design

During the planning stage, it took twelve (12) weeks to conceptualize the idea. The initial step made by the researcher was to gather the data or information related to the study. It also included making the schematic and block diagram of the IWFMS. In purchasing the needed components and materials it took (2) weeks because some of them were not available near the locale of the study. Another two (2) weeks for the software and hardware development and that includes the fabrication of the wire fence. Another two (2) weeks were allotted for the testing and evaluations, and three (3) weeks for finalization of the design of IWFMS. Documentation was done from week 1 to week 12. Fence installations must comply with the present regulations and standards to ensure the safety of the people, and extreme care should always be taken into consideration when installing, testing and maintaining electric fence. The following safety precautions must be observed when installing or maintaining electric fence: (1) Always seek planning approval from concerned authority; (2) Always display warning signs of at least 6 meters intervals along a fence; (3) Always ensure the fence is well insulated, to prevent fence posts or electric shock.

The factors to be considered in the specification are height, line-wire, number of wires and spacing, the distance of each post. The requirements for fence height is 2.13 m or more in height or a combination of 1.8 m or more of fence fabric and an extension utilizing three or more strands of wire. The wire of an electric fence can be of either steel, aluminium, or aluminium alloy. Steel wires are either of medium-tensile strength, high-tensile strength, or spring-steel. Conducting wires can be either single or multi-stranded and range in diameter from 1.6 mm to 3.15 mm (0.06 - 0.12 inches).

The sensor is the main part of the system as it is the one that will detect any possible intrusions in the area. Once the sensor detects any object obstruction, the timer will start and the LED bulb will be energized. This is placed along with the wire fence to monitor intruders in the area. There were various sensors installed in every post, 4 sensors with different positions in each post with a distance of 1.5 meters in order to capture all the area for possible intruders or any intrusions. At the middle post of each area, there are LED bulb with different colors installed to determine the exact locations of intrusions. The LED bulb in each area has designated colors and could also be monitored in the panel board by the controller.

The alarm is a device that signals the occurrence of some undesirable event. This was designed to warn the owners or the neighbors as well to a sense of intrusion or call to a state

of preparedness. When an object is detected by the sensor, the LED bulb will be energized in the vicinity, however, if the object gets out the range, the light will automatically turn off. If the object stayed-detected for 10 seconds, the siren will activate and the LED bulbs in all posts will automatically turn on. Fig. 1 shows the flow of the program.

All detection appeared in the vicinity were monitored in the panel board. The panel board has the control of all the switches. It consists of the following: Switch, Fuse, Voltmeter, Output, Manual Control, Reset button and the LED bulb. The switch is used to switch on and off the system. Voltmeter measure the applied voltage on the wire fence; output is the signal that comes out on the system; manual control where the voltage can be adjusted manually; reset button is designed to stop the sound of the alarm and the LED, displays the light.

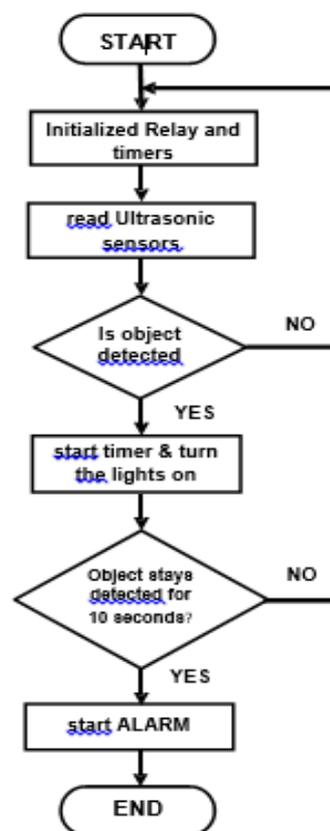


Fig. 1. Flow of the Program

The wire fences will be powered by a minimum of 205V. The voltage controlled regulator increases the voltage of the wire fences as the number of areas detected increases. The hardware design of the IWFMS shown in fig. 2 consists of the servo transformer, motor control circuit, microcontroller, and ultrasonic sensor. The following block diagram components were operationally described below, its technical specifications, operations, and schematic diagram. Fig. 3 shows the components that make up the power supply, and it includes the transformer, which steps down the input voltage, a rectifier which converts AC to

DC voltage and a capacitor which removes the ripples in the pulsating output voltage.

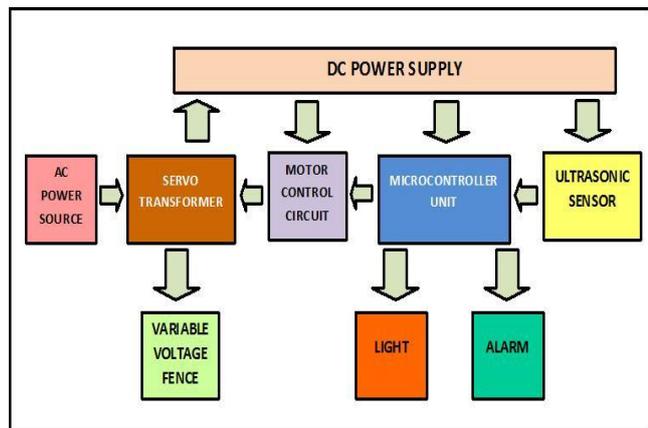


Fig. 2. Block Diagram of Intelligent Wire Fence Monitoring System

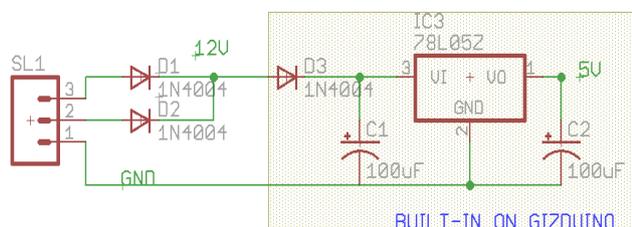


Fig. 3. DC Power Supply

The device has a built-in microcontroller unit, the brain of the circuit. This will process the data gathered by the Ultrasonic sensor, it will set the fence's voltage by controlling the motor position using the motor control circuit and will determine whether to start the light and alarm. The Gizduino is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as Pulse Width Modulation outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller and its Arduino UNO compatible. The Gizduino will make a sample of each location using ultrasonic sensor and record its reading. This reading will be used to decide the position of the motor that corresponds to the voltage, alarm, or to light an area. For the connection to the circuit, refer to the schematic diagram of IWFMS in fig. 5. The technical specifications are shown in Table I.

The wire fences will be powered by a minimum of 205V. The voltage controlled regulator increases the voltage of the wire fences as the number of areas detected increase

Table I. Technical Specifications of microcontroller

Description	Specification
Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage	7-20V
Digital I/O Pins	14
PWM Digital I/O Pins	6
Analog Input Pins	6

DC Current per I/O Pin	20mA
DC Current for 3.3V Pin	50mA
Flash Memory	32KB
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

The AC Power Source is a two-phase power source commonly seen in households; this will be the source of power to be stepped- down for regulation. A servo transformer will be used to step down AC power source for DC regulation and will serve as a power source for Variable voltage fence. Table II shows the technical specifications of servo transformer.

Table II. Technical specifications of Servo Transformer

Description	Specification
Model	SVC
Input voltage	110-250V
Output voltage	200V-340V, 90V-210V , 12V
Frequency	50Hz/60Hz
Dielectric strength	1,500V/min
Ambient temperature	-10±40°C
Temperature rise	lower than 60°C
Insulation resistance	≥2MΩ Hz

A motor control circuit is composed of a quad half h-bridge driver used for controlling the motor direction and position using Microcontroller Unit. The direction of motor is controlled by current flow directions. Using an h- bridge driver SN754410 it is possible to control the motor using two digital pin of any microcontroller. The motor will move if these pins have different value, or else it will not have a current flow resulting in the motor to stop. The specification of the motor control circuit is defined by the h-bridge driver, SN754410. The maximum output current is 1A, motor input voltage is between 4.5V to 36V and the Logic Input Voltage is 5V TTL and CMOS compatible.

The device is installed with an ultrasonic sensor. A device for measuring distances using ultrasonic sound, the distance of the object is calculated using the speed of sound. To start the measurement, Trigger of SR04 must receive a pulse of high for at least 10us, this will initiate, and the sensor will transmit out 8 cycle of ultrasonic burst at 40 kHz and wait for the reflected ultrasonic burst. When the sensor detected ultrasonic from the receiver, it will set the Echo pin to high and delay for a period which proportion to distance. To obtain the distance, measure the time of Echo pin before it will turn high. Distance in centimeters = Time / 58; where, Time= Width of Echo pulse, in micro second. Fig. 4 shows the timing diagram of ultrasonic HCSR04.

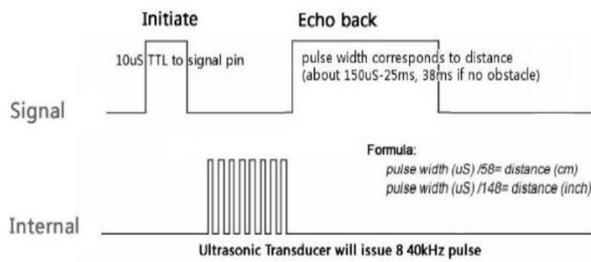


Fig. 4. Timing Diagram of Ultrasonic HCSR04

The device is also equipped with a light and alarm system. It provides light and activates the alarm if the intruder is in the area. Light and alarm are controlled using relay and a transistor which serves as a switch. When the base of the transistor has a voltage greater than 0.7 V, the collector to emitter junction will energize the electromagnet and turn on the alarm or light. If the base voltage is equal or lower than 0.7 V there is no conduction that will occur and will eventually result in to open circuit. Fig. 5 and 6 show the circuit connections of the system, and the relays act as switches.

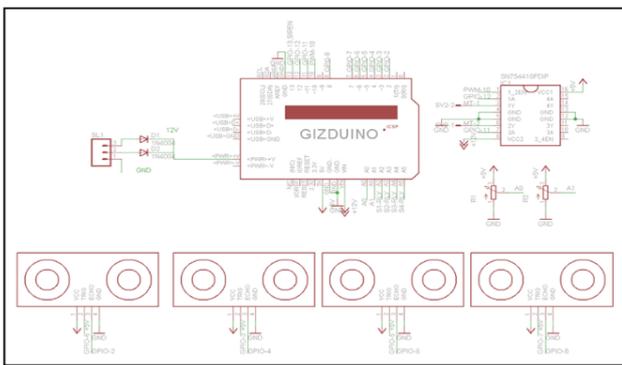


Fig. 5. Schematic Diagram of IWFMS

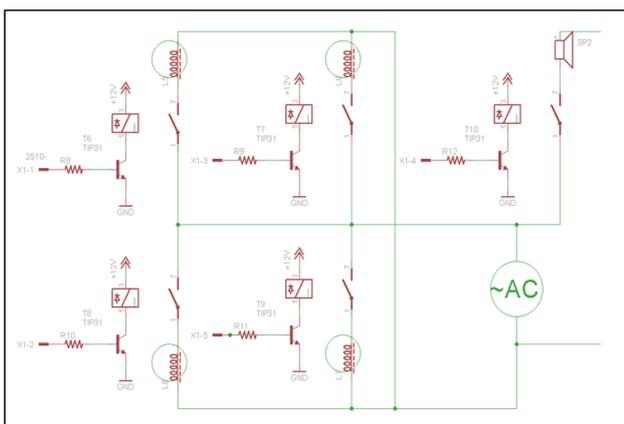


Fig. 6. Relay Circuit Diagram

Fig. 7 and 8 show the actual PCB layout that will serve as a guide in the assembly of different circuit boards.

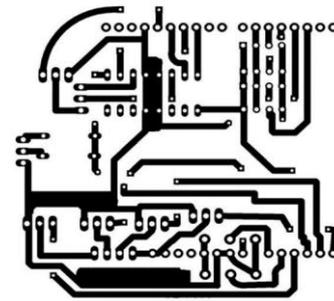


Fig. 7. Main Board PCB Layout

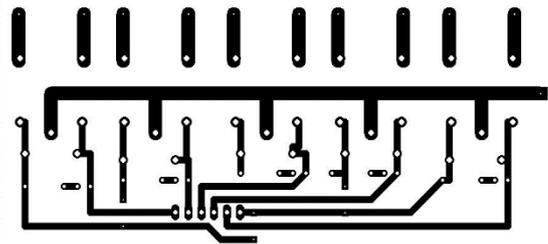


Fig. 8. Relay PCB Layout

Preparation and Procurement of Components and Materials

The components and materials used in IWFMS were divided into four categories namely: 1) Main control circuit; 2) Fabrication of wire fence; 3) Alarm and other peripherals and 4) Miscellaneous expenses. The total cost for the main control circuit was P5,704.25; Fabrication of wire fence was P4,298.00; Alarm and other peripherals was P1,726.00; and the miscellaneous cost was P2,139.00. The total cost of materials and components used in IWFMS amounted to P13,867.25

Table III. Summary of total cost

Item	Amount
Main Control Circuit	5,704.25
Fabrication of wire fence	4,298.00
Alarm and other Peripherals	1,726.00
Miscellaneous	2,139.00
Total	13,867.25

Construction of Sensors, Alarm conditions and the Efficiency in terms of sensitivity and voltage injected in the wire fence

The sensor is the main part of the system as it is the one that will detect any possible intrusions in the area. Once the sensor detects any object obstruction, the timer will start and the LED bulb will be energized. This is placed along with the wire fence to monitor intruders in the area.

When an object is detected by the sensor, the LED bulb will be energized in the vicinity however, if the object gets out of range the light will automatically turn off. If the object stayed-detected for 10 seconds it means that it has the intention to intrude, thus, it will activate the siren and the LED bulb in all posts will automatically turn on. The siren

will continue to alarm unless the reset button at the panel board is pressed.

Sensitivity and voltage injected in the wire fence

The researcher conducted an experiment to test the sensitivity of the device. Table IV shows the maximum distance for object detection and increase of voltage in the wire fence. The wire fences will be powered by a minimum of 205V. The voltage controlled regulator increases the voltage of the wire fence as the number of areas detected increases, Table VI. However, the amount of voltage can also be manually controlled using a potentiometer in the panel board.

Table IV. Determining the Accurate Maximum Distance of Object Detection

No. of Trials	Distance (in)	Sensing of Sensor	
		Yes	No
1	15	✓	
2	20	✓	
3	25	✓	
4	30	✓	
5	35	✓	
6	35	✓	
7	35	✓	
8	36		✓
9	36		✓
10	37		✓
11	37		✓
12	38		✓
13	38		✓
14	39		✓
15	40		✓

Based on Table IV, fifteen trials were done to determine the farthest distance that has detection. The result shows the farthest distance that the sensor has detected an object is 35 inches. The researcher conducted several trials on the same distance to know the accuracy. In trials 5, 6 and 7 the result was the same with a distance of 35 inches while trials 8 to 15, with a distance of more than 35 inches, there was no detection. Therefore, based on experiments, it can be concluded that 35 inches was the farthest distance that can be detected.

Table V. Sounding of Alarm

No. of Trials	Exposure time upon detection (sec)	Alarm	
		Yes	No
1	1		✓
2	2		✓
3	3		✓
4	4		✓
5	5		✓
6	6		✓
7	7		✓
8	8		✓
9	9		✓
10	10	✓	

11	11	✓
12	12	✓
13	13	✓
14	14	✓
15	15	✓

Table V shows the result on how the alarm is activated. Fifteen (15) trials were performed to determine the exact time the alarm will be activated. In trials 1 to 9, the alarm was not activated, while trials 10 to 15 with 10 seconds and above the alarm sounded.

Table VI. Voltage Injected in the Wire Fence in each area

No. of Area	Voltage
1	205
2	230
3	260
4	306

Table VI shows the measured voltage in each area. A digital voltmeter was used to measure the applied voltage on the wire fence. The researcher measured reading of 205V when one area was activated. The voltage increases to 230V when intrusion was detected in two areas. Similarly, when three and four areas were detected, the voltage measured was 260V and 306V, respectively.

V. CONCLUSIONS AND RECOMMENDATIONS

In the light of the findings, the following conclusions were drawn: 1) IWFMS is an effective system to deter illegal encroachment and intrusions in the perimeter area such as the farm and private houses; 2) The design of IWFMS provides effective and reliable security solution for a wide variety of applications. 3) IWFMS serves as an alarm and defense system as well; 4) The IWFMS gives proper signal and warn the occupants and neighbors for any intrusion detected; and 5) The variable voltage injected on the wire fence provides the appropriate signal to ward out persistent intruders so as not to have fatal injuries on them.

In the light of the findings and conclusions, the following recommendations were formulated: 1) There should be an installed UPS (Uninterruptible Power Supply) for backup supply during power interruptions; 2) A high-end resolution CCTV must be placed on every corner of the establishment for immediate recognition of intruder/s; 3) GSM based intrusion warning to the owner and wireless board for easy operation and less maintenance; 4) Conduct an economic viability study if to be mass-produced, and 5) To conduct an acceptability study of the system to possible users.

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Household Waste Analysis during the Situation of COVID-19 in Thailand

^[1] Thanarak Prasertwit, ^[2] Dr.Kanchana Kanchanasuntorn

^[1] School of Engineering, University of the Thai Chamber of Commerce, Bangkok, Thailand

^[2] School of Engineering, University of the Thai Chamber of Commerce, Bangkok, Thailand

Abstract— During the situation of COVID-19 since 2020, people lifestyle has been changed for example the way to buy the product, the way to have a meal and personal self-protection. These changes lead to increase E-commerce value of retail business growth 81% from 2019 and food delivery order increase 78-84% from 2019 and expected to reach 120 million orders in 2021. The changes are not only creating the value in the supply chain but also generate the big amount of waste. Therefore, it is vital to analyze the change of customer behavior during this situation which is related to the household waste and to provide the household waste reduction. The research found that the household waste during the situation has been increased in term over all plastic waste which come from E-commerce order and food delivery order and hazardous waste such as infectious waste also spike up as the people has to protect their health. Then the research provides the suggestion to reduce waste which the government and private sector try to promote the campaign for reducing waste and also review the practice of other countries.

Index Terms— Infectious Waste, COVID-19, Food Delivery, Plastic Waste

I. INTRODUCTION

The COVID-19 was first detected in Thailand on February, 2020. Since then, Thailand has applied to a new normal lifestyle because of the obstruction of face-to-face participation. People has to keep social distancing, cannot gather in a big group and also has to apply self-hygiene protection. The change from the situation of COVID-19 and the new normal life style led to new job value creation such as sell product online, food delivery project and many hygiene items launching. On the other hand, wastes are also generated. Therefore, the aims of this paper are: 1) to analyze the change of customer behavior related to household waste which happen before and during the situation of COVID-19 and 2) to propose the suggestion to reduce the household waste that occurs. The research methodology has done by specific searching for the data refer to the reliable sources, then correct and analyze the data related to household waste which happen before and during the situation of COVID-19, finally conclude the data led to the suggest to reduce the waste.

II. COVID-19 AND SOCIAL CHANGE IN THAILAND

Since the COVID-19 has detected in Thailand, the peak of the total number of cases are more than 21,000 cases per day. The country has been locked down, department store has been shut, the customer cannot sit in the restaurant, people have to keep social distancing. There are 3 obvious changes in Thai society during the situation which are: 1) the way to buy the product from the real store to online store, 2) the way to have their meal at the restaurant to send direct to their home and 3) the way to find the item to protect their health.

Since, the lifestyle has been changed, then the new job is created. Street vendor moves to an online merchant, truck driver applies to be a parcel deliver, motorbike taxi becomes food rider. From these changes can be seen in the

value of e-commerce business that is in 2020 e-commerce value grew 31.3% compared to 2019 and expected to grow 19% in 2021 with the value of 71,800 million Baht [1]. Meanwhile, food delivery business in 2020 grew 78-84% compared to 2019, the packaging in term of plastic from the historical growth rate was around 1.5% but in 2020 growth rate almost reach to 9% [2]. It is because of the customer's need from E-commerce business and food delivery business

III. THE IMPACT OF COVID-19 ON THE ENVIRONMENT

From the COVID-19 situation led to the change of customer behavior, when consider in term of benefit point of view. It creates many new job's value, decrease traffic and PM 2.5, or even create new innovation for health protection. On the other hand, the situation causes environmental impact. To list the environmental impact from COVID-19, it can be described in term of the main activities that are changed in Thais society which are E-commerce activity, food delivery and health protection

A. E-Commerce activities

The value creation of E-commerce activities is the product has been sent directly to the customer's address. Moreover, the product when it is sent to the customer has to be in a good condition. So, the packaging takes an important role to protect the product along transportation process. The growth of the Thai E-commerce market is stronger than previously anticipated due to COVID-19 that drives Thai people to get familiar to shop online. The E-commerce value of retail business in 2019 worth 163 billion Baht, in 2020 grows 81%, worth 294 billion Baht and it is projected to grow 20% per year [3]. In the next 5 years the retail E-commerce in Thailand is expected to reach 750 billion Baht [4] as shown in figure 1.

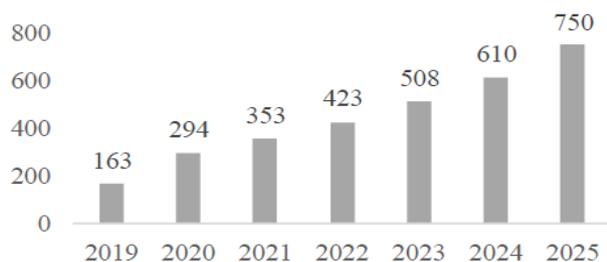


Figure1. E-commerce retail business value 2019-2020 and 5 years forecast

In 2020 the research from Priceza found that the online merchants have been increased 50% from 2019 to open their store on the 3 E-commerce platform which are Lazada, Shopee and JD-Central. The well-known brands have also been increased 46% from 2019 to open the official store on Lazada and Shopee. From the great number of the E-commerce values, Thailand post reported that the peak of order number during the situation of COVID-19 around 8 million parcels per day. Normally E-commerce parcel may use up to seven types of packaging materials which are paper bills, envelopes, cardboard box, plastic bags, woven bags, tape, and protective materials (bubble) [5]. Therefore, waste from E-commerce packagings cause the environmental impact. During the situation, not only non-food products, but also food (fruit and vegetable) was delivered via 3PL provider service. Moreover, in the peak period of COVID-19, the distribution center has to shut down because the staff is infected the disease so the product is damaged and spoiled and become food waste [6].

B. Food Delivery

During the situation, the government command the closure of many services, closing time for restaurant service is only 9 p.m. and government ask the business to let staff work from home which will help greatly in reducing the spread of infection. During the lockdown period, customers cannot sit in the restaurant to have their meal. Before the outbreak of COVID-19 Food delivery business was worth up to 33-35 billion Baht. Then in 2020, the customers use food delivery application service was 66-68 million times which increase 78-84% from the same period in 2019. [7] forecast that in 2021 the food delivery order is expected to reach 120 million times with the value of 53.1-55.8 billion Baht as shown in Table 1.

Table1. Food delivery number orders and value in Thailand Before and During Covid-19 Situation

Year	Food delivery order per year (million orders)	Food delivery value per year (billion THB)
2019 (Before Covid-19 Situation)	37.0	33.0-35.0
2020 (During Covid-19 ripple 1-2)	66.0-68.0	N/A
2021 (During Covid-19 ripple 3)	120.0	53.1-58.0

The most popular applications are LINE MAN and Grab Food, with the usage statistics has been increasing by 300-400% compared to the pre-Covid period [8]. Thailand Research Development Institute (TDRI) estimate that 1 of food order may use up to 7 pieces of plastic waste, including food boxes, sauce bags, plastic spoons, plastic forks, cutlery bags, soup bags and plastic food handle bags [9].

C. Health protection and Self-Examination

During the situation of COVID-19, not only the change of customer behavior in term of how to buy the product and food nut also the people have to apply the important tools such as social distancing and self-protective tool. The example of health protection items are disposable face masks, N95 masks, spray alcohol, vaccinated syringe, medical gloves regarded as infectious waste. Usually, hazardous waste in hospital is terminated by the incinerator's method in high-temperature. Meanwhile, people have been using disposable face masks every day during the situation and throwing them away every day. So, it should consider as infectious waste too. Approximately, 70 million of Thai citizens use 40 million disposable face masks and create an average of 20 million pieces of infectious waste per day because some people may reuse [10]. Other health care items that significantly use during the pandemic are groves, ATK test kit, and vaccination syringe. Consider to the vaccination dosage that Thailand expects to reach is around 100 million dosages which means there are 100 million of plastic syringes that become waste.

IV. ANALYSIS OF CHANGE IN HOUSEHOLD WASTE DURING COVID-19

From the change of people lifestyle, the way to buy the product both food, non-food, and also a health care item. The data shown that the value of E-commerce and food delivery has been increased continually. On the other hand, the activities lead to waste that impact the environment. To analyze the household waste during the situation of COVID-19 therefore it has been analyzed in 3 main categories which are 1) total of plastics waste, 2) plastic waste form food delivery business and 3) infectious waste Procedure for Paper Submission

A. Total of plastic waste Submit your manuscript electronically for review.

Data from the Ministry of Natural Resources and Environment has shown that the total amount of solid waste increased almost 4 million tons from 24.11 million tons in 2009 to 27.93 million tons in 2018. From the plastic waste problem, the consumption of plastic bag from over the world are 500 billion to 1 trillion pieces per year, or at least 1 million plastic bags are used in every minute. In Thailand, the use of plastic bag is up to 45 billion pieces per year, or an average 8 pieces per person per day [11]. Since the spread of COVID-19, the amount of plastic waste has been increased 15% or from 5,500 tons per day in 2020 to 6,300 tons per day in 2021 [12]. The amount of plastic waste accounted for 12% of solid waste or 3.35 million tons

which including waste that can be recycled 60% and cannot be recycled 40% the proportion has been shown in figure 2.

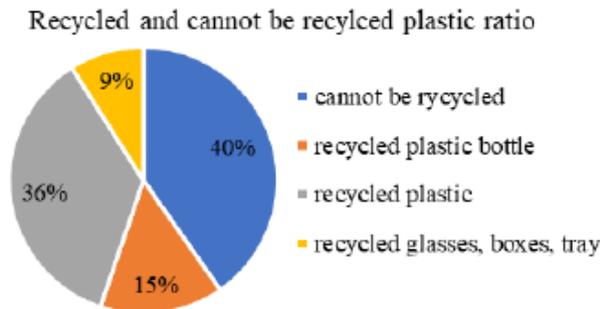


Figure 2. proportion of recycled and cannot be recycled of plastic waste in 2019 in Thailand

It is only 2 million tons are recycled which 500,000 tons are plastic bottles and 1.5 million tons of plastic waste is divided into plastics 1.2 million tons and the rest are glasses, boxes, and trays [13]. Moreover, it has been found that during the situation of COVID-19 the plastic waste in Bangkok increased 60% from 2,115 tons per day (January to April 2019) to 3,432.3 in 2021 at the same period. The number of recycled plastic waste is 659.8 tons and contaminate plastic waste is 2,772.5 ton per day [14] as shown in figure 3.

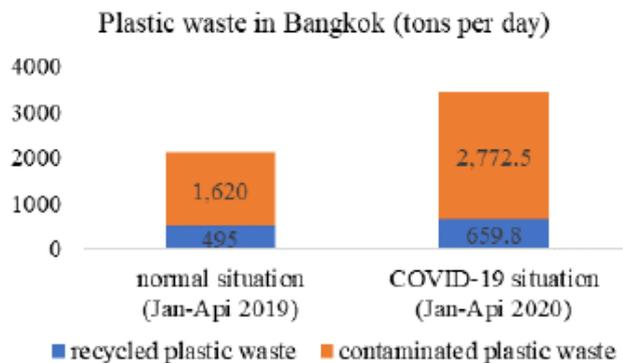


Figure 3. The amount of plastic waste in Bangkok before and during Covid-19 Situation

In contrast, the recycled waste decreased from 23% to 20% due to lack of waste sorting and plastic waste contaminate with food waste as shown in figure 4.

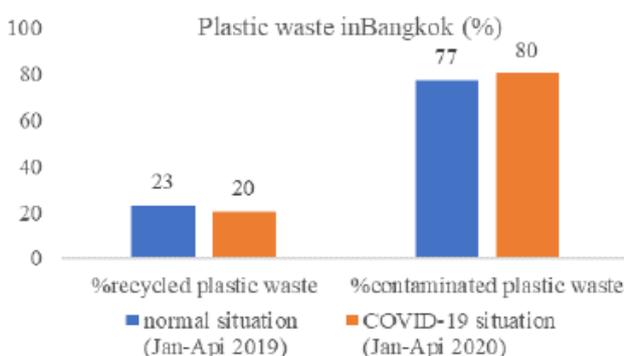


Figure 4. The percentage of plastic waste in Bangkok before and during Covid-19 Situation

B. Plastic waste form food delivery business

To analyst the waste from food delivery business so it can be accounted in term of plastic packaging that come with food. Then to forecast the amount of plastic waste from food delivery in the future, it is based on a minimum and maximum quantity of plastic waste per order. A minimum quantity is 4 pieces of plastic waste per order which is counted from Food Passion company and maximum is 11 pieces come from The Department of Pollution Control. Environmental Research Institute of Chulalongkorn University found that in 2020, the quantity of plastics waste from food delivery was 1,120-3,080 billion pieces and expected to reach 2,325 – 6,395 billion pieces in 2025 or 34,883 – 95,928 tons as shown in figure 5.

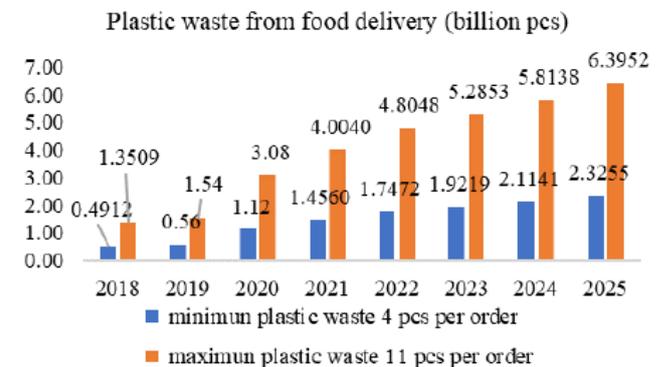


Figure 5. The amount of plastic waste from food delivery 2018-2020 and 5 years forecast

C. Infectious waste

Due to the situation of COVID-19, at the same time, infectious waste has also been increased from the activities that most of people has used the item to protect their health such as disposal face mask, Antigen Test Kit (ATK), gloves, PPE, and syringe. The data from the Department of Health found that infectious waste has been increasing every year, in 2020 infectious waste reach 34.5 million kg. [15]. However, in 2021 the situation of COVID-19 is worse than 2020, during July, an average of infectious waste reach 275 tons per day and in August expected to reach 330 tons per day. Therefore, the infectious waste is expected to increase at least doubled time as shown in Figure 6.

The Environment Department of Bangkok report that infectious waste comes from general infectious waste and infected waste from COVID-19 approximately 37,000 kg - 41,000 kg per day including disposal face masks and Antigen Test Kit (ATK) that rapidly increase recently. Both common infectious waste and infectious waste from COVID-19 have to terminate by burning. Meanwhile, since the pandemic, the fuel burners have to work all the time to let incinerator operate 24 hours a day to terminate the infectious waste which collected from all departments, including hospitals, public health departments, clinic and state quarantine. The amount of infectious waste collected at this time does not exceed the capacity of an incinerator as 70 tons per day, but when the amount of infectious waste exceeds the capacity, then it will be taken to a conventional

solid waste incinerator which can support 500 tons per day [16].

V. WASTE MANAGEMENT PRACTICE

From the change of people lifestyle, the way to buy the product both food, non-food, and also a health care item. The data shown that the value of E-commerce and food delivery has been increased continually. On the other hand, the activities lead to waste that impact the environment. To analyze the household waste during the situation of COVID-19 therefore it has been analyzed in 3 main categories which are 1) total of plastics waste, 2) plastic waste from food delivery business and 3) infectious waste Procedure for Paper Submission

A. Thailand practice

Even before the situation of COVID-19 Thailand has to face the waste problem, then the government try to find the solution to reduce waste. Then, during the pandemic, the waste from the activities of E-commerce, food delivery and infectious waste have been increased continually. The e-commerce order is not including not only the product, but also unwanted material that became waste such as packaging. Moreover, as it is mentioned that waste is also from the food packaging order and after used disposal of hygienic protection. To reduce waste that occurs, the food delivery platforms help to apply the option to the customer to not receive the fork, spoon and straw or somehow if the customer chooses to receive it then the has to pay as optional. Encourage restaurants to switch to environmentally friendly packaging such Food packaging made from the pulp and bagasse is another solution to reduce plastic waste. The direction from government need to reduce of using plastic and foam, then in 2022 plastic bag thinner than 36 micrometers, styrofoam boxes for food packaging, single-use plastic cups and straw have to be canceled, then target to use 100% recycled plastic in 2040. Waste sorting is one of the practices which should be divided into 3 categories [17] 1. Infectious waste, which is suspected to be contaminated with mucus, saliva, and secretions of patients such as masks, tissues, containers and equipment used for single-use foods such as spoons, forks, glasses, straws, and PPE kits collect in red bags and collect in the red trash. During the situation Bangkok sets the station to place the orange trash to support the disposal face mark after use and prepare the red bag to support in public area 1,000 station also control not to let the other solid waste throw in the trash then collect the trash to terminate in the incinerator [18]. 2. General waste includes waste that is not contaminated with mucus, saliva, and secretions of patients such as paper, plastic bags, metal cans, glass bottles, milk boxes, plastic bottles, candy bags, various packaging, collect and pack garbage into the black bag. 3. Food waste collects in a specially arranged container to make fertilizer.

B. Other Countries Practice

The solution to reduce waste from other countries are not only find the new material that can be recycled, but also the regulation plays an important role to enforce the producer

to concern and response to their product. Governments of large countries around the world are increasing their efforts to develop waste recycling or reusing programs. Germany has become the best waste recycling rate in the world. In 2018, Germany recycled 56.1% of the total waste they produced [19]. The government issued a decree to avoid packaging waste and let the manufacturers response for their own packaging waste. Therefore, manufacturers began to put the symbol 'Green Dot' on their packaging by contracting with the waste collection company to guarantee that the packaging will be reused led to a parallel garbage collection system with the existing community waste.

The Korea government has enforced the policy ban all colored plastic and PVC bottles by 2020, then reduce and eliminate the use of disposable glass and plastic straw within 2027.

The example to reduce waste from the giant E-commerce platform as Amazon is to offer the option to allow the product to be shipped without excessive packaging so it can avoid the product that already pack in the box and then shipped in the big box. When the product has been sent from the same warehouse, the marketplace can request the customer to ship the product together and offer a discount as privilege because the customer might take more 2 days waiting for the product delivery. Another solution that can reduce the waste in term of customer is to shop from the companies that use recyclable and compostable material to produce the packaging [20].

VI. CONCLUSION

The change of personal lifestyle has been forced from the situation of COVID-19, The research found that there are 3 changes which are the way to buy product online, the way of food delivery and the implement of hygienic products. When the way of buy product and food online instead of offline and the increasing of hygienic product as the result, the research also found that the wastes are generated and increased more than normal situation. The unwanted material that comes with the product they buy, after used of catering material and hygienic item are the result from the change of behavior, then the research provides the practice to reduce the waste in term of Thailand and other countries. In Thailand, the government and private sector try to implement the solution to reduce waste the occur. In other countries, regulation enforcement is also important then the research provides the case from Amazon that use to reduce the waste.

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Stair Detection and Classification Using Deep Neural Network for the Visually Impaired

^[1] Ashwini Gaikwad, ^[2] Dr. Vinaya V. Gohokar, ^[3] Dr. Rupali Kute, ^[4] Bhakati Paranjape

^{[1][2][3][4]} Dr. Vishwanath Karad, MIT World Peace University, Maharashtra, Pune, India

Abstract— Stair case detection is very challenging task for visually impaired people. It plays very important role to avoid accidents. Detecting stairs are comparatively easy but classification of stair case as up and down is a complex task. The literature survey more focuses on classifying up stair cases. However, detection of downstairs is also more important for visually impaired. The paper presents work done in the field of stair case detection for visually impaired people custom dataset of stairs up and down is prepared. The images are taken under various light conditions and background. It mainly focuses to detect up and down stairs using a different pertained model and comparative performance analysis is presented. The fine-tuned VGG-19 pretrained deep learning model gives better performance.

Index Terms— Stairs detection, Stairs classification, Deep learning, Custom dataset, Faster R-CNN ResNet50V1, VGG-19

I. INTRODUCTION

As stated by world health origination, globally at least 2.2 billion people have a near or distance vision impairment [16]. In India 15 million people are visually impaired [18]. It is very difficult for them to carry out their daily tasks and they require support to do these tasks. When visually impaired people come at the age group of 60-80 these problem becomes more serious for injury and death. Amongst all the daily tasks stair case detection and classification is one of the most important areas in research for visually impaired people to avoid accidents.

Stairs are of many types and shapes. These different varieties of stairs become more dangerous if it is not correctly detected or classified. Therefore, detection and classification are the most important tasks to avoid accidents. Visually impaired people may fall if stairs are not correctly classified. Already many devices are designed as Helmet, low weigh stick, smart cap and more models developed using latest technologies for visually impaired people to make their life more comfortable.

In this paper the stair case detection is done using deep neural network. Faster R-CNN Resnet50v1 pretrained model is used. The designed model detects up and down stair condition with high score. Deep neural network is used to achieve high accuracy. Deep neural network has many features in application areas such as defense, medical, automatic driving car etc. It provides features like object recognition and detection, image classification, face recognition and detection. For classification of stairs as up and down VGG19 pretrained convolution neural network is used.

For this research custom dataset of stair case is created using Google's open image dataset v6, some images are downloaded from internet and some images are taken from the surroundings. These all images are labeled and given as an input to the pretrained model. Stair case detection model is trained using pretrained Faster R-CNN Resnet50v1 and staircase classification is done using VGG19 pretrained model.

The organization of paper is as follow, section 2 describes the literature review. Section 3 describes the proposed work of the system. In section 3.1 stair case detection proposed work is described and in section 3.2 describes the proposed work of stair case classification. Section 4 describes the experiment and analysis of staircase detection and classification. Section 5 describes the conclusion of the paper with future work.

II. LITERATURE REVIEW

Deep learning techniques are used to design a model which can solve complex problems. Deep learning provides many features like online newspaper paper reading, image captioning, face and text detection and recognition, object detection, drug pill recognition system. In many systems to improve accuracy of the system deep learning algorithms with pretrained networks are used. Md. Ahsan Habib, Md. Milon Islam et al. [1] developed hybrid system using sensor. Faster R-CNN Inception-v2-COCO model is used for the system for both upstairs and downstairs detection. And achieved accuracy of 98.73%. Low weight stick using ultrasonic sensor for staircase and manhole detection is developed by sreenu ponnada et al [2]. Bivariate Gaussian Mixture Model is used for both upstairs and downstairs detected with 88% of accuracy. Anderi ciobanu, Anca Maorar [12] developed real time stair case detection on mobile device using structure sensor. Staircase detection algorithm is used for detection and only upstairs are detected. Ascending order stairs and location of stairs are detected from the images by Sara Carbonara, Cataldo Guaragnella [15]. Researchers used characteristic frequency spectrum method for this model. Camera system on helmet is developed by Hannes Harms, Eike Rehder et al. for real time assistance for visually impaired people. Only ascending stair detection is done with good accuracy. Anurag Ramteke, Pradip K. Das et al. [4] using convolution neural network different types of full and partial stair case detection is done using GPS and pixel information. Python environment is used to develop the model. And achieved classification accuracy of 89.74%.

From this literature survey, it is seen that different techniques and algorithms are used to detect staircase. But there is less work done on detection and classification of both upstairs and downstairs. In this paper the research is done to design model for both detection and classification for both upstairs and downstairs using deep neural network. Faster R-CNN ResNet50V1 pretrained model is used for staircase detection. And for Up and down staircase classification VGG-19 pretrained model is used. Different pretrained model like Xception, MobileV2, VGG16 and VGG-19 were used for classification for performance analysis and comparison. Model obtained good results using VGG-19 and achieved accuracy of 83% for classification.

III. PROPOSED METHODOLOGY

The two proposed methodologies, A. Staircase Detection B. Staircase Classification is explained in the following sections.

A. Staircase Detection

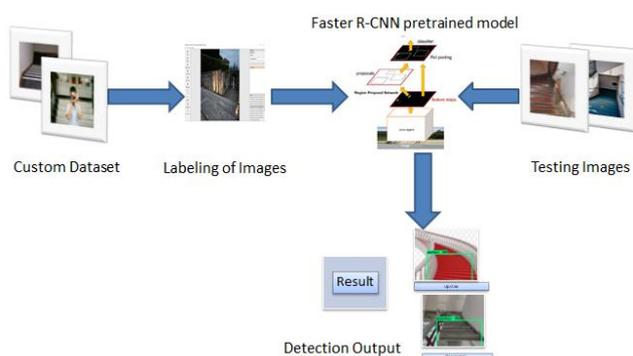


Fig. 1. Block Diagram of Staircase Detection System

Block diagram of staircase detection is shown in figure1. Input for this system is set of staircase images. Custom dataset is created. Dataset is labeled using labeling application. It is popular and user friendly application. In this application labels are saved in .xml file format of PASCAL VOC which is a popular format. This dataset contains upstairs and downstairs images. Labeling is done for upstairs images as 'upstair' and downstairs images as 'downstair'. Sample image labeling in labeling as shown below. Training is done using this labeled dataset. For training Faster R-CNN ResNet50V1 pretrained model is used. After completing the training, model is tested by giving test images. At the output stage upstairs and downstairs detection results are obtained.

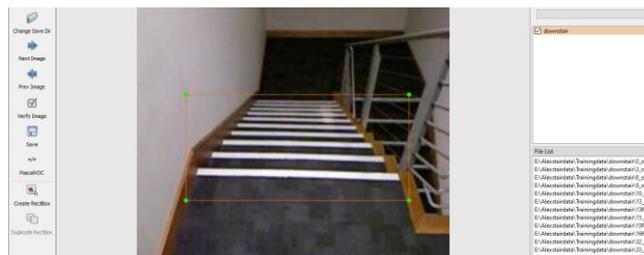


Fig. 2. Image Labeling.

B. Faster R-CNN ResNet 50 V1

Faster R-CNN is improved version of Fast R-CNN. Region proposal and convolution models are used in Faster R-CNN. Faster R-CNN contains two modules. First model is deep fully convolutional network and second module is Fast R-CNN detector that uses the proposed regions. Faster R-CNN is faster than Fast R-CNN. Faster R-CNN is one of the most accurate algorithms for object detection. The architecture of Faster R-CNN is shown below.

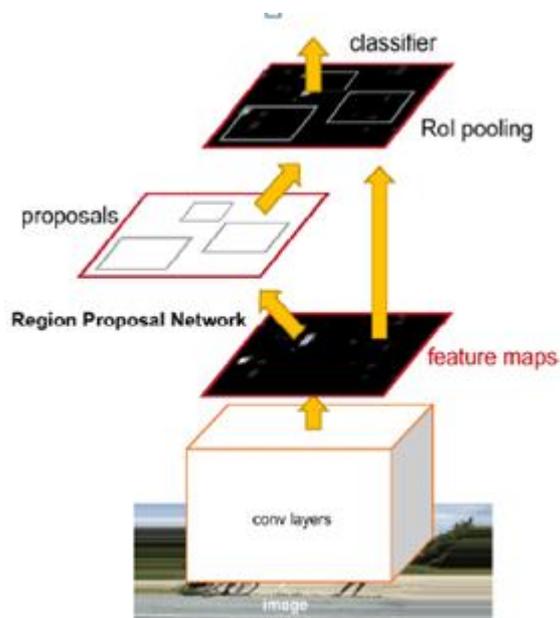


Fig. 3. Faster R-CNN Architecture [17]

Model is trained using Faster R-CNN ResNet50v1 pretrained model. This model is trained on COCO 2017 dataset. COCO is a large dataset which has several features: object detection, recognition and segmentation. The images are scaled in 640x640 size in Faster R-CNN ResNet50 v1 model. Faster R-CNN with Resnet-50 (v1) initialized from ImageNet classification checkpoint [20].

B. Staircase Classification

The block diagram of staircase classification is shown below

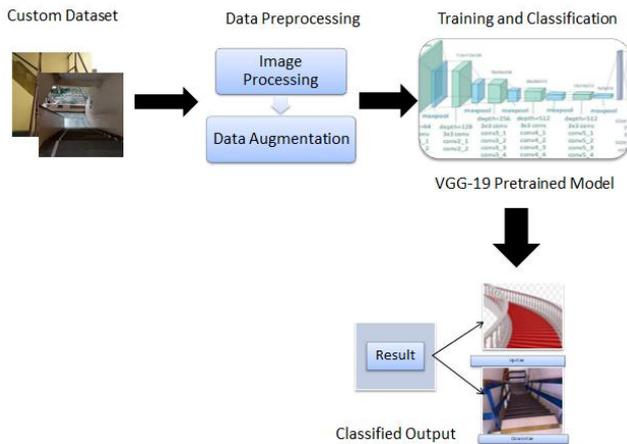


Fig. 4. Staircase Classification Block Diagram.

The block diagram shows the staircase classification model to classify upstairs and downstairs. Custom dataset is created and pre-processed to make dataset suitable for our model. There are different pretrained models are available for image classification like VGG-16, ResNet50, Inceptionv3, EfficientNet etc. We are trained our model using different pretrained model like Xception, MobileV2, VGG16 and VGG-19. Analysis is made from these models. From analysis, VGG-19 is used which gives good results. Model is tested by giving test images and output is observed. The model is correctly classified upstairs and downstairs images.

1) Pretrained Models

VGG-19: VGG19 is a 19 layer deep pretrained model. It is an improved version of VGG-16. It is trained imageNet dataset. It can classify large number object category of images like people, pencil, animals. Input size for this model is 224x224. VGG-19 is used as both feature extraction and fine tuning. The architecture of VGG-19 is shown below,

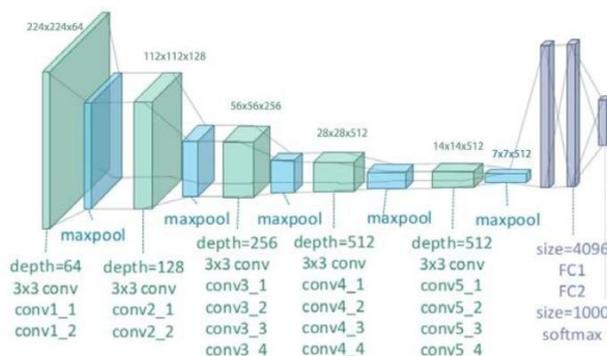


Fig. 5. VGG-19 Architecture [3].

VGG-16: VGG-16 is 16 layer deep convolution neural networks. This model is used for classification and detection. The model achieves 92.7% top-5 test accuracy in ImageNet, which is a dataset of over 14 million images belonging to 1000 classes [18]. The architecture of VGG-16 is shown below. Input image size required for this network is 224x224 RGB images. There are some drawbacks of

VGG-16, it is slow to train and weights in network architecture are larger so more disk space required.

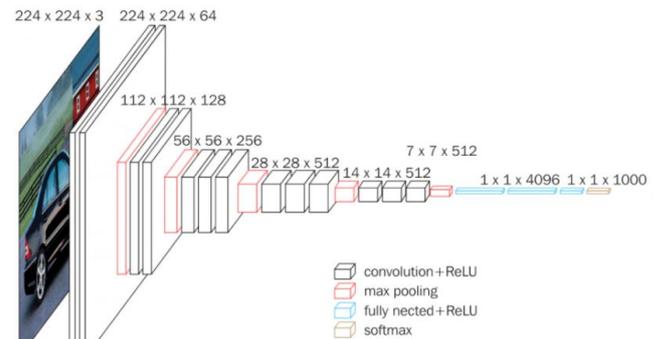


Fig. 6. VGG-16 Architecture[18]

MobileNetV2: MobileNet2 works well for mobile devices or any device which has low computational power. It is most important pillar for feature extraction .It is also widely used for object detection and segmentation. The architecture of MobileNetV2 is shown below.

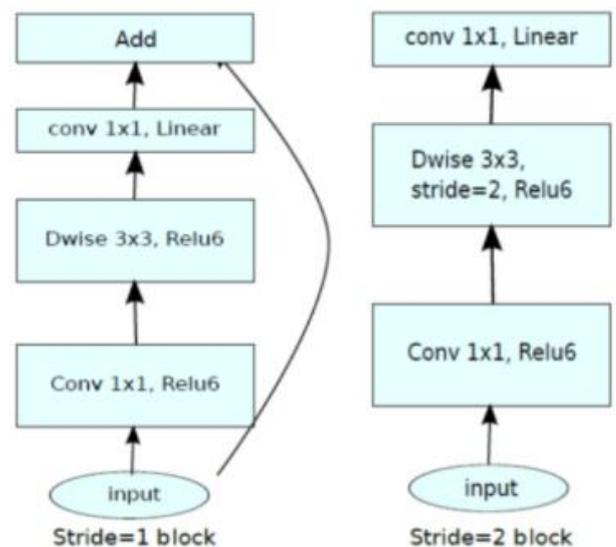


Fig. 7. MobileNetV2 Architecture [13].

Xception: Xception is deep convolution neural architecture that involves depth wise separable convolution. Xception is based on architecture of inception model. Stander inception model is replaced with depth wise separable convolutions. The architecture of xception model is shown below. In this model first data flows in entry level. After entry level it flows in middle level and repeated eight times and finally in exit flow.

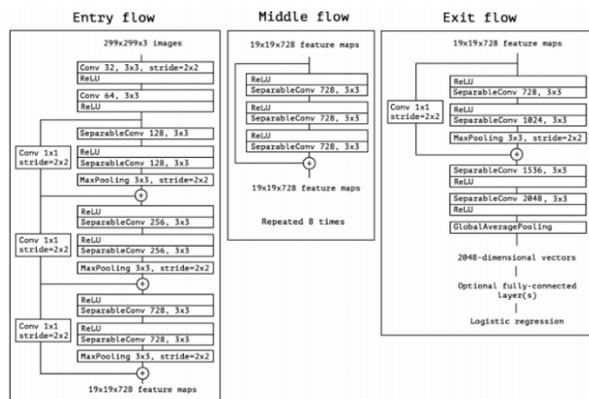


Fig. 8. Xception architecture [13].

IV. EXPERIMENTS AND ANALYSIS

Once the model is trained, we get detection and classification results on test set. Experiment is performed for two categories A. Staircase detection B. Staircase classification. Availability of staircase dataset in already existing dataset was checked. As it was not available, custom dataset was created. The staircase dataset is downloaded from Google’s open image v6 dataset, internet and some images of residential buildings. Images are resized to 227x227 sizes for less processing time. Below figure shows some sample of custom dataset images which are collected for staircase detection.



Fig. 9. Sample of custom dataset images.

Data augmentation: In deep learning applications large number of data is required. For our system to get larger dataset some image processing function is applied for which color transform and flipping functions have used. Custom dataset is divided into training and testing sets. Model is trained on this training dataset. Trained model is tested on the testing dataset. Also output analysis is done using testing dataset.

A. Staircase Detection:

Stair case ‘Upstair’ and ‘Downstair’ condition is detected by the system with high score. Using Faster R-CNN ResNet50v1 model is trained while training there is loss at each step. When training start loss is high and it get decreases during training progress. We stopped our training at 20 K steps. At this step minimum loss is obtained. Training time required is 2-3 hours for 20 K steps. In figure 9 shows loss at each step. Staircase detection output is shown below figure 10.

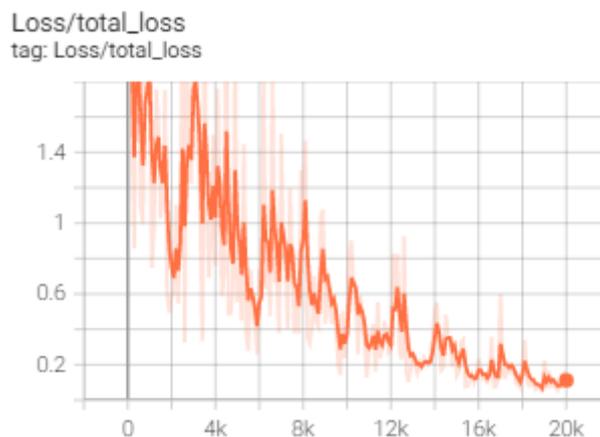


Fig. 10. Graph of total loss during each iteration.

A. Test Image	B. Detected Image

Fig. 11. Staircase Detection.

B. Staircase Classification:

Model is trained using different pretrained model like Xception, MobileV2, VGG16 and VGG-19. This trained model is applied on test set and analysis is done. Classification report shows the accuracy, precision and recall obtained by models.

Performance analysis is done on following parameters. Model is correctly classify upstairs and downstairs is represented by True positive(TP) and True negative(TN) while model is incorrectly classified upstairs and downstairs is represented as False positive(FP) and False negative(FN). Performance metrics parameters, definition and equations is explained in below table.

Table 1. Performance metrics

Performance Metrics	Definition	Equation
Accuracy	It is ratio of number of stairs prediction done correctly to total number of prediction made.	$\frac{TP + TN}{TP + FP + TN + FN}$
Precision	It is ratio of correctly predicted positive stairs to total number of positive result obtained.	$\frac{TP}{TP + FP}$
Recall	It is ratio of correct stairs prediction outcomes to the actual results obtained.	$\frac{TP}{TP + FN}$
F1-Score	It is the average of precision and recall. Higher the F1-score better is the performance.	$\frac{2 \times (\text{Recall} \times \text{Precision})}{\text{Recall} + \text{Precision}}$

All performance metrics accuracy, precision, recall and f1-score obtained using different pretrained model is shown in classification report. VGG-19 model gives high accuracy 83 % and it is more efficient and accurate. Classified images of upstairs and downstairs is shown in below figure,



Fig. 12. Classified Images.

Table 2. Classification Report

Sr No	Model	Precision (%)	Recall (%)	F1 Score (%)	Support
1	VGG-19				
	Upstairs	82	82	82	50
	Downstairs	83	83	83	54
	Accuracy			83	104
	Weightedavg	83	83	83	104
2	VGG-16				
	Upstairs	90	73	80	62
	Downstairs	69	88	77	42
	Accuracy			79	104
	Weightedavg	81	79	79	104
3	MobileNetV2				
	Upstairs	68	94	79	50
	Downstairs	91	59	72	54
	Accuracy			76	104
	Weightedavg	80	77	75	104
4	Xception				
	Upstairs	67	92	77	50
	Downstairs	89	57	70	54
	Accuracy			74	104
	Weightedavg	78	75	73	104

V. CONCLUSION

In this paper stair case detection using deep neural network for visually impaired people is proposed. For visually impaired people classify stair as up and down is difficult. In this paper detection and classification is done. Faster R-CNN ResNet50v1 pretrained model is used for staircase detection. Model is detected upstairs and downstairs with high accuracy. VGG-19 pretrained model is used for staircase classification as upstairs and downstairs. The developed model achieved detection accuracy of 99% and classification accuracy of 83%. The working flow and architecture of the system is explained well with proper diagrams and tables. In future, this model can be used for real time stair detection with some danger alarm system. This alarm system become more user friendly for visually impaired people for indoor and outdoor stairs detection.

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Development of Medium-Sized Multipurpose Agriculture Vehicle

[1] Kanchana Daoden, [2] Sureeporn Sringam, [3] Supanat Nicrotha, [4] Thanawat Sornnen

[1][4] Faculty of Industrial Technology, Uttaradit Rajabhat University, Thailand

[2][3] Independent Researcher

Abstract— In this decade, the farmers in Thailand suffered from a labour shortage, loss during harvest, improved productivity and increased cost of the farming part. The rice crop plots of the northeast province have been set to the case study. This research aimed to develop the Medium-Sized Multipurpose Agriculture Vehicle (MSMAv) innovative from the conventional agriculture tractor for two purposes. The firstly is to present the novel modified technique of automatic gear for the MSMAv to serve the development of automatic control that expect to reduce the number of labour while controlling machine. Secondly, extending the implementation for several peripheral via a drawbar or hitch system means minimizing the cost of the machine investment. Therefore, the research team has collaborated to develop the conventional farm tractor by changing from a manual to an automatic gear system, including supplementing equipment such as a remote-control system, GPS, car camera, sensors, voice command, for instance, based on existing technologies. The research team expects the development prototype of the vehicle for rice production will be the novelty approach, which provides both opportunities and knowledge to farmers at the same time.

Index Terms— Medium-Sized Multipurpose, Harvesting, Organic rice

I. INTRODUCTION

Most of Isaan (the north-eastern part of Thailand) population live in agricultural activities [1]. The Northeast region (NE) (Figure 1) also has an area of around 41,724,732 acres or 33.17%, which is comparable to one-third of Thailand's total area, making it the largest in the country. This region currently has approximately 5,378.95 acres of farmland, of which 5,259.57 acres on rice production, and trend to expand in the future, which the farmers aim to expand the production area, including managing everything from ranching, sowing, planting, weeding, watering, and humus. Therefore, farmers were established on behalf of Social Enterprise Company Limited to help farmers and sell rice, causing the economy's circulation. They have a marketing plan to distribute various rice varieties to known all over the country in the future.

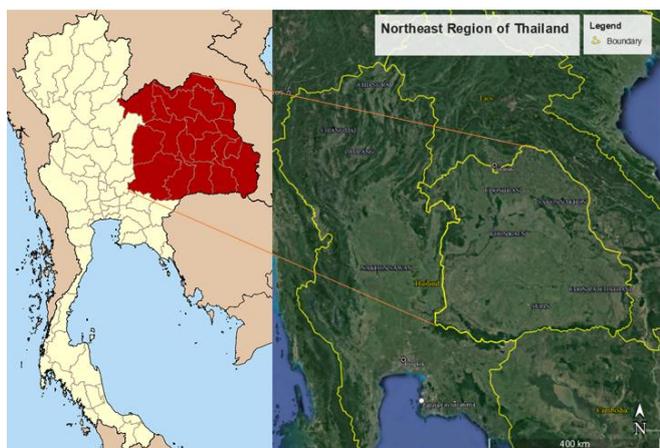


Fig.1. The map of the Northeast region of Thailand.

Figure 2 is an example of a paddy field in the NE region conducted to meet consumer demand. However, most farmers in the group faced problems in rice production, such as labour shortage in the agriculture sector and the requirement careful of chemical contamination problems following market demands and government policies. Therefore, the existing conventional agricultural tools [2-4] do not respond to these problems. In addition, there is a problem of harvesting time for some varieties that desire to improve the quality to get the best rice taste and aroma, it is necessary to harvest in a limited time. Moreover, an important problem of a general harvester is an obstacle to small plots and uneven terrain of paddy production. It made the farmers working in small and narrow spaces unable to use the combined harvester as it is a significant obstacle in using large and heavy agricultural machinery [7-8].



Fig.2. A croft area of the province with the cultivation of rice.

Finally, farmers will have to face the problem of access to capital, as they require significant investments in new technology, equipment and agricultural machinery. This problem is complex for farmers who wish to purchase farming machinery to make them more convenient and efficient; therefore, we can develop agricultural machinery with modern technology, such as the development of powerful engines [9]. Including interfacing with a semi-automatic control system for rice growing needs by developing from this medium-sized multi-purpose vehicle called that E-Tak truck can solve the shortage of labour factors in production. The issues mentioned earlier will lay the foundation and spark the development of modern technology for the new generation of farmers in Thailand.

In the first sample area, the research team explored the problem and attended a meeting to listen to opinions and ask questions about farmers' needs in Nong Bua Lamphu province, therefore the most extensive rice production area in the NE. The village community leaders supervised the research team to meet and discuss the initial problems and present the solution to this research problem.

II. MATERIAL

The problem with farmers in many provinces is that they have not had tractors/trucks for farming for a long time. Due to many factors such as economic problems, personal problems, and many other technical problems, this province is still an emerging province. Agricultural scholars or agricultural mechanical engineers are still not enough to help each other bring modern technology to aid in agriculture [12]. Therefore, the research team has tried to push government agencies to help the farmers, assisted by The Thailand Research Fund Thailand Science Research. Innovation, which will start in Nong Bua Lamphu province as beginning with the development of a medium-sized vehicle from "E-Tak vehicle" as a small agricultural truck, has a low horsepower. Save solar fuel in driving to have the ability to work by improving and developing the limitations of E-Tak vehicles in general in three areas as follows: Firstly, we can reduce the number of vehicle operator workers from two to only one person. Then, we will modify the structure of the E-Tak vehicle, which was initially thick steel material, to be lighter material to reduce the burden of carrying a lot of weight, resulting in unnecessarily high fuel consumption and production costs. Finally, we are present to biodiesel (palm diesel) as diesel fuel produced from agricultural products in the area. The final research was to develop the control of this medium-sized multipurpose with a semi-automatic remote-control system.

A. Study on the medium-sized-vehicle prototype



Fig.3. The operation of the prototype vehicle in the farm [18].

We studied the information of the actual vehicle in use present-day—the performance characteristics of vehicles and peripherals required for farmers. Figure 3 shows the researcher team visit to the existing site to study the operation of a full-size car and survey the materials used and related technologies to design a medium-sized multipurpose agriculture vehicle prototype, particularly the hydraulic system structure.

B. Researcher designing of hydraulic system

The researcher team has designed the hydraulic structure system by visiting the area to study and develop the medium-sized-purpose vehicle structure suitable for the actual operation. The researcher team has investigated the model of a full-size vehicle prototype agricultural with farmers who use it in this region.

C. The system of the medium-sized-multipurpose vehicle

The entire system of the MSMAv in this research is divided into three distinctive design sections to the most relevant results based on existing technology. 1) the mechanical structure design, then 2) the electronics hardware plans and sketch followed by 3) a system of the invention is software application designing.

D. The Mechanism Design

The mechanism design consists of complete designing such as hydraulic system design, power transmission design, steering mechanism design, and brake system design.

III. METHODOLOGY

A. Hydraulic System Design

We design considerations to meet function requirements, including performance specification, life expectancy, facilitate good maintenance practice and efficient operation. We developed a system for power transfer controlled by hydraulic oil compressing. Since adding a pressure for the device to change the stress of hydraulic oil to mechanical energy (Actuator) or (Hydraulic Cylinder), the system relies on the leading equipment as follows: Figure 4 showed the prototype of this research for the development of a medium-sized multipurpose agriculture vehicle.

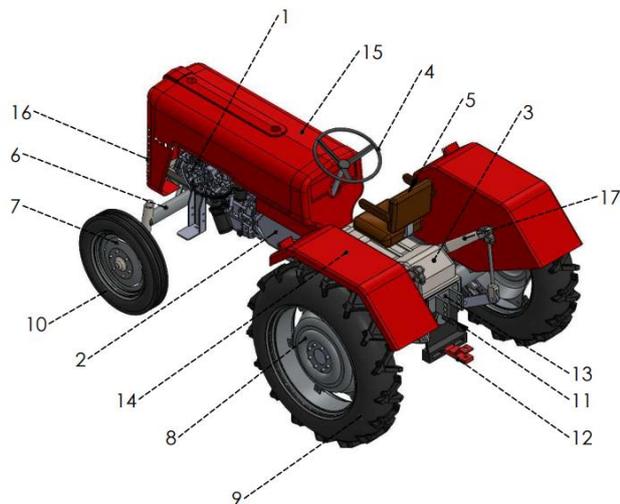


Fig.4. The main driveline units of the medium-sized-purpose vehicle.

Table 1 shows the number of objects of the prototype Medium-sized multipurpose agriculture vehicle.

TABLE I Number of the objects

No.	Object
1	Diesel engine
2	Gear box
3	Differential gear
4	Steering wheel
5	Seat
6	Front axle
7	Front brake set
8	Rear brake set
9	Back tire
10	Front tire
11	PTO Shaft
12	Towing set 1
13	Towing set 2
14	Rear fender set
15	Mid hood
16	Front grill
17	Lifting set

B. Power Transmission Design

The design of the tractor transmission system has two functions: First, to free the engine from the tractor wheels when changed gear. Second, to transmit the smooth torque without shocks and jerks to the engine to change the engine torque and engine speed into the torque and speed required by the road wheel for the different tasks required of a tractor. The transmission system is our design; the driveline of a medium-sized-purpose tractor in our case consists of components that transmit the torque developed by the engine to the driving on wet/dry field wheels and to vary the torque and direction of rotation of the ground wheels [16-17].

The power transmission system design consists of the following parts: Firstly, the clutch – the device that connects or disconnects two torque-transmitting devices. Then an apparatus for transmitting power at a multiplicity of speed and torque. Then, power take-off drive – the parts that transmit torque from the engine to the PTO spline on the tractor's rear. Then, the differential part– the device, usually in the axle housing, allows the two wheels on an axle to rotate at different speeds. Then, the brake system, usually in the axle housing, stops the tractor's motion. Then axle – the shaft and connecting parts that transmit torque from the differential or final gear reduction to the wheels. Finally, engine – crankshaft system – flywheel system – clutch system– transmission box system – differential system – final drives system – axle – drive wheels. In this research, a medium-sized-purpose vehicle transmission system has two functions: isolate the engine from the medium-sized vehicle wheel when desired. Then, provide for an auxiliary power outlet in the form of power take-off for powering the implements and stationary machinery.

C. Steering Mechanism Design

An alternative steering mechanism's preliminary design and calculations are present, which dedicate to lightweight medium-sized-purpose vehicles. This mechanism aims to keep both steered wheels at ideal turning angles in the rice field dry or wet. Therefore, a tool has been designed based on our optimal spiral path method. The advantage of this steering, besides eliminating error that the machine can self-locking. This mechanism is ideal for autonomous application, as the system does not require energy to hold the turning angle consumes energy when the angle is changed. This research covers the main theoretical concept, design fundamentals, and calculations.

TABLE II experimental parameters

Parameters	Description	Range
β_{La}	The steering angle of the outer wheel	0-45
β_{Li}	The steering angle of the inner wheel	0-75
β_{LaA}	The idea of turning angle	0-65
β_F	The deviation between the ideal steering angles	0-50
S_{RH}	The center of gravity (Vertical)	N/A
L_F	Center of the front to the rear axle	3.80
L_y	Center of the half between front axle to the rear axle	1.90

Typically, a vehicle steering mechanism requires to give the steerable wheels a correlated steering angle of the wheel such that the intersection of the wheel axes should meet at the centre of the bend [20].

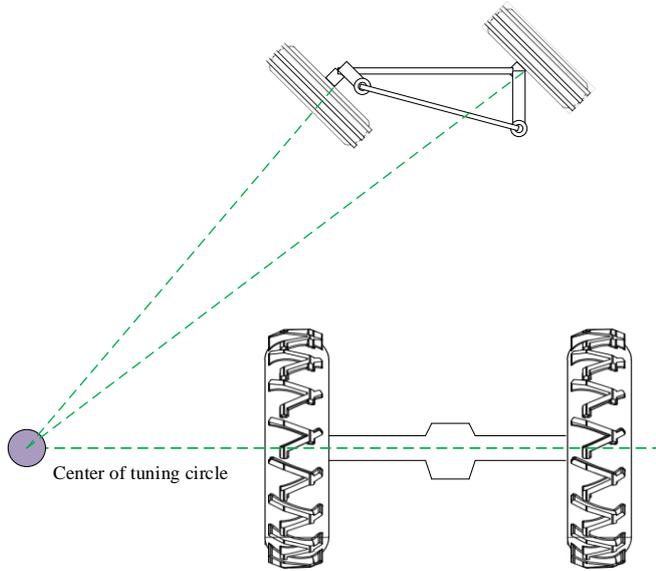


Fig.5. Steering Mechanism Design.

This rule can also see for a two-axle vehicle in figure 6 has known as the “Ackermann Theory”, in equation (1). Mathematically, Ackermann Principle as:

$$\beta_{LaA}(\beta_{Li}) = \tan^{-1} \frac{1}{\cot \beta_{Li} + \frac{j}{L_F}} \quad (1)$$

Where β_{La} is steering angle of the outer wheel, β_{LaA} is the idea of turning angle, which is obtain from equation (1) for a given steering angle β_{Li} of the inner wheel. The deviation β_F between the ideal steering angles of the wheel, which is cause by the steering mechanism geometry, is called “the steering error” or “Ackermann Error.”

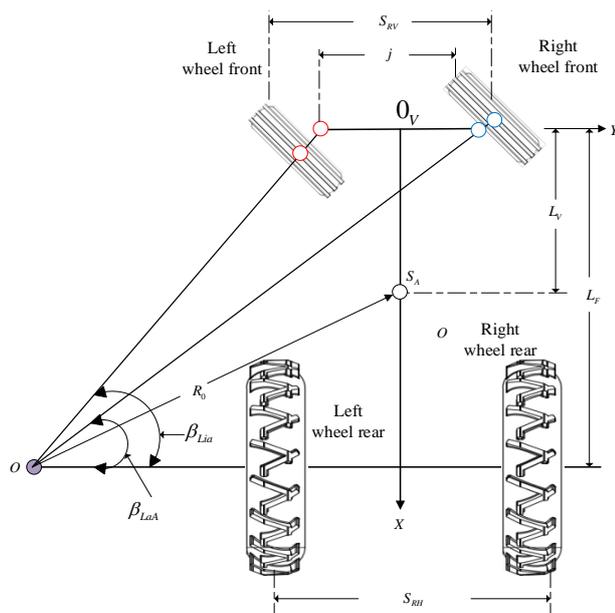


Fig.6. Geometry left wheel front angle by Ackermann steering theory.

Generally, the mechanism of steering of a full-size vehicle should satisfy with the Ackermann principle theory of forgiven steering error tolerances. β_F can be written the following:

$$\beta_F(\beta_{Li}) = \beta_{La}(\beta_{Li}) - \beta_{LaA}(\beta_{Li}) \quad (2)$$

The position of the tie rod of a multi-link steering system also affects the vehicle tracking (β_v) deviation of the wheel (Fig.7.) as well as the maximum steering error. Therefore, the multi-link steering mechanism during the kinematic design process, the deviation of (β_v) caused by the wheel travel have to take into calculation

D. Brake System Design

The tractor vehicle brakes system is designed and balanced for the fully working loaded condition and makes excessive braking on some axles when the vehicle is not fully loaded [26]. This problem is compound because the rice field actual practice, a structured brake system design in a medium-sized vehicle, an engine-driven compressor provides liquid oil. It collects in a disk brake controller.

In this research, we design a brake system as a disk brake because the brake pads grip the side of a metal disc to delay the rotation of wheels down of a metal disc to delay the rotation of wheels down.

E. The Electronics Design for medium-sized multi-purpose vehicle

The overall electronics design for taking the medium-sized-purpose vehicle to operate consists of six parts such as the radio transmission part, receiver part, antenna part, digital control part, encryption part, GPS receiver path and screen interfacing such as the follows.

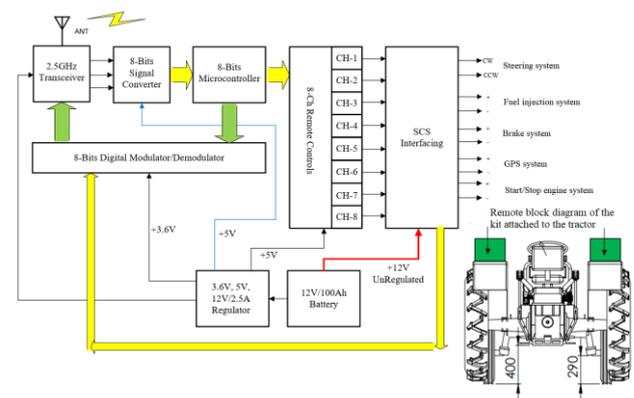


Fig.7. Overall, block diagram of transmission control for medium-sized-purpose vehicle.

1) Radio Transmission Part Design

The radio transmission of the box diagram and PCB Module. It consists of 2.4 GHz. (2.40–2.48 GHz.) transmission/transceiver with an output transmission power of 5 watts, and our design is suitable for all types of multi-purpose vehicles. The operation type selects according to the purposed vehicle used and various hybrid functions. It

is ideal for all types of fixed-wing, glider and multi-rotor. The model type can choose according to the tractor used. Illustrate Figure starts the first box is 2.4-2.48 GHz.—transceiver or two-way communication for receiving the GPS signal, which installs at rice field. If the GPS1 signal is coming through this box, it feeds to an 8-bits signal converter for compared the valid location with the GPS2 signal. If they are balanced, the medium-sized-purpose vehicle will be stopped and turn right or left next. Then 8-bits microcontroller will process all signals is coming and feed to the 8-out-of-1 multiplexer and receive activity from an 8-Ch remote control such as steering wheel, fuel injector, brake system, GPS control, and the engine starts/stop controls.

2) Antenna Part Design

The radio transmission has an omni-direction antenna, a pattern around the transmitter with 6-dBi antenna gain and 5 watts power output. Therefore, it can send the electromagnetic wave of the radio wave from 1 to 5,000 meters in space. It is ideally suited to control the car in broad fields.

3) Digital Control Part Design

The digital control part with our design consists of 5 sections. Firstly, 8-bits signal converter. Then we have an 8-bits microcontroller for any input process. Then, 8 out of 1 multiplexer circuit. Then we have an 8-bits digital modulator. Finally, this research has 8-channels of remote control, as the block diagram.

4) The GPS Receiver Module

We cannot design the GPS part because we take import from china country are both modules. Therefore, we just designed the direction of the tracker from the GPS 1 and GPS 2 receivers.

5) The Screen Interfacing Module

The design of the screen interface using the Android operating system and create by PCB with consists of semiconductor components. This part is an interfacing board between digital control and video camera installed at the medium-sized-purpose vehicle for watching the front view of the vehicle moving. Thai farmers can watch the environment of his/her field while the medium-sized-purpose vehicle tracking time.

6) The Application Software Design

Figure 8 is a functional flowchart of a remote-control system that can control the medium-sized-purpose to move through the fields with a start/stop engine. The fuel injection control rate allows the accelerator pedal to inject or reduce the accelerator as the car approaches the GPS 1 installed on the edge of the field, and steering controls, etc., while the work platform will place on the cloud (Crown Management Platform), which the farmer can use from a smartphone to real-time control.

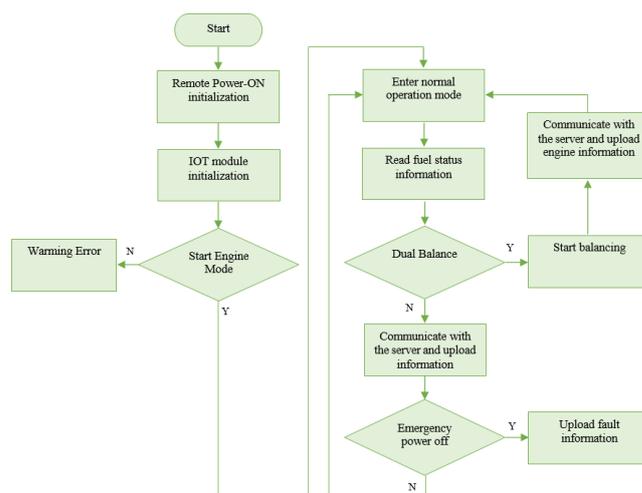


Fig.8. Flowchart of medium-size multipurpose agriculture vehicle remote control.

The researcher team also develops the transmitter support software is used for other project tasks like loading transmitter/receiver firmware to the remote, backing up model settings, editing settings and running radio-remote simulators. That is available for Windows, Apple OSX and APK for smartphones.

IV. RESULT AND DISCUSSION

The results of prototype medium-sized-multipurpose vehicle performance testing for rice harvesting will be an experiment of phase I. The research team designed this vehicle for harvesting rice in an actual paddy field and prepared to test its performance in Non-Sang district areas. In the case study, we have an experimental plot at the farmer plot in Non-Sang District, Nong Bua Lamphu province.

Non-Sang District is a significant rice-growing area. This research focuses on and aims to use as the area for testing vehicle performance and collecting the numbers of quality around 198 Acres. Therefore, the villagers allow the researcher to set and test this innovation in paddy fields have to cooperate on data collecting concerning management problems, yield, cost, and economic impacts. This research presents a prototype of medium-sized-multipurpose vehicle innovation for supporting farmers to harvest rice production.

The research team sincerely hopes that this prototype will be a small utility vehicle that might help the farmers under 55°C sunshine with the electronics operating and cover varieties of function.

It can be derived from high, low, uneven areas; uneven terrain allows farmers to work more efficiently in the northeast region as Nong Bua Lamphu province topography. Moreover, it has the ability to serve the purpose of rice farmer groups directly. Therefore, they have to understand how to learn the machine and technology applied in the medium-sized-multipurpose vehicle. In the future, the researcher expects that they will provide

excellent cooperation and also attempt to improve or extend this innovation to the non-profit organization in their area.

Table 2 shows the specification of the prototype Medium-sized Multipurpose Agriculture Vehicle innovation for rice harvesting prototype vehicle.

TABLE III Specification of Toyota Hilux Engine and basically of medium-sized multipurpose vehicle innovation car

Specification	Description	Testing
<i>Engine</i>		
Model	Diesel 2L	working
Type	4 strokes, water-cooled	working
Combustion	IDI, naturally aspirated	working
Number of cylinders	4	working
Bore x Stroke	92 x 92 mm	working
Displacement	2.4L (2446 cc)	working
Compression ratio	22.3 :1	working
Combustion chamber	Swirl chamber	N/A
Nozzle type	Throttle	working
Cooling system	Pressurized circulation	working
Continuous power output	53.6 kW at 4000 rpm	N/A
Torque	155.9 Nm at 2200 rpm	N/A
Gear system	Automotive transmission	working

V. CONCLUSION

Since the system allows users for remote control, installing various types of equipment at the drawbar or hitches. The medium-sized-multipurpose vehicle will assist farmers from the conventional practice to the new technology of intelligent farming with a powerful engine and practical. These advantages are for both rice farmers and those who are operating agriculture in Thailand.

Nevertheless, the radio link implemented does provide a reliable and communications protocol coupling to the transfer of control data. This research demonstrates that the final solution is achievable where a completely wireless remote system would solve the inconvenience of medium-sized-multipurpose vehicle automatic tracking.

The research team plans to finish the prototype vehicle testing in the actual paddy field concerning future work. Then evaluate its performance associated with the car's running mate, the fuel consumption, the controlling through the application, including the harvest efficiency of the rice harvesting part compared with the manual labour. The expansion of the experiment results, improving, testing the performance, and promoting this vehicle to be one of machinery in agricultural machines cooperative of local rice organization the Non-Sang district of Nong Bua Lamphu province for instance.

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Development of Agricultural Spraying Drones Prototype for Coconut Beetle Weevil Control

^[1]Kanchana Daoden, ^[2]Thanawat Sornnen, ^[3]Tanachai Pankasemsuk,
^[4]Pawerasak Phaphuangwittayakal, ^[5]Sureeporn Sringam, ^[6]Supanat Nicrotha

^{[1][2]} Smart Electronics Engineering, Faculty of Industrial Technology, Uttaradit Rajabhat University, Thailand

^{[3][4]} Faculty of Agriculture, Chiang Mai University, Thailand

^{[5][6]} Independent Researcher, Thailand

Abstract— Coconut is an important cash crop of the southern provinces and coastal areas of Thailand, with an area of more than 160,000 hectares and an increase of 85% every year. The total annual output is more than 500,000 tons for domestic consumption, and almost half exported. Part a decade, the coconut growers have suffered from quantity and quality yields decrease. Some coconut trees are destroyed and eventually die by insect pests, especially coconut rhinoceros beetle, black-headed caterpillar and hispine weevils. The difficulty of preventing and eliminating is the nature of the tall coconut plants. The level of wind speed in the coastal areas affects high labour costs. The chemical applied quantities and the risk of the chemical hazards that impact health costs. This research develops the agricultural spraying drones' prototype for coconut beetle weevil control by spraying directly to the coconut shoots, mainly focusing on the development of spraying systems to get closer to the tops of the coconuts and cover the leaves area as much as possible. The methods mentioned above aimed to reduce the wastage of chemicals and nutrients sprayed where conventional manual labour methods cannot reach a critical part of the coconut shoot, the coconut inflorescence, which will develop into a part of the coconut fruit. The results research developed drone based on the idea the real-time video data in combination with high-quality IP cameras to determine the location of the coconut inflorescence, installed a 6-arm, 12-propeller, with not over 40 litres load capacity, four high-pressure pumps, 8-nozzles. The research team designed the autopilot system, allowing the drone to learn and recognize its operation in an identical area. The resulting test showed that it can spray 4.5-5.2 litres of water/min, spray radius width 0.5 – 1.2 meters in the case of fixed spraying and 6.5-8 meters wide spray in case of general spraying. An anti-collision system works all the time precisely on a battery 14S size 22,000 mAh. This prototype can spray up to 13-18 rais (2.08-2.88 hectares), fly continuously for 22 minutes in the case of using a single battery, and when compared to spraying using conventional drones. It found that this innovation saved 20-25% of the chemicals applied.

Index Terms— Agricultural Spraying, Drones, Coconut Beetle Weevil Control

I. INTRODUCTION

The botanical name of the coconut palm is *Cocos nucifera*; it is currently believed to have originated in the coastal areas of Southeast Asia and Melanesia. Present, the coconut palm is found throughout the tropics. In the Pacific region, it continues to be an essential economic and subsistence crop. Almost every part of the coconut palm is a significant food, oil, fibre, and wood source. [1] Coconut is a small-holder palm which environment-friendly to the tropical zone, covering 12.28 million hectares in 90 countries with an annual production of 64.3 billion nuts. Coconut provides USD\$ 7.73 billion per annum to global coconut small-holders. The first four ranking of the worldwide country produced coconut are the Philippines, Indonesia, India and Thailand [2]. In Thailand, there are more than 1.6 hundred thousand hectares of coconut plantations and increasing every year in the southern provinces and coastal around the Gulf of Thailand. The nature of the tree is a strait, large and tall. The total annual yield is more than 500,000 tons. From January – May 2021 and 132,251 tonnes of coconuts have been exported, valued at US\$110.25 million [3][4].

The quality and quantity of mature coconut yield have been greatly affected due to the disease that affects the coconut inflorescence is a disease of top rot and fruit drop caused by fungi. The rhinoceros beetles and the coconut beetles destroy young shoots, resulting in a fan-shaped cleavage, and the coconut will die off and become the decapitated

coconut shoot. It is difficult to spray chemicals to prevent diseases and pests due to the large and tall nature of the coconut tree.

Several research studies have suggested the development of sprayers capable of altering the spraying rate by using image processing methods for disease and pest-infested coconut plantations. This sprayer is designed with a remote monitoring system, the traverse and crane control system; once the target is confirmed, the nozzle is moved to the target area. Then the pump sprays to the target at the specified rate. This result is recommended for coconut trees 5-9 m tall, including the distance between nozzle and destination (1 m), pressure (1.5 bar), spring rate (2.712 l/min), maximum travel speed (1.5 km/h), fuel consumption (0.58 L/h) and working capacity (0.056 ha/h). The researcher attempted to develop an innovation based on remote control installed with drones to spray coconut shoots [5]-[11]. They were principally focusing on developing spraying systems to get closer to the tops of the coconuts and cover as much area as possible. Nevertheless, the previously mentioned techniques also resulted in chemicals wastage, including the substances and nutrients injected that do not reach the coconut shoots' vital part.

Development of Unmanned Aerial Vehicles (UAVs) for spraying pesticides to eliminate coconut pests by increasing removal accuracy, replacing human labour, reducing the use of the chemicals, and promoting the chemicals used

safety through lowering direct exposure pesticides on agricultural workers. Simultaneously, improving yield quality and reducing the impact of the chemical residue on the environment. The survey of the epidemic coconut pests' problems in target areas of Prachuap Khiri Khan Province, Thailand found three main pests: coconut rhinoceros beetle, black-headed caterpillar and hispine weevils. The chemical spraying around the coconut crownshaft, leaves, and inflorescences are tricky, mainly in the case of using man labour. Therefore, the coconut farmers desire some equipment to help their work. Nowadays, drones are prevalent, so the trend of applying drones by the coconut farmer is higher than usual. However, the most common problem with drone use is the chemical waste, pesticide residues on production and the environment. The only drone sprayed chemicals by remote control are still inaccessible and do not cover some critical parts, especially coconut inflorescences around the crownshaft.

In this research, the flight control system was designed to be more autopilot, including the Digital Image Processing method is applied for a position indicator of the spray to reduce restrictions of such drones.

II. OPERATION SYSTEM DESIGN

The proposed drone is designed to be a 6-axis, 12-propeller, capable of carrying liquids up to 40 litres in volume, has an ultrasonic bumper sensor (6 sensors), equipped with an IP camera in the front able to control the tilt angle of 90 degrees vertically when pulling the plane parallel to the ground. Central operation control with ECU type Adriano Mega. Flight control is designed into two systems: 1) Manual control using remote control type Radio Master Link, controlled via radio frequency at 2.4 GHz. The control scheme has 16 channels that contain both the flight system and the liquid spray. 2) Auto-Pilot control based on the drone's flight position from GPS-Spectrum AR12120, which uses decision data from all eight satellite connections, as well as avionics control based on video camera image data. It works by tracking objects classified according to the characteristics of coconut leaves, coconut palms, coconut palms, and fruit. Coconut Propeller rotation control uses 6 Brushless Motors, two propellers each, controlling both speed and flight direction through CC3D Revolution, a highly efficient flight control technology commonly used today. There are four Atomizing Pressure Pumps and eight spraying tanks in the chemical spraying part, with a block diagram working as shown in Figure 1.

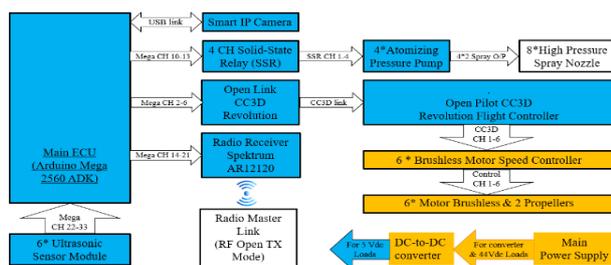


Figure 1. Block diagram of operation system.

There are two main spraying methods: 1) spraying from the top of the coconut tree by spraying from eight nozzles simultaneously. The distance from the nozzle to the top of the coconut is about 1-2 meters. Eight nozzles which this spray pattern It is a standard chemical spray that is commonly used in general. 2) Spraying from the side to make a plane with the coconut tree is positional spraying of the coconut derrick by the Tracking method. The object designed specifically for this research is to be sprayed from two nozzles on either side that corresponds to the location of the coconut gannet. The distance from the nozzle to the coconut leaf is about 1-2 meters. The spray is made at a wide angle of 30 degrees measured from the centre of the Sobal image. Operator and then spread the spraying angle to the left and right 15 degrees. The Block diagram of the whole system operation is shown in Figure 2.

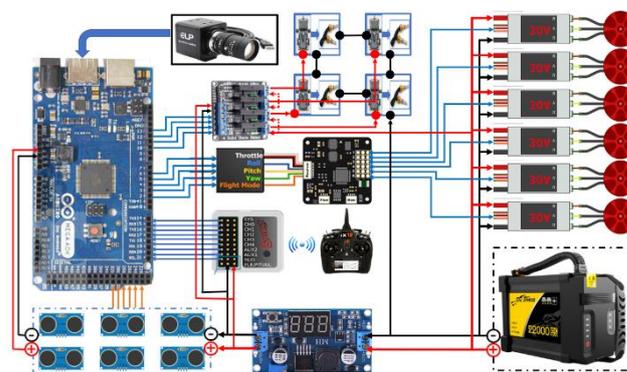


Figure 2. Hardware connection system.

III. HARDWARE CONNECTION

A. Development of flight controllers

For this research, the original structure of an unmanned vehicle agricultural (drone) with a carrying capacity of 40 litres, 6-arms, 12- propellers is maintained for this research. 1) Main power supply kit, Lipo 145 battery type 44 V. 22000 mAh. 2) Magnetic type Brushless Motor with torque 1500 Nm, speed 2200 RPM, and 3) 30 Amp Brushless Motor speed control unit. The newly designed and developed part is the flight controller and spray control unit.

The flight controller consists of a dc-to-dc converter to adjust the voltage and current from the main power supply to 5 VDC; the electric current 3000 mA allows continuous control of the control system, though the main power supply has a low operating current. The main ECU uses Arduino Mega 2560 ADK, then programming with Arduino IDE and C++, which is easy to design system control software. The input and output ports of the system consist of 1) 2-megapixel (1080P) video camera, the recorded image size is 1920x1080 pixels, and the frame rate is 30 FPS, which supports vibration for sharp images and simplifies the process of image processing toward specifying the desired object location. 2) The flight protection equipment consists of six ultrasonic sensors to prevent collisions in all six directions: top, bottom, left, right, front, and rear. The flight distance has been set to

three levels (50 cm, 80 cm, and 100 cm) designed to allow the software to make automated decisions based on object density conditions or the number of trees and coconut leaves. 3) Remote control can be controlled by two systems: manual control using the commander's decision and automatic control Pilot, which relies on the machine's original recognition and flight data to compare the original GPS position of each flight area. Including the processing of flight patterns and flight directions based on the distance measurement data of the Ultrasonic Sensor and the processing of video images from the built-in camera. 4) CC3D Revolution & Fight Control is a flight controller designed to work with the Auto Pilot flight model. The work will mainly refer to the GPS coordinates of the drone and then compare the data from the coordinates from the satellite at least eight to prevent the deviation of the GPS within a distance of not more than +/- 10 cm. 5) Control unit for high-pressure injection pump and pressure tank set. The design allows the spray angle to be adjusted vertically and horizontally to accommodate the vertical coverage spray pattern and the exact positional spraying of the coconut leaf needed from the horizontal. Figure 3 shows the hardware connections of the entire system.

B. An Unmanned Aerial Vehicle (UAV) Sprayer

The proposed drone operation begins when the power is turned on and connects between the ground control station and the UAV. The UAV will process the operation commands received from the control station until all sides are ready and wait for the following commands. Command to start when the UAV begins to take off, the order will be processed again in which form to fly. In other words, it will receive commands from the remote control or in Auto Pilot format. Only the pilot is that the drone will begin to check the GPS coordinates from the data of the eight satellites and the current coordinates of the drone to select the operative area. Once a working area has been selected, the system will monitor the liquid level inside the tank and begin a recorded programmed flight until the fluid level warning system informs the tank emptiness of the preset threshold. When an alarm is triggered, the drone will return to its original location to fulfil the tank repeatedly. The operation will continue to loop until a callback command is received and terminated—the UAV sprayer operating details can be illustrated in a schematic diagram in Figure 3.

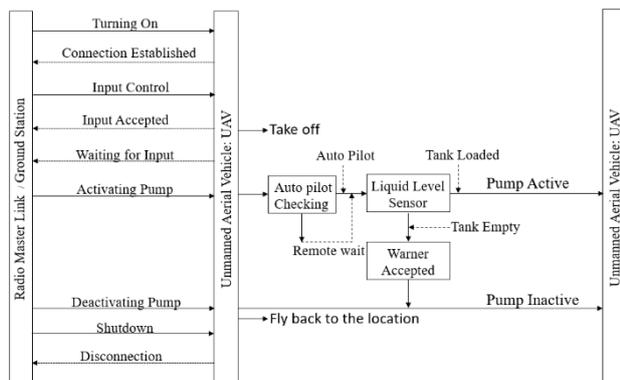


Figure 3. The UAV Sprayer Schematic Diagram.

IV. IDENTIFYING COCONUT INFLORESCENCE LOCATION

The process of determining the location of coconut inflorescence by Digital Image Processing method consists of 4 steps are as follows.

A. Image Enhancement Process

An image enhancement is a process to improve the sharpness of images by using a spatial domain process and the result is in the spatial domain as well by using

$g(x, y) = T[f(x, y)]$, when $f(x, y)$ is the original image, $g(x, y)$ is the resulting image, and $T[]$ is the function $h(r_k) = r_k$ which adjusts the brightness and histogram values of the image in the neighbour point (x, y) .



(a) (b)

Figure 4. Spatial domain Enhancement (a) Original image (b) After enhancement.

B. Image Filters

In this case, the second derivative is used to create an Isotropic Filter [12]. That means no matter which direction the image data rotates when processed with an Isotropic Filter, the result will be the same. The second-order partial derivative implemented is the Laplacian method, which is the most straightforward second-order partial derivative operator used to create an undirected filter. The Laplacian operator of a two-variable image $f(x, y)$, defined as,

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

when Laplacian is used to improve discrete data images. The derivative solving must be calculated using nearby data when taking the sum of the partial derivatives along the axis x and y of the images are written together to form the partial derivatives $\nabla^2 f = [f(x - 1, y) + f(x + 1, y) + f(x, y - 1)]$. Then sharpen the image again with Laplacian.

$$g(x, y) = \begin{cases} f(x, y) - \nabla^2 f(x, y), & \text{Laplacian is negative} \\ f(x, y) + \nabla^2 f(x, y), & \text{Laplacian is positive} \end{cases}$$

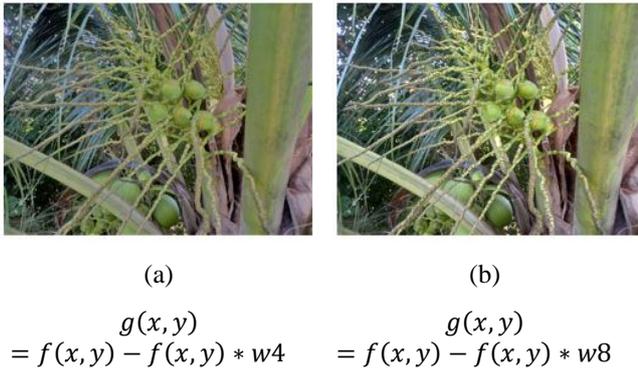


Figure 5. An example of sharpening the image signal with the Laplacian method.

C. Image Registrations

Image registration is the automatic overlaying of images. This process defines the key points that match the two images by selecting from the feature edges position and corners of the image or the image characteristics corresponding to the default template. The next step is translation, rotation, and scaling along the lines (x,y) . This technique calls "Matching Correlation", that is, $X = x \cos \theta - y \sin \theta + h$, and $Y = x \sin \theta + y \cos \theta + k$, which do along the x-axis in h-pixels and along the y-axis in ratio s-times and rotates along the angle θ .

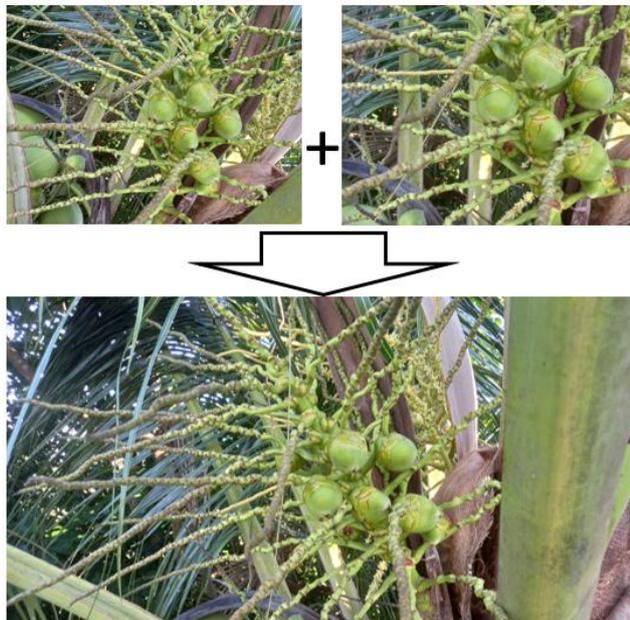


Figure 6. Image Registration Process.

D. Image Segmentation and Edge Detections

The image obtained through the entire process is a segmentation image to be compared before the location of the Edge Detections feature image is determined. In this study, the Gradient method was derived from the gray level difference of pixels around the x and y-axis, which 2D-Gradient, $I(x,y)$ described as vector $VI = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial I}{\partial x} \\ \frac{\partial I}{\partial y} \end{bmatrix}$ Since an image is digital, its pixels are considered discrete.

Hence, the gray level difference between $I(x,y)$ and surrounding pixels have been found as $G_x = \frac{\partial I(x,y)}{\partial x} = \lim_{\Delta x \rightarrow 0} \frac{I(x+\Delta x,y) - I(x,y)}{\Delta x}$ and $G_y = \frac{\partial I(x,y)}{\partial y} = \lim_{\Delta y \rightarrow 0} \frac{I(x,\Delta y) - I(x,y)}{\Delta y}$. This result is called a mask; this mask can use to create an edge detection by referring to the direction of the Gradients Vector is $\Phi(u,y) = \tan^{-1} \left(\frac{G_y}{G_x} \right)$ and refer to the size of Gradient Vector $E(u,y) = \sqrt{G_x^2 + G_y^2}$. The last process is searching the location of the image captured by the camera. This study chose the method of the Sobel operator because it focuses on the centre line of the point of interest, making the edges of the object are clear. According to the program design, the filter mask of the Sobel operator of the x-axis is

$$H_x^S = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \text{ and Sobel operator of y-axis is } H_y^S = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$



Figure 7. The Sobel operator filter mask applies for locating the position of an image.

V. EXPERIMENTS AND RESULTS

A. Experiment

The proposed drone performance testing is divided into two approaches are as follow:

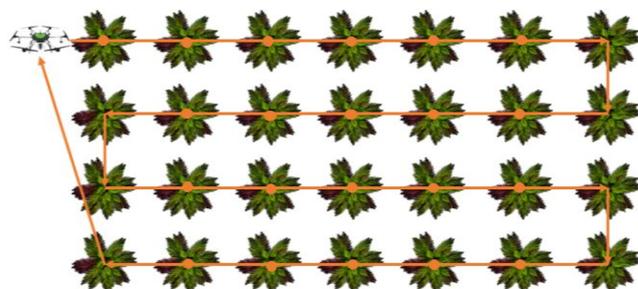
1. A comprehensive spraying test

A drone hovers over the top of a coconut tree before reading the coconut canopy diameter by Tracking Object of the video footage. Later, when the drone flies to a vertical coordinate at an angle 90-degree, corresponding to the centre of the canopy, then the ECU analyzes the size of the top. The coconut canopy is divided into three sizes in this research: S, the canopy is no larger than 7 m in diameter. Size M is 7-7.5 meters, and L- size is more extensive than 7.5 meters up. Then the ECU commands the injector pump and spray chemicals to the target object. On the condition of spraying is complete, the drone will operate to the next coordinate being in a straight line, continuously work until the tank is empty. Eventually, the drone was turned to initial coordinates to refuel and resumed operations at its final coordinates before recalling in figure 8 (a).

2. Spraying drone by locating coconut inflorescences

This is done by piloting the drone in a horizontal plane with the coconut crownshaft in a circular motion and then facing it; while moving, the system will do a Tracking Object the

inflorescences simultaneously. The drone will command to stop, spray liquid to the centre of the inflorescence and fly in a complete circle (360 degrees) if the coconut inflorescences detect. After that, it moves to the following crownshaft. The flight paths of this approach are illustrated in figure 8 (b).



(a) Drone flight paths for comprehensive spraying.



(b) Drone flight paths for spraying inflorescences located detection.

Figure 8. Two approaches of drone flight paths to performance testing.

B. Results

The results of the drone test in two spraying patterns are shown in Tables 1–2 as follows.

Table 1. Drone testing results for comprehensive spraying based on the tree canopy.

Tree No.	Canopy Size	Spray radius (m)	Liquid volume (litre)	Spray time (sec)
1	S	6.780	1.780	21.360
8	S	6.580	1.580	18.960
15	S	6.890	1.890	22.680
21	S	6.860	1.860	22.320
Average			1.78	21.33
2	M	7.440	2.440	29.280
3	M	7.490	2.490	29.880
4	M	7.380	2.380	28.560
6	M	7.440	2.440	29.280
9	M	7.410	2.410	28.920
12	M	7.260	2.260	27.120
13	M	7.380	2.380	28.560
17	M	7.360	2.360	28.320
18	M	7.490	2.490	29.880
19	M	7.500	2.500	30.000
22	M	7.230	2.230	26.760
23	M	7.340	2.340	28.080
Average			2.39	28.72
5	L	7.880	2.880	34.560
7	L	7.960	2.960	35.520
10	L	7.640	2.640	31.680
11	L	7.740	2.740	32.880
14	L	7.920	2.920	35.040
16	L	7.630	2.630	31.560
20	L	7.880	2.880	34.560
24	L	7.820	2.820	33.840
25	L	7.960	2.960	35.520
	Average		2.83	33.91
Overall Average			2.450	29.405

The results from Table 1 illustrated that the comprehensive spraying based on the coconut tree canopy consumed the liquid 2.450 litres by average—the bushes size S spray about 1.78 litres of liquid. M-size sprays about 2.39 litres,

and L-sized bushes spray fluid about 2.83 litres. Considering spraying time spent regarding the S-sized canopy diameter takes the shortest spraying time, followed by L-sized and M-sized, respectively.

Table 2. Drone testing results for spraying detected inflorescences location.

Tree No.	Inflorescences /Spray radius (m)					Liquid volume (litre)	Spray time (sec)	Remarks
	Inf. 1	Inf. 2	Inf. 3	Inf. 4	Inf. 5			
1	1.050	0.754	0.682			2.490	29.880	
2	0.960	0.680	0.540			2.272	27.258	
3	0.653	0.720	0.997	1.150		3.228	38.739	
4	0.840	0.584	0.651			2.197	26.359	
5	0.557	0.685				1.602	19.221	
6	1.140	0.512	0.863			2.511	30.129	
7	0.523	1.150	0.548	1.145	0.521	3.490	41.884	
8	0.851	0.654	0.945			2.464	29.572	
9	0.684	0.662	0.950			2.354	28.252	
10	1.100	0.645	0.682	0.488		2.796	33.556	
11	0.850	0.815	0.658			2.374	28.483	
12	0.760	0.682				1.745	20.935	
13	1.020	0.820	0.610	0.547		2.855	34.258	
14	0.598	0.525	0.992			2.225	26.701	
15	0.845	0.680	0.460			2.132	25.587	
16	0.997	0.523	1.140	0.692	0.710	3.615	43.383	*refilled the liquid.
17	0.756	0.589	0.654	1.250	0.562	3.436	41.233	
18	0.689	0.599	0.570	1.320		2.984	35.809	
19	0.520	0.580	0.932			2.166	25.990	
20	0.910	0.581	0.821	0.544		2.754	33.050	
21	0.660	1.200				2.043	24.516	
22	0.921	1.180	0.511	0.834		3.175	38.105	
23	0.570	0.821	0.685			2.197	26.367	
24	0.680	0.942	0.640			2.330	27.961	
25	0.693	0.680	1.220	0.750		3.102	37.223	
Average	0.793	0.731	0.761	0.872	0.598	2.582	30.978	

The Drone testing results for spraying detected inflorescences location in Table 2 reflected the less efficiency of this approach observed from the liquid volumes used 2.58 litres by average higher than the first approach around 0.132 litres. Similarly to the spraying time, a comprehensive spraying approach is preferred because of a shorter spraying time.

VI. CONCLUSION

In this study, standard digital image processing has been applied to enhance the potential of the proposed UAV, which aims to support the tough jobs of the coconut farmers. Moreover, due to the coconut trees physically characterized are relatively large and tall. These are the barrier for them on insect pests management. The coconut inflorescence, which will finally develop into the coconut fruits, is the significant factor affecting their income. So, they need equipment and tools like sprayers that can replace

labour, decrease the directly touching chemicals, increase the efficiency of eliminating and controlling pests (precise method).

This research developed a prototype agricultural spraying drone to control coconut insect pests by spraying directly on the tops of coconuts, focusing on developing spraying systems close to the coconut crownshaft. As a result of this research, the sprayer reduces the quantity of chemicals used, means decreased cost, reduces the risk of direct chemical exposure, and increases the efficiency of coconut pest control.

Nevertheless, the effectiveness of coconut pest protection and control still has to consider other factors besides the efficiency of the equipment brought in to help farmers, drones. Since the research study in this section has not measured the effectiveness of spraying that directly affects the elimination of coconut insect pests.

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Smart Band for Elderly Fall Detection Using Machine Learning

[¹] C. Ranjeeth Kumar, [²] M. Kaleel Rahman, [³] E. Derrick Gilchrist, [⁴] R. Lakshmi Pooja, [⁵] C. Sruthi

[¹] Assistant Professor (sr.gr), Department of Information Technology, Sri Ramakrishna Engineering College, NGGO Colony, Coimbatore, Tamil Nadu, India

[²][³][⁴][⁵] Department of Information Technology, Sri Ramakrishna Engineering College, NGGO Colony, Coimbatore, Tamil Nadu, India

Abstract— Fall is a common issue for senior citizens, as they are weak and need assistance. A fall could result in serious injury or perhaps death. So giving proper attention as soon as possible will reduce the impact of the fall. The main goal of this research is to perceive the appropriate machine learning algorithm for the scenario and illustrate the deployment of the fall detection system. So if the person is under fall, the system detects it immediately and intimate the concerned person by sending a message through SMS along with the person's current location as a google map link. So that they can arrive at that spot and help them before the situation gets out of hand. It is a wearable device that should be worn in order to detect a person's fall. The hardware and software are combined in the design and implementation to detect and report the elderly's collapse in a seamless manner.

Index Terms— Supervised learning; Medical wearable sensors; Internet of things; Care notification system

I. INTRODUCTION

Falling is a huge issue for the elderly, as they are physically weak, it can result in serious injuries or even death. So proper attention should be provided immediately. It is not a problem if someone is available to take care after the individual. However, if the person is alone, they will be unable to help themselves. So they need care as soon as possible. So a system that detects fall and intimates the concerned people immediately. We use the domain wearable technology and machine learning for the fall detection system.

Instead of relying on patterns and conclusions computer systems use Machine Learning. It is a scientific study of algorithms and statistical models. Machine learning algorithms use sample data, referred as "training data," to create a mathematical model that can make predictions or judgments without needing to be explicitly programmed.

The wearable device detects factors such as the person's pulse rate and body acceleration. The parameters are trained using supervised machine learning classification. This supervised classification model determines whether or not a person is in danger of falling. This model is a binary classification model which gives output as either fall or not.

II. LITERATURE REVIEW

Various researches have been done for Wearable devices for elderly. This research helped in understanding the various methods that were used in wearable and external devices for healthcare monitoring. It also helped to identify the benefits and drawbacks of the existing system and how to improvise it.

Adults above the age of 65 are the ones who have the most deadly falls. Every year, 37.3 million falls are severe enough to necessitate medical attention. Fall-related injuries may be fatal or non-fatal though most are non-fatal [1]. The rates of HIT use decreased from 32.2% in the age group 65

to 74 to 14.5% in the 75-84 age group, and 4.9 percent in the 85-plus age group. However, attending or talking to a medical specialist, eye doctor, or physical therapist/occupational therapist (PT/OT) was only marginally linked with HIT usage in older males, whereas seeing or talking to a mental health professional was only slightly associated with HIT use in older women [2]. Fall detection and prevention are 2 common studies, and both aim to improve people's lives by utilising pervasive computing [3]. Despite the fact that the field of human activity recognition (HAR) has been discussed continuously, there are still critical factors that, if addressed, would result in a dramatic shift in how people interact with mobile devices [4]. Elderly individuals are eager to live alone in their homes, despite the fact that they are mentally strong but not physically strong. Using two or more of the following phases of a fall event: beginning of the fall, falling velocity, fall impact, and posture after the fall, three distinct detection algorithms with increasing complexity were tested [5]. Artificial Neural Networks (ANN) have a low computing cost, making them easier to deploy on a mobile device. They also increase fall detection accuracy by bypassing standard threshold-based fall detection approaches [6]. The wearable has the ability to communicate with a cell phone within a 100-foot range. When the wearable device senses a fall, it sends a notification to the phone [7]. There is a need for continuous monitoring of health using wearable and other IOT devices. There are a variety of health-monitoring options for the elderly with specific issues as well as general issues such as falls. When technology for the elderly is offered, human comfort must be addressed [8]. There are various technologies available in monitoring systems for the elderly. The technologies are also divided into three groups: vision-based recognition, radio-based recognition, and sensor-based recognition. In sensor-based recognition systems accelerometers and gyroscopes are used together. Sensor-based recognition outperforms other

categories for geriatric monitoring systems [9]. When the aged people meet any sudden critical situation, a multi-information fusion-based geriatric care system is capable of sending a GPRS notification to the elderly person's family members. The concept of a band can be simplified into a product that is easy to carry and wear all of the time [10].

SVM builds a non-probabilistic binary linear classifier. Fractional Gradient Descent reduces the training time but also the precision of the support vector machine algorithm [12]. Combined with cloud computing, machine learning is used for various health care applications like health monitoring and risk of disease analysis from medical profiles. Some of the commonly used classifiers for health care are Decision tree and random forest classifier [13]. A wireless sensor is widely used to collect vital information and pass it to a cloud service where it is stored and analyzed. The features are passed in to K Means classifier [14]. Advancements in the medical field have increased the application of machine learning algorithms. The various toolkits used for machine learning are pandas, NumPy, matplotlib and scikit-learn [15].

Various types of sensors like motion sensors and vital sensors can be used for monitoring the health of an elderly. Different methodologies are used for health monitoring using wearable devices. Both motion tracking and vital sensors can be used for better applications [16]. The elderly face many difficulties alone when the caretaker is not present. Smart systems are very helpful for their medical conditions or in critical situations. The accelerometer based approach produces better accuracy than acoustic based approach [17]. Emergency alert systems which use IOT and Machine Learning are proved to be an enhanced system compared with their predecessors [18]. Accelerometers can be used to detect the acceleration of the body. GPS is used to get the location of the elderly for various applications like providing the location of the elderly in a case of emergency [19]. The health care system contains wearable devices such as smart cloth, smart watch and body tag which detects the users health parameters. These parameters are stored into the database and then converted into the person's health analysis report. The care system will check if the parameter values differ from the threshold value [20].

The global community is currently experiencing issues related to a variety of factors, one of which requires our attention is the ageing society. Healthcare sectors do not yet have viable solutions to the aforementioned issues. The Elder Care System (ECS) is a device that monitors the behaviour of older patients who are confined to a bed with a specially built system. A notification system, an in-bed position prediction system, and a real-time monitoring system are all part of the system [21]. Automatic classification of daily activities can be used to encourage health-enhancing physical activity and a healthy lifestyle. Everyday activities such as walking, jogging, and cycling are classified. Artificial neural networks, custom decision trees, and automatically generated decision trees are all used [22]. A Machine Learning-assisted Integrated Data-

driven Framework (MLA-IDDF) that can acquire signal features based on personalised characteristics from older patients to increase compressive sensing performance with fewer measurements for a more precise model. MLA-IDDF creates semantic models that characterise patient situations and decision-making mechanisms based on the interpretation of acquired data, allowing for accurate observations of elderly patients [23]. A multi-sensor integrated measurement system (IMS) for monitoring physical activity that is worn on the body. To improve battery power efficiency while lowering energy consumption, an adaptive-scheduling system was developed. Experiments on humans have revealed that the multi-sensor IMS is more successful in detecting activities of varying intensity [24]. A Wireless Sensor Network (WSN) is made up of a large number of sensor nodes that are placed in an unattended and remote location to monitor a few physiological parameters. People tend to forget things as they become older, which might pose a threat to their safety. So for fire detection, gas leakage detection, and determining whether a door is closed or open, sensors such as temperature sensors, LPG sensors, and contact sensors are used [25].

III. SYSTEM ANALYSIS

The research is about fall detection using Supervised Machine Learning Classification Algorithms. The purpose of a wearable gadget is to detect pulse rate and body acceleration. These parameters are given as input to the Machine Learning model that predicts whether the fall has occurred or not. If fall occurs, the location of the person under fall is being detected and a message is sent to the concerned person stating that he/she has collapsed and they require immediate attention.

IV. MACHINE LEARNING ALGORITHMS

A. Naive Bayes Algorithm

Naive Bayes classification algorithm is applied to binary and multi-class classification problems. The classifiers calculate the probability of a given input sample to be of a certain category, based on prior knowledge. They employ the Naive Bayes Theorem, which states that the influence of one feature of a sample is unaffected by the effects of other features.

$$P(\text{Class} | \text{Features}) = \frac{P(\text{Class}) \cdot \prod P(\text{Feature}_i | \text{Class})}{\sum P(\text{Class}_j) \cdot \prod P(\text{Feature}_i | \text{Class}_j)}$$

The global community is currently experiencing issues related to a variety of factors, one of which requires our attention is the ageing society. Healthcare sectors do not yet have viable solutions to the aforementioned issues. The Elder Care System (ECS) is a device that monitors the behaviour of older patients who are confined to a bed with a specially built system. A notification system, an in-bed position prediction system, and a real-time monitoring system are all part of the system [21]. Automatic classification of daily activities can be used to encourage

B. Stochastic Gradient Descent Algorithm

In simple words, gradient means the slope of a surface. As a result, gradient descent entails descending a slope to the lowest point on the surface [11]. It is an iterative process that starts at a random point on a function and gradually descends its slope until it reaches the function's lowest point [12].

C. Support Vector Machine Algorithm

Support Vector Machine is a supervised machine learning algorithm. It can be used to solve classification and regression problems. The SVM algorithm's purpose is to find the optimum line or decision boundary for categorising n-dimensional space into classes so that additional data points can be readily placed in the correct category in the future. A hyperplane is the name for the optimal choice boundary.

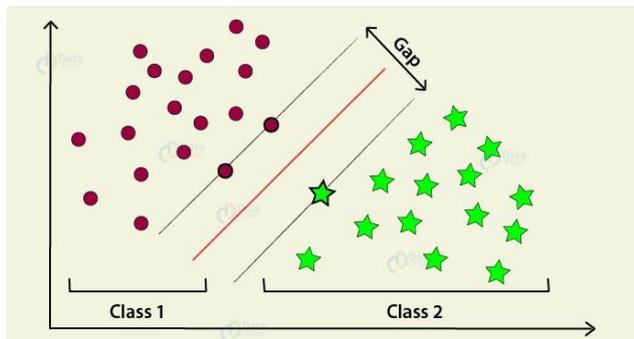


Fig. 1 Visualization of Support Vector Machine Algorithm's working

D. Decision Tree Algorithm

In this supervised learning algorithm, we start from the root of the tree to forecast a class label for a record. The root and record attributes are compared. The Decision Node and the Leaf Node are the two nodes of a Decision tree [13]. Decision nodes have multiple branches which are used to make any decision and Leaf nodes do not contain any further branches which are the output of those decisions.

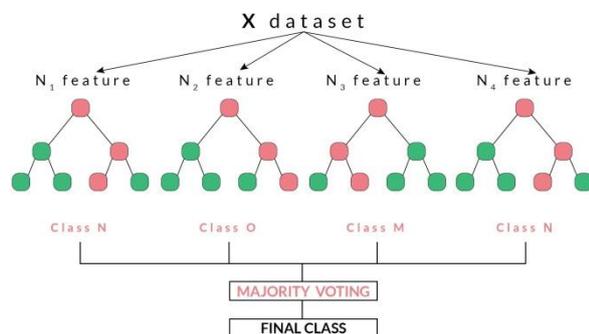


Fig. 2 Visualization of Decision Tree Algorithm's working

E. Random Forest Algorithm

A Random Forest algorithm is obtained by ensembling various individual decision trees. In the random forest each tree produces a class prediction. The class which has

secured the most votes becomes the model's prediction. Random Forest is a classifier that combines a number of decision trees on different subsets of a dataset and averages the results to increase the dataset's predicted accuracy. The bigger the number of trees in the forest, the more accurate it is and the problem of overfitting is avoided.

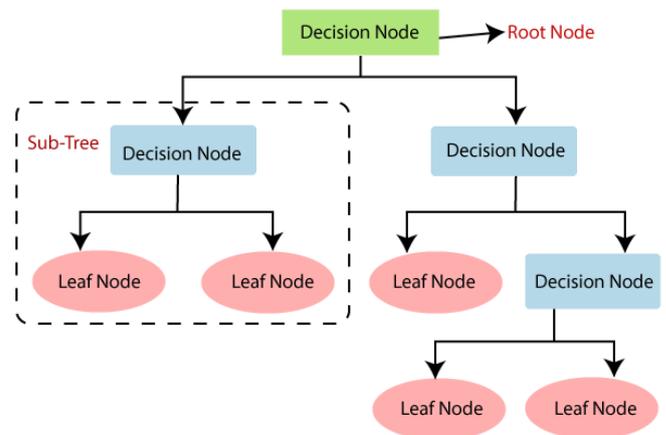


Fig. 3 Visualization of Random Forest Algorithm's working

Table 1 : Training and testing accuracies for various machine learning algorithms

Serial No.	Machine Learning Algorithm	Train Accuracy	Test Accuracy
1	Naive Bayes algorithm	94.30397%	92.75362 %
2	Stochastic Gradient Descent	91.40506%	88.50724 %
3	Support vector machine	96.83544%	94.20289 %
4	Decision Tree Classifier	100.0%	98.2456%
5	Random Forest Algorithm	99.4117%	96.4912%

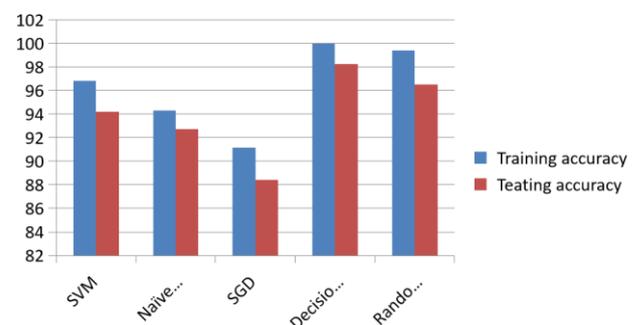


Fig. 4 Accuracy comparison graph of different models

The above graph illustrates the different test and train accuracy obtained from 5 different machine learning algorithms (Naive Beye, Stochastic Gradient Descent, Support Vector Machine, Decision tree classifier, Random Forest). Overall, The random forest algorithm produced the

highest training and testing accuracy whereas the stochastic gradient descent produced the least accuracy. The training accuracy of the decision tree leads the random forest algorithm's accuracy with nearly 0.6%, the same trend is applied to the test accuracy where the decision tree stays superior to the Random forest with around 2%. The naive bayes algorithm produced the second least amount of accuracy. The SVM algorithm's testing and training accuracy are approximately 94% and little more than 94%.

V. MODULES

There are 4 modules involved in this project. The first module is data collection which is followed by data preprocessing. Using the preprocessed data on the next module 5 different machine learning models are trained. From that the model with highest accuracy is chosen and deployed in the prototype.

A. Data Collection

Arduino UNO board is used for data collection. The data was collected in real time by connecting the pulse rate sensor and tri-axial accelerometer sensor to the person's wrist. The data is collected with the different movements of the person like walking, standing, running, sitting, falling etc.

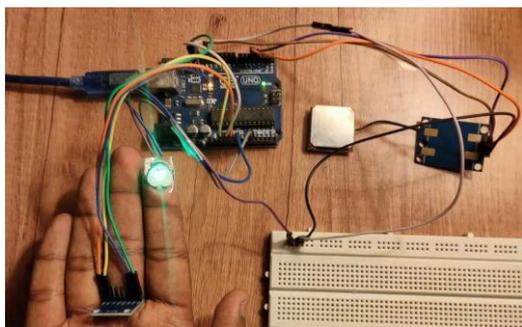


Fig. 5 Data Collection Using Arduino UNO

The activity fall is labelled 1 and all the other activities other than fall are labelled as 0. The collected data is stored into a csv file. The csv file has 5 columns i.e BPM(pulse rate), X (X-coordinate), Y (y-coordinate), Z(Z-coordinate), LABEL(fall or not).



Fig. 6 Real time Data collection

Here are some of the pulse rate and triaxial sensor values which are recorded in Arduino IDE.

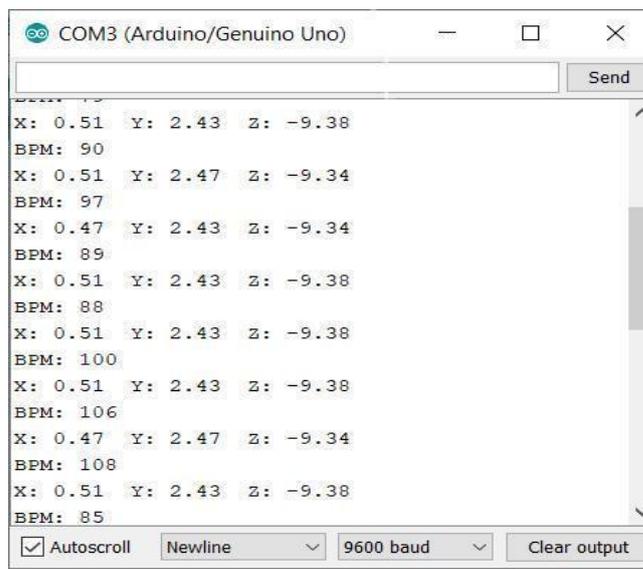


Fig. 7 pulse rate And Acceleration Values

B. Dataset Preprocessing

The Data which is collected from different actions of various persons is then divided into training data and testing data. The ratio between train and test data split is 70:30. The data set is labelled into fall or not fall. For fall the label is set to 1 and for not fall the data is set to 0.

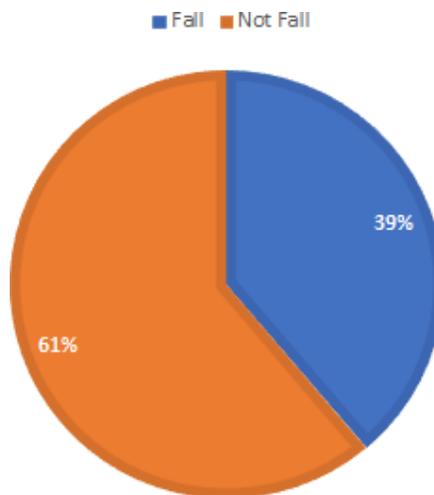


Fig. 8 Fall and Not Fall total data ratio

The total data values collected is around 1900. Out of which 730 data values are fall which is labelled as 1 and rest 1150 data values are not fall which is labelled as 0.

17	170	11.45	-8.55	-5.06	1
18	155	8.59	-4.51	-1.37	1
19	131	9.96	2.55	-4.31	1
20	97	3.26	3.3	-8.9	1
21	218	-8.63	3.84	-4.35	0
22	218	-7.45	5.57	-3.61	0
23	202	3.26	4.67	-5.37	0
24	46	-9.38	1.22	-1.45	0

Fig. 9 Preprocessed Data

C. Model Development

Support vector machine (SVM), Naive bayes algorithm, Random Forest algorithm, Decision Tree algorithm, and Stochastic Gradient Descent algorithm are among the machine learning algorithms that are trained using the preprocessed data [15]. They produce different training and testing accuracy. When compared with all trained models the decision tree algorithm produced better accuracy. The nodemcu esp8266 is connected with the sensors that detects the essential data from the elderly. The arduino requires code to read the input value from the sensor. This value is sent as input to the decision tree machine learning model. If the model predicts 'fall' then the location of the elderly person is detected using a GPS module. Then the alert message which is attached with the location of the elderly person is sent to the caretaker and emergency services.

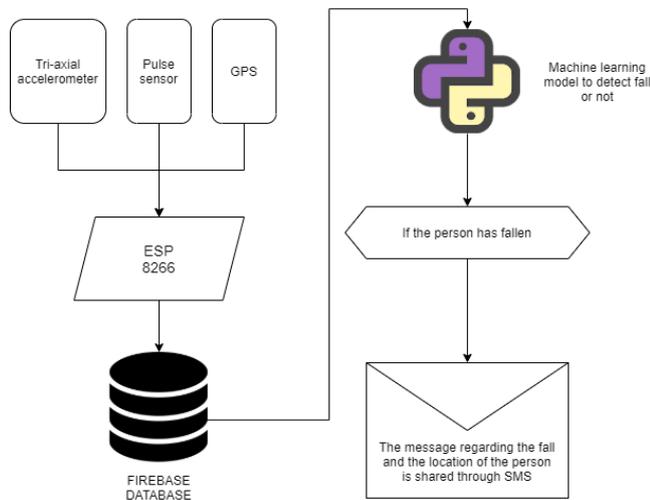


Fig. 10 Flow Chart

D. Implementation and deployment

The system consists of 3 main sensors namely NEO 6M GPS, ADXL345 triaxial accelerometer and Pulse sensor. The pulse rate sensor which is used is a plug and play type sensor which operates in +5V or +3.3V. This pulse rate sensor can be placed directly in the veins for example on a person's finger tip or on the ear tips or on the wrist. The Tri-axial accelerometer which is used is ADXL345 which operates in 1.8V- 3.6V. Its bandwidth measure of the X and Y axis ranges from 0.5HZ to 1600HZ. Z axis ranges from 0.5HZ to 550 HZ bandwidth. The NEO 6M GPS operates on voltage between 3.3V – 6V. These sensors are connected

to the nodemcu esp8266 module, the ports and the corresponding functionality are configured in Arduino IDE.

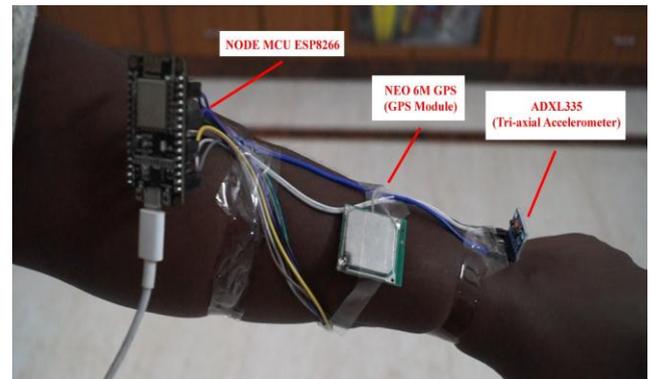


Fig. 11 Component Configuration (1)

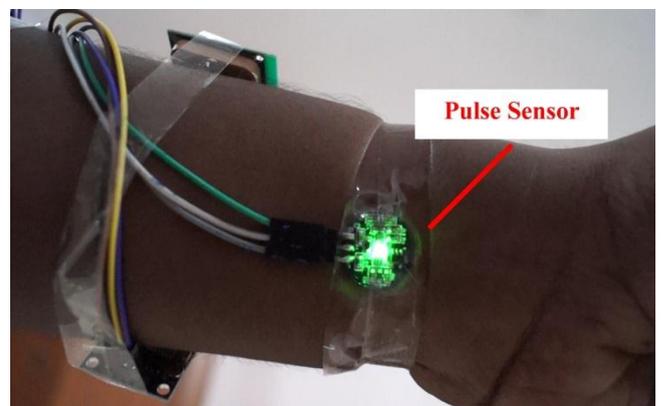


Fig. 12 Component Configuration (2)

The BPM value from the pulse sensor, the X,Y,Z coordinate values from the Triaxial sensor, and the latitude and longitude values from the GPS sensor are displayed in the Arduino IDE's serial monitor. All the BPM and X,Y,Z values are recorded in a time interval of 300 millisecond(ms). Nearly three data values are recorded per second. But the latitude and longitude values are recorded in a time interval of 3 seconds(s).

```

COM3
BPM:388
X: -0.75 Y: 10.24 Z: -0.27
http://maps.google.com/maps?&z=15&mrt=yp&t=k&q=11.0677094+77.0024456
BPM:371
X: -0.71 Y: 10.20 Z: -0.24
http://maps.google.com/maps?&z=15&mrt=yp&t=k&q=11.0677094+77.0024456
BPM:170
X: -0.82 Y: 10.16 Z: 0.27
http://maps.google.com/maps?&z=15&mrt=yp&t=k&q=11.0677094+77.0024456
BPM:198
X: -0.86 Y: 10.12 Z: 0.20
http://maps.google.com/maps?&z=15&mrt=yp&t=k&q=11.0677094+77.0024456
BPM:390
X: -0.94 Y: 10.16 Z: 0.63
http://maps.google.com/maps?&z=15&mrt=yp&t=k&q=11.0677094+77.0024456
BPM:394
X: -0.94 Y: 10.12 Z: 0.63
http://maps.google.com/maps?&z=15&mrt=yp&t=k&q=11.0677094+77.0024456
BPM:7
X: -0.98 Y: 10.12 Z: 0.59
http://maps.google.com/maps?&z=15&mrt=yp&t=k&q=11.0677094+77.0024456
    
```

Fig. 13 Sensor output displayed in serial monitor

The pin configuration for the connection of node mcu esp8266 module along with Pulse sensor, ADXL345 Tri-axial accelerometer sensor and NEO 6M GPS sensor are shown in the Figure. 19.

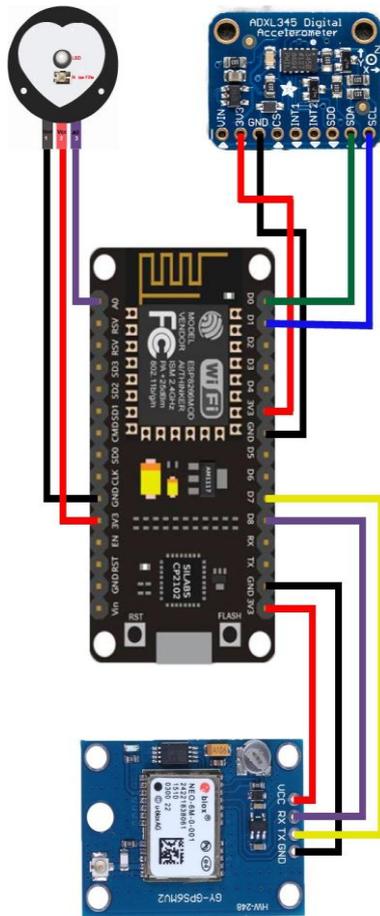


Fig. 14 Pin Configuration

The data from the sensor is uploaded to a cloud database [14]. Here, Google Firebase is utilised to construct a realtime database, which is then connected to nodemcu using the database's api credentials. Thus all the sensor values are passed instantly from the nodemcu esp8266 module to Google's firebase. The green coloured data entry can be seen in Figure 18, Which denotes the live feed of data values into the database.

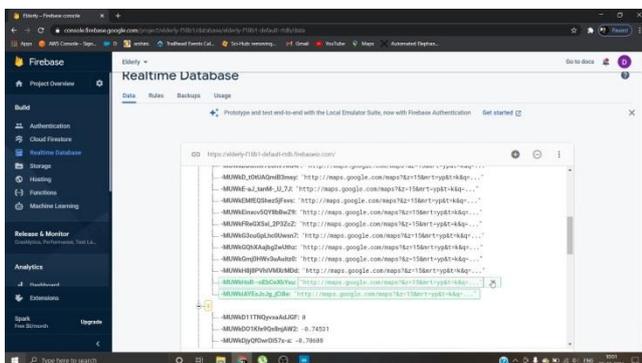


Fig. 15 Realtime data feed in Firebase

The sensor values from this Firebase are passed to Google Colab seamlessly as soon as the data is received from the nodemcu. The google colab has the decision tree machine learning model which is already trained and ready to predict whether there is fall or not by getting the data values. This model uses live feeded inputs from the firebase to estimate whether or not the person's condition would collapse. It has been programmed to send an alert message to the local hospital as well as the caretaker along with the person's location as a google map link, if any falling motion is predicted.

VI. EXPERIMENTAL RESULT AND DISCUSSION

The goal of this project is to efficiently monitor a person's pulse rate and acceleration. This model determines whether a person has fallen by inferring sudden falling propensity or a change in pulse rate. If the above circumstance exists, it sends a message to the concerned person.

Different Machine Learning models like Naive Bayes classifier, Random Forest Classifier, Stochastic Gradient Descent, Decision Tree Classifier have been used but the highest test and train accuracy is gained by Decision Tree Classifier Algorithm.

When the model classifies the input value as fall an alert message is sent along with a google map link which holds the person's location [7][18]. The person's location will be displayed in Google Maps when the link is clicked.

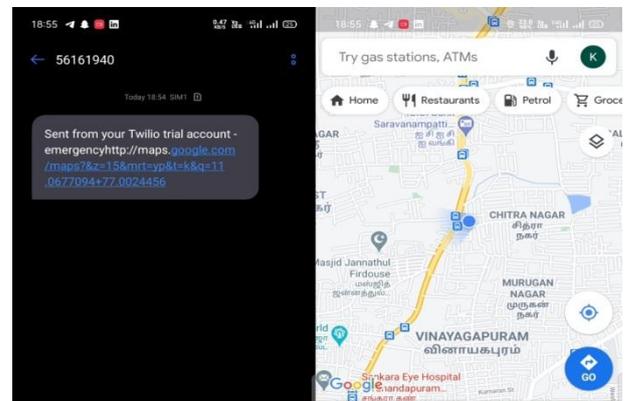


Fig. 16 Alert message received with location link

A. Merits

- 1) Monitor the health of the elderly people who are weak and are more prone to falls.
- 2) Monitors vulnerable Patients.
- 3) Give proper attention to the person under fall.
- 4) The cost of the wearable device is cheap.

B. Demerits

- 1) Battery life of the wearable device is less and it needs to be recharged regularly.
- 2) Maintenance is also difficult.
- 3) Many old people would not like to wear devices all the time [19].

VII. CONCLUSION

As a result, our project assists older individuals who are in particular emergency situations in order to save them from the consequences of their falls. The project was built on a low cost components so that people from all walks of life are capable of affording it. This project can also benefit persons who are blind, autistic, intellectually retarded, with walking problem, or paralysed. The proposed method

can be enhanced in the future by transforming the wrist band-based product into a simpler form that is easier to carry and wear all the time.

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Unsupervised Modified Clustering Technique Based on Fuzzy Set Theory to Categorize the Real-Life Data

R Devi

Department of Mathematics, Pachaiyappa's College, Chennai, India

Abstract— The fuzzy C-means clustering algorithm is appropriate for segmenting datasets and is commonly utilized in real-life settings. The growth of huge data has posed numerous obstacles for clustering approaches. Due to their high density and execution time, traditional clustering approaches cannot be applied for such vast amount of real-world data. To address these challenges, we offer an unsupervised clustering method for automatically categorizing large-scale datasets without requiring labels, with a focus on the real-life dataset. Experiments on real-world datasets show that our suggested unsupervised technique performs well and has high precision. The outcomes reveal that the proposed approach effectively segregate unstructured real-world database into distinct clusters.

Index Terms—Clustering, Complex structure, Fuzzy C-Means, Uncertainty

I. INTRODUCTION

Clustering analysis is the act of discovering data objects and grouping things altogether based on its characteristics. A cluster is a collection of things that are very similar to other clusters. As a result, clustering [3] is classified as an unsupervised process because it does not have a previous group ID. The center can have attributes of the same dimensions as the object in the data. Alternatively, it can be a symmetric high-level element such as a linear or non-linear subspace or function. Although clusters can be thought of as segments of a larger data set, one categorization method could be based on the fuzzy or crispness of the subsets. The hard clustering approach [17] is based on set theory and requires data regardless of whether it belongs to a cluster or not. Most clustering approaches assume that the clusters are well defined and that each pattern can belong to only one cluster [1]. This option can overlook the natural ability of data to be distributed in different clusters. Fuzzy clustering [11] can be used to overcome the weaknesses in this case by using fuzzy logic. Soft clustering algorithm is more natural than crisp clustering because elements at the boundaries of many clusters are not forced to belong entirely to any of the clusters. The clustering approach [19] has been used in a variety of real-world situations. Because there is no clear demarcation between groups in many real-world scenarios, fuzzy clustering is better suited to the data. Fuzzy set-based clustering [18] is a great way to extract features from data elements that have a local structure. Fuzzy clustering techniques are used to show the local structure of a dataset by predicting membership degree of every data element in the cluster. In fuzzy set theory [7, 13], membership values are often associated with a degree of membership. These membership-level assignments and their subsequent use for allocating data components to clusters are known as fuzzy clustering [5]. Instead of uniquely assigning objects to the cluster, fuzzy clustering uses a membership level of 0 to 1. Such membership can be used to undertake soft data analysis that considers non-linear data structures. It is, however, merely bounded at local minima and is sensitive

to changes in the environment [4,9]. Krishnapuram and Keller [6] proposed the PCM technique, which simplifies the probabilistic requirement and permits a possibilistic view of the membership equation as a degree of typicality. The PCM results, are extremely dependent on the initialization and frequently depreciate owing to the overlap clustering problem. Pal et al [8] introduced a fuzzy induced possibilistic c-means clustering approach that addresses the flaws in both FCM and PCM algorithms. Even if the FPCM is the combination of FCM [14] or PCM, the typicality value becomes very low as the size of the dataset rises. As a result, this task seeks to provide an effective clustering technique for evaluating dataset by merging membership values, typicality, and distances guided by the Cauchy kernel. This work is structured as follows: The Preliminaries are given in Section 2 of this study. The proposed technique is given in section 3. Section 4 explains the experimental results of artificial and benchmark data. Finally, Section 5 brings the conclusion.

II. PRELIMINARIES

2.1 K-Means Clustering

K-means clustering is a very well-known unsupervised machine learning algorithm. It is used to solve many problems of unsupervised machine learning. The K-means clustering algorithm attempts to group similar elements in the form of a cluster. The number of groups is represented by K. K-means clustering aims to reduce distances inside a cluster while increasing distances between clusters. It is an iterative procedure to use K-means. The approach is based on the optimization method. It functions by doing the below stages after fix the number of clusters:

1. Select prototypes at arbitrary for each group.
2. Find the detachment between each data elements and the prototypes.
3. Allocate data elements to the group that would be nearest to them.
4. Locate individual group's new prototypes.

5. Reiterate the steps 2, 3, and 4 till all data elements have converged and the center of the cluster has stopped moving.

2.2 Fuzzy Set

A fuzzy set F of a set U can be defined as a set of well-ordered pairs $\{(x, \chi_A(x)): x \in U\}$, each with the first data from U and the next data from the interval $[0, 1]$ by precisely 1 ordered pair exist for each element of U . This defines a mapping, μ_F among objects of the set U and degrees in the interval $[0, 1]$:

$$\mu_F: U \rightarrow [0, 1].$$

The degree zero is used to represent exact non-membership, the degree one is used to represent exact membership and values among the interval are used to denote transitional grades of membership.

2.3 Kernel Distance

Kernel-induced distance is an effective way to extract information from high-dimensional data by transforming elements from small-dimensional to high-dimensional space [10]. For all mathematical methods that can be specified in a dot product relationship, the mapping provides a linear to non-linear connection. In functional space, the kernel is described as an inner product. The map transforms the n -dimensional data into the inner product of the feature space, and kernel resembles to the inner-product of the feature-space. In this study, to calculate the dot product, we describe the inner product space of the kernel as follows:

$A(u, v) = \langle \pi(u), \pi(v) \rangle$ The above procedure is used for calculating the value of the inner product of the feature space. The kernel induced distance is defined as $\|\pi(u) - \pi(v)\|^2 = \langle \pi(u) - \pi(v), \pi(u) - \pi(v) \rangle = A(u, u) + A(v, v) - 2A(u, v)$. Therefore, the kernel induced distance is as $\|\pi(u) - \pi(v)\|^2 = 2 - 2A(u, v)$, since $A(u, u) = 1$ & $A(v, v) = 1$. $\|\pi(u) - \pi(v)\|^2 = 2(1 - A(u, v))$.

III. MODIFIED POSSIBILISTIC KERNELIZED FUZZY CLUSTERING WITH WEIGHTED TERM (MPKFCW)

To deal the outlier problem and heavy noise in segmenting real world dataset [12], the Modified kernelized Fuzzy Clustering algorithm is given in this section. The proposed technique is developed by incorporating the Weighted term. The Weighted term is effectively regularized the clustering process and is worked as fuzzifier of the system.

The new objective function is formulated as

$$O(m, p) = 2 \sum_{p=1}^n \sum_{j=1}^c (m_{jp} + p_{jp}^\alpha) (1 - C_w(z_p, v_j)) + \frac{2G}{n} \sum_{j=1}^n \sum_{p=1}^c m_{ik} \log \left(\frac{m_{jp}}{c_j} \right) \quad (1)$$

Where, $C_w(z_p, v_j) = 1 - (1 + \gamma \|z_p - v_j\|^2)^{-1}$, and γ denotes the regularization parameter. G is the Geometric mean value of all detachment between the data and prototype and C_i is the probabilistic weight of the i^{th} cluster.

The following equality constraints are used to optimizes this problem

$$\sum_{j=1}^c m_{jp} = 1, \sum_{p=1}^n p_{jp} = 1 \text{ \& } \sum_{j=1}^c C_j = 1 \quad (2)$$

3.1 Membership Function

To obtain the effective membership function to measure the degree of similarity between the data and prototype, the proposed model is minimized subject to the membership constraint.

The general equation for updating membership function is attained as

$$m_{jp} = \frac{c_j \exp[C_w(z_p, v_j) \frac{G}{n}]}{\sum_{l=1}^c c_l \exp[C_w(z_p, v_l) \frac{G}{n}]} \quad (3)$$

3.2 Prototype Equation

Optimizing the *MPKFCW* objective function, the center v_j is evaluated. The cluster center is given by

$$v_j^t = \frac{\sum_{p=1}^n \gamma (m_{jp} + p_{jp}^\alpha) (1 + \gamma \|z_p - v_j^{t-1}\|^2)^{-2} z_p}{\sum_{p=1}^n \gamma (m_{jp} + p_{jp}^\alpha) (1 + \gamma \|z_p - v_j^{t-1}\|^2)^{-2}} \quad (4)$$

Where, 't' denotes the t^{th} iteration.

3.3 Typicality

Using the required condition of the Lagrangian technique, the objective function is minimised, yielding the following generalised membership of typicality:

$$\Rightarrow p_{jp} = \frac{((1 - C_w(z_j, v_p)))^{-\frac{1}{(\alpha-1)}}}{\sum_{l=1}^n ((1 - C_w(z_l, v_j)))^{-\frac{1}{(\alpha-1)}}} \quad (5)$$

3.4 Evaluation of C_j

To derive the updating equation for computing C_j the above proposed model is minimized with respect to C_j . Differentiating partially with respect to C_j , we get

$$C_j = \frac{\sum_{p=1}^n m_{jp}}{n} \text{ for all } j=1, 2, \dots, c \quad (6)$$

The steps of *MPKFCW* Procedure:

- Set cluster number
- choose the centers of each cluster
- Compute the degree of membership through (3)
- Update the cluster center using (4)
- Estimate the typicality value using (5)
- Evaluation of C_j by (6)
- Repeat Step 3, 4, 5 & 6 till the process reaches the result

IV. EXPERIMENTAL WORK

The efficacy and performance of the suggested fuzzy clustering approach were evaluated through a set of trials in this study. The proposed approach has been examined in

experimental studies using the generated and TAE datasets [15]. This section first demonstrated the efficacy of the proposed technique using artificial data. The results of the Existed Method-1[5] and Existed Method-2 [16] are given in Figures 2(i) and 2(ii). The proposed fuzzy c-means approach influenced the effective allocation of data elements to accurate clusters with target functions derived by the Cauchy kernel based on distance measurements. The result of the proposed algorithm is given in Fig. 2(iii). This figure also shows that *MPKFCW* completely separates the two clusters.

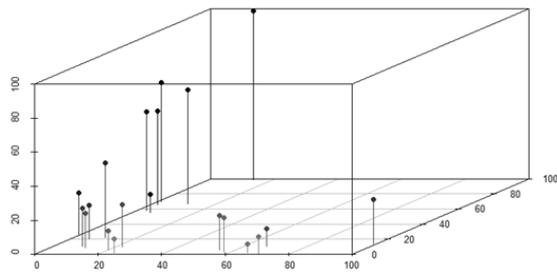
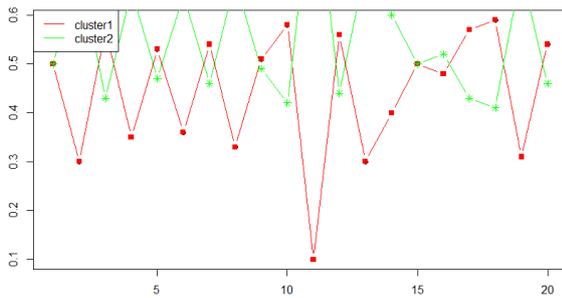
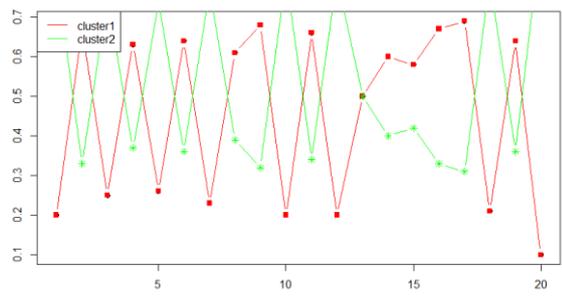


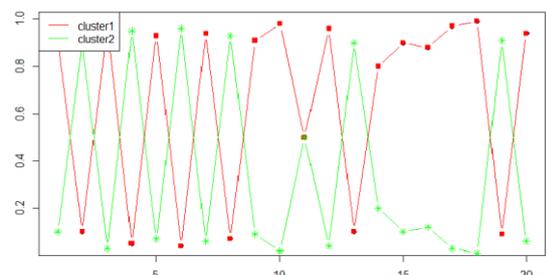
Fig:1 Artificial Data



(i)



(ii)



(iii)

Figure 2. Memberships by (i) Existed Method-1 (ii) Existed Method-2 and (iii) Proposed Method

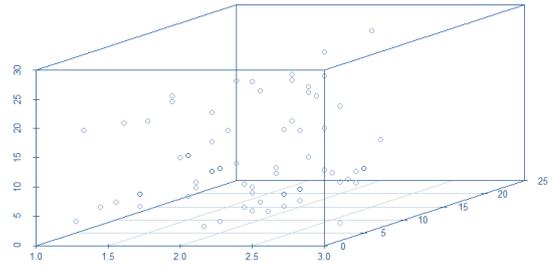


Fig 3: TAE Dataset

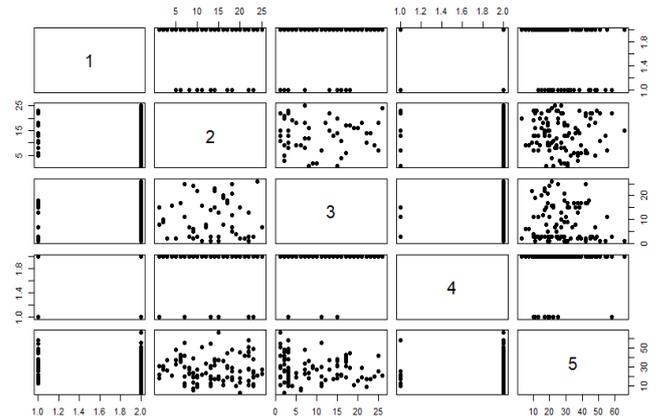
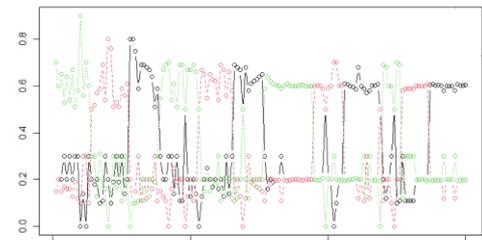
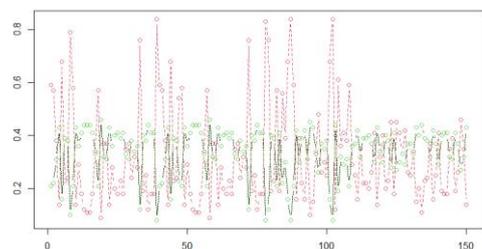


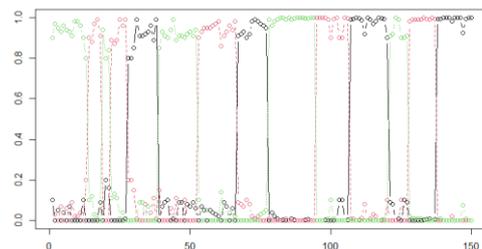
Fig 4: Correlation Plot of TAE Dataset



(i)



(ii)



(iii)

Fig 5. Memberships by (i) Existed Method-1 (ii) Existed Method-2 and (iii) Proposed Method

Table 1. Comparison of Algorithms

	Existed Method 1	Existed Method 2	Proposed Method
No. of Iterations	11	8	5
Clustering Accuracy	81 %	89 %	97.2%

This experiment splitting a TAE dataset into three clusters. The Teaching Assistant Evaluation dataset contains is depicted in Fig.3. This segment focuses specifically on the impact of the proposed method on TAE dataset. This part compares the outcomes of the proposed approach with the outcomes attained by existing approaches to demonstrating the usefulness of the proposed method in clustering TAE dataset. Fig 4. shows the correlation plot from a TAE dataset. The results of the existing clustering approaches are shown in Figures 5(i) and 5(ii). Due to the Cauchy kernel with weighted term, the proposed approach has been affected in efficiently allocating data items into accurate clusters. The outcome of the proposed method is shown in Fig. 5(iii), and this figure also shows that the proposed method completely separated the three clusters.

The Existed Methods entails more iterations to achieve clustering of the three subtypes of the TAE dataset. In addition, existing method-1 diminish the accuracy of the TAE database. Compared to the proposed approach used in this experiment, the accuracy values showed lower accuracy values for the existed algorithms. The proposed method groups the TAE dataset into three clusters, as shown in Table 1 and Figure 6, with good accuracy [2], a shorter running time, and fewer repetitions.

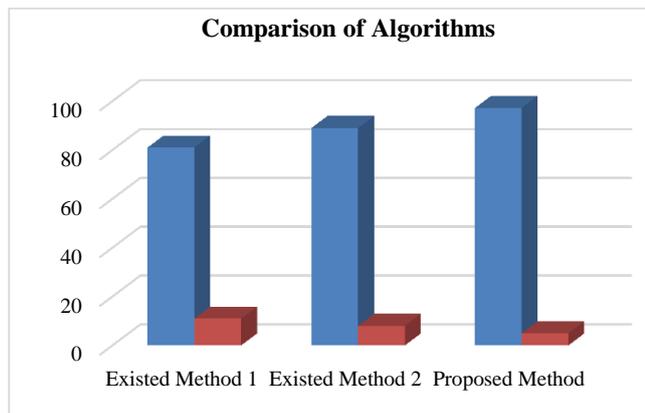


Fig 6: Comparison of Algorithms

V. CONCLUSION

This study introduces a Modified Cauchy kernel FPCM with weighted term based on membership functions, typical techniques, and kernel functions for cluster recognition in real world databases. This work demonstrated experimental work on both artificial and TAE datasets to determine the effectiveness of the proposed approach. This study showed the superiority of the proposed algorithm in grouping similar expressions in a benchmark dataset by showing the number of iterations representing the accuracy of

clustering, reiterations count, and suitably partitioned clusters.

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Infrastructure Evaluation of Affordable Housing Projects Built Under BSUP Scheme: A Case of Lucknow City

Dr. Rina Surana¹, Raunak Prasad²

¹ Associate Professor, MNIT Jaipur, India

² Assistant Professor, Manipal University Jaipur & Research Scholar, MNIT Jaipur, India

Abstract— Planning of affordable housing is one of the major requirements for any country to deal with the growing issues of housing shortage and growth of slums and squatter settlements in urban areas. In India, the government shifted its prime focus on development and planning of urban areas by introducing a scheme in the year 2005 called Jawaharlal Nehru National Urban Renewal Mission (JNNURM). The component of affordable housing under JNNURM was addressed through two verticals Basic Services to Urban Poor (BSUP) & Integrated Housing and Slum Development Programme (IHS DP). The BSUP scheme was introduced to provide formal housing to urban poor equipped with mandatory physical and social infrastructure. The scheme had seven broad deliverables, namely affordable housing, secured tenure, water supply and sanitation, education, health, and social security to the economically weaker section. The scheme was proposed in 63 mission cities in India. Lucknow city being one of those mission cities was benefitted under the scheme with 7 projects having 5570 housing units along with basic services, executed in 23 different areas. The goal of the paper is to study the deliverables under the scheme guidelines and investigate the present situation of these projects after 10 years of their completion. The study investigates the condition of various infrastructural services through 13 infrastructural, and neighbourhood-level attributes selected through various post occupancy studies and evaluate their status as per the scheme commitments. The findings are then interpreted to recommendations for design and planning of upcoming affordable housing schemes in a sustainable manner.

Index Terms— Affordable housing, Basic Services, Infrastructure, Neighbourhood, Urban Poor, Lucknow

I. INTRODUCTION

Affordable housing schemes was launched with the basic objective to provide a permanent house with elementary facilities for the urban poor who are otherwise forced to live in slums, squatter settlements, dilapidated structures, and temporary housing. Indra Awas Yojana launched in 1990 to provide housing in rural areas, was the stepping stone towards the aim of housing for all. Later the focus shifted to urban areas by introduction of Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in the year 2005.

These housing schemes have been catering to the Economically Weaker Sections (EWS) and Lower Income Groups (LIG) and with the introduction of Pradhan Mantri Awas Yojana (PMAY) in 2015, Middle Income Group (MIG) has also been included in the beneficiaries. There is a change in the supply mechanism of housing units under the schemes, but even with these changes, there are certain issues identified related to governance, guidelines, and end-users, which apply to all existing schemes.

Ministry of Urban Development introduced two verticals of affordable housing schemes namely Basic Services to Urban Poor (BSUP) and Integrated Houses and Slum Development Program (IHS DP) launched in 2005 under JNNURM had an objective to encourage and expedite urban reforms and include 1.5 million houses for the Urban Poor in 65 mission cities between 2005-2012.

1.1 Basic Services to Urban Poor (BSUP 2005-14 extended till March 2017)

It is one of the two verticals of JNNURM introduced in December of 2005 which aims at provision of pakka houses

with basic services for the urban poor. The scheme focused on provision of formal housing with all essential civic amenities to the slum dwellers. The scheme ensures overall development of urban poor by the provision of essential elements listed as follows:

1. Secured tenure
2. Pakka (permanent) housing at affordable price
3. Infrastructure facilities: water supply, sanitation, electricity, etc.
4. Social infrastructure: health, education, and security. (MoHUPA 2009)

II. METHODOLOGY OF THE STUDY

The study is based on the physical survey carried out in 23 BSUP projects in Lucknow City. Non-Participant observation technique is used to gather the required data. The qualitative aspect of the research included mapping the condition of physical infrastructure provided, condition of open space and green areas, construction, maintenance, cleanliness, and proximity to essential social infrastructure like education and health care facilities. The data was collected physically from the site in the form of pictures and videos. The quantitative aspect of research included accessibility to the project, availability, and type of physical infrastructure provided, availability and distance of social infrastructure in the area, safety and security, communication, and connectivity. An observatory tool consisting of 13 infrastructure and neighbourhood-level attributes and 39 sub-attributes was prepared to record the availability of various infrastructures and get insights into these services after 10 years of project completion. The data collected in three different project typologies is indexed in the table showing respective percentage distribution of

infrastructure availability. Further, the findings in each project typology are compared with each other for making relevant inferences.

III. PROJECTS UNDER BSUP SCHEME IN LUCKNOW CITY

The rising demand of housing for the urban poor in Lucknow city has been addressed through projects built under various Affordable housing schemes. Under JNNURM, Lucknow has been part of both BSUP and IHSDP. Lucknow city was selected as one of the 63 mission cities for intervention under BSUP in 2005, whereas the other towns of the district like Kakori, Mahona, and Malihabad were benefitted under IHSDP. Later in 2013 Lucknow city was selected under RAY for slum

redevelopment and is currently part of the ongoing affordable housing scheme PMAY. Table 1 enlists the projects taken under BSUP in Lucknow city. Under the BSUP scheme in Lucknow City housing development was done in two formats - Relocation and In-Situ. The construction started in 2007 and continued till 2015 for few projects (Prasad, 2021). There are 14 in-situ and 9 relocation sites in Lucknow. In-situ development involved onsite upgrading and improvements of existing housing and infrastructure for beneficiaries having house ownership, whereas In-Situ Redevelopment - In Nishatganj, the existing slum area is redeveloped in G+3 housing, and slum dwellers have been benefitted. Relocation projects involved construction of group housing projects having building in G+3 and G+2 formats.

Table 1. Projects under BSUP in Lucknow City

Sr. No	Area	Houses	Total	Development Type	Developer Organization
1	Para	504	1488	Relocation	Uttar Pradesh Avas Vikas Parishad (UPAVP)
	Kharika, Telibagh	312			
	Semra Gauri	288			
	Hawat Mau Maveya, Ibrahim Pur	384			
2.	Amausi	506	593	In-situ	Uttar Pradesh Project Corporation Ltd.(UPPCL)
	Gadarian Purwa,	26			
	Chandan	30			
	Chaudhry Purwa , Dewa	31			
3	Kila Mohammadi,	44	364	In-situ	UPPCL
	Aorangabad,,Raja Bijli Pasi	75			
	Sugamau,	72			
	Jarhara,	97			
	Rahimabad, Raja Bijli Pasi	76			
4	Bhakti Khera Kanpur Road	60	181	In-situ	UPPCL
	Rahim Nagar, Dudauli	75			
	Munshi Khera	29			
	Behsa, Amausi	17			
5	Chak Malhauri, Chinhat,	336	336	Relocation	UPPCL
6	Umrao Hata, Nishatganj	176	176	In- Situ (Redevelopment)	UPPCL
7	Rashmi Khand, Sharda Nagar,	80	2432	Relocation	Lucknow Development Authority (LDA)
	Sector -H, Vasant Kunj	896			
	Sector -T, Vasant Kunj	1184			
	Bhadruk	272			

IV. OBSERVATION SURVEY PARAMETERS

An observation survey is conducted to perceive the availability and condition of various infrastructural services in the projects. The survey helped us to understand the type of facilities provided and observe their qualities after almost 10 years of construction of these projects.

Further, the findings were studied to understand the gap in the implementation of these schemes as per their guidelines. The parameters of the observation survey are selected after studying various post-occupancy evaluations for the neighbourhood as mentioned in table 2-

Table 2. Observation Parameters

Sr.No	Parameter	Indices	References
1	Water	Supply system	(Ilesanmi 2010) (Behloul 1991) (BIJOUX, SMITH and LIETZ 2008) (Bonaiuto, Fornara and Bonnes 2003) (Ziama and Li 2018)
		Supply Duration	
		Quantity	
		Quality	
		Storage	
		Recycle	
		Bills	

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2	Solid Waste	Collection system	(Behloul 1991) (Bonaiuto, Fornara and Bonnes 2003) (Ilesanmi 2010)	
		Access to communal waste point		
		Cleanliness of communal waste point		
		Recycle		
3	Sewage and Drainage	Sewerage system	(Bonaiuto, Fornara, & Bonnes, 2003)	
		Drainage system		
		Rain water collection point		Bonnes 2003) (Ilesanmi 2010)
		Recycling rain water		
4	Electricity	Supply duration	(Ilesanmi 2010) (Ziama & Li, 2018)	
		Bills		
Social Infrastructure				
1	Education facilities	Primary and Secondary school	(Bonaiuto, Fornara, & Bonnes, 2003)	
		Government college		
2	Health centers	Clinics and dispensaries	(Ziama & Li, 2018)	
		Government hospitals		
3	Public areas and green space	Size	(Youth for Unity and Voluntary Action and Indian Housing Federation, 2018)	
		Quality		
		Accessibility		
		Cleanliness		
		Outdoor play areas		
		Streetscape		
Transport and Roads				
1	Accessibility	Road width	(Behloul, 1991) (Bhattacharya, 1998)	
		Road condition		
		Pedestrian lane		
2	Public transport and traffic	Bus frequency		
		Walking distance to the nearest station		
		Traffic density		
		Parking facilities		
Employment opportunities				
1	Employment opportunities	Distance to workplace	(Ziama & Li, 2018)	
		Local market opportunities		
		Demand for laborers in the local area		
Safety and security				
1	Level of safety in the building	Fire escape	(Ilesanmi 2010) (Behloul 1991) (BIJOUX, SMITH and LIETZ 2008) (Bonaiuto, Fornara and Bonnes 2003)	
		Lighting in building		
2	Safety in neighbourhood	Gated community		
		Street lighting		
		Firefighting measures		
		Community guard		
		Institutional support		
Communication				
1	Communication	Network coverage	(Ilesanmi 2010)	
		Internet/ broadband		
		Postal services		
		Door to door service		

V. OBSERVATION TOOL

The observation tool is prepared using parameters selected mentioned in table 2. The tool is based on 6 broad parameters - physical infrastructure, social infrastructure, transport and roads, Safety and security, communication, and employment opportunity. Future divided into 13 attributes and 39 sub-attributes. The findings of the observation survey of BSUP projects in Lucknow City are discussed below –

5.1 Physical Parameters

The key aspect of the affordable housing schemes in India is to provide basic amenities to the poor. land utilization, water supply, electricity supply, and sanitation the most critical parameters for any housing development as the success or failure of the projects depends largely on these aspects.

Table 3. Observation of Physical Infrastructure in BSUP projects

Attributes	Sub- Attributes	Observations	In-situ (%)	Relocation (%)	Redevelopment (%)
Land Utilisation	All residential		100	100	100
	Both residential and		0	0	0
Water Sup- ply	Piped Connection	Household	100	100	100
	Boring	Project (Jal Nigam)	0	100	100
		Individual	58	0	0
	Community supply (Jal Nigam)	Tap	0	0	0
		Overhead	50	100	100
		Hand pump	75	22	0
Sanitation	Piped Outlet	Community	8	100	100
		Municipal/	92	0	0
	Soak Pit		100	100	100
	Surface Drains	Open	100	100	100
		Covered	0	0	0
	Rainwater Collection		0	0	0
Solid Waste	Municipal Bins		0	11	100
Electricity	Metered Connection		100	100	100
	Community Distribution Lines	Overhead	100	100	100
		Underground	0	0	0

5.1.1 Land Utilization

The parameter was studied to understand onsite land use activity distribution in the projects. The development of all three project types i.e. in-situ, redevelopment and relocation is done on residential land and major land-use activity is residential. Although there are few encroachments of small shops, animal shelters, and other informal workspaces within the facility.

5.1.2 Water Supply

Across 23 sites all 9 projects under relocation and one under redevelopment have an overhead tank and piped water connection through *Jal Nigam*, 2 of the projects also have hand pumps installed for communal usage. The capacity of the rooftop water storage tank is 200 liters as seen in Figure 2. For the in-situ projects, in 7 projects the dwellers have installed individual borings and 9 projects have community-level tanks and handpumps installed as seen in Figure 2. Further all the relocation projects and insitu redevelopment project are provided with overhead water tank within the project premise, Figure 3.



Figure 1 Roof top water storage tanks at BSUP project in Chakmalhauri



Figure 2 Handpump at Insitu project of Amausi



Figure 4 Biogas digester at Haibat Mau



Figure 3 Overhead water tank at Insitu redevelopment project at Nishatganj



Figure 5 Sewer & drains overflowing at Semra Gauri

5.1.3 Sanitation

In the relocation projects, the wastewater from the houses is drained through piped outlets to the manholes on the street, which finally connects to the community septic tank. Projects at Haibat Mau and Para are provided with fixed dome biogas digester for production of biogas, but currently are non-functional as seen in Figure 4. The sewage is overflowing in most of the projects as observed in Figure 5.

In the in-situ projects, the wastewater is drained through piped outlets to the manholes leading to the village/ municipal line. Although the service and stormwater drains are present, they are all open and are overflowing in all the projects as seen in Figure 6.



Figure 6 Open-drain at Insitu project at Aorangabad Pasi

5.1.4 Solid waste management

There is no formal arrangement of solid waste management in any project. The projects lack communal waste collection and segregation points except in one relocation project at Para, where a municipal bin was provided Figure 8. In few projects, the residents have made the collective arrangement of the door-to-door waste collection. Piles of waste are a common sight across all the projects, as seen in Figure 7. Condition of Insitu redelopment project at Nishatganj is even more critical, as the project premise is used for dumping the construction materials and debris of near by areas, Figure 9.



Figure 7 Heaps of garbage at Vasant Kunj sector P project



Figure 8 Municipal bin at Para project



Figure 9 Construction materials dumped at Nishatganj project

5.1.5 Electricity

All the projects under the BSUP scheme have metered electricity connections in each house. The overhead distribution lines are placed at the roadside mounted on a concrete pole. In few projects, even the streetlights are placed on these poles as seen in Figure 10. A series of tangled wires can be seen on electric poles placed close to the buildings in all the projects, violating the mandatory clearance norms as per model building bye-laws. This can be seen in Figure 11.



Figure 10 Overhead distribution lines at Haibat Mau



Figure 11 Overhead distribution lines at Bhadrak

5.2 Social Infrastructure

Social infrastructure is a necessity for all housing communities, education and health facilities need to be present in walkable proximity. Public areas and green spaces are mandatory to develop any housing scheme, there can be the park, garden or children play area in different sizes and locations.

Table 4. Observation of Social Infrastructure in BSUP projects

Attributes	Sub- Attributes	Observations	In-situ (%)	Relocation (%)	Redevelopment (%)
Education Facilities	Primary School	0-1 km	92	56	0
		1-3 km	8	33	100
		more than 3 km	0	11	0
	Secondary School	0-1 km	83	56	0
		1-3 km	17	44	100
		more than 3 km	0	0	0
	College/ Technical School / University (Government)	0-1 km	17	22	0
		1-3 km	75	33	100
		more than 3 km	8	44	0
Health Care Facilities	Clinics/ Dispensaries/ Hospitals	0-1 km	67	56	100
		1-3 km	33	44	0
		more than 3 km	0	0	0
Commercial Facilities	Small grocery or Convenience store	0-1 km	100	100	100
		1-3 km	0	0	0
		more than 3 km	0	0	0
	Pharmacy	0-1 km	75	33	100
		1-3 km	25	56	0
		more than 3 km	0	11	0
	Food establishment (Restaurants/ Dhaba etc.)	0-1 km	100	67	100
		1-3 km	0	33	0
		more than 3 km	0	0	0
	Entertainment (e.g., movie theatre)	0-1 km	0	0	100
		1-3 km	17	44	0
		more than 3 km	83	56	0
	Post office	0-1 km	0	22	100
		1-3 km	50	56	0
		more than 3 km	50	22	0
	Bank	0-1 km	42	11	100
		1-3 km	58	67	0
		more than 3 km	0	22	0
Petrol Pump	0-1 km	17	22	100	
	1-3 km	67	67	0	
	more than 3 km	17	11	0	
Recreational Facilities	Parks and play ground		33	100	0
	Community centre		17	44	0

5.2.1 Education facilities

All three typologies of educational institutions are located within a distance of 3km except in the project at Vasant Kunj sector P where the nearest primary school is located beyond 3km. These include both government and private institutions.

5.2.2 Health centers

Physical Health centre's(PhC's) in form of clinics, dispensaries, and hospitals are located within a range of 3km in all the projects. Under relocation projects, Semra Gauri is equipped with PhC within the project Figure 12 and a temporary health kiosk is setup in the community hall of Para project Figure 13. An urban PhC was observed in

Insitu project of Sugamau, shown in Figure 14. The PhC's include both government and private facilities.



Figure 12 PhC at Semra Gauri



Figure 13 Community hall converted to health kiosk at Para



Figure 15 Shops at Insitu project of Sugamau



Figure 14 PHC at Insitu project of Sugamau



Figure 16 Streets encroached for shops at Semra Gauri

5.2.3 Commercial facilities

Almost all the projects have commercial facilities within the range of 3 km except for banks and post offices. The shops in Insitu projects are provided in dedicated space in an organized manner as seen in **Error! Reference source not found.** and Figure 15. Fifty percent of the In-situ projects have post offices beyond a distance of 3km due to their distant locations from the city centre. The same scenario was observed in two relocation projects of Vasant Kunj Sector H and sector P due to their far-off location from the main city. The shops within the project campus have developed encroaching access lanes and parks as seen in Figure 16 and Figure 17.



Figure 17 Streets encroached for shops at Vasant Kunj sector H



Figure 15 Shops at Insitu project of Jarhara

5.2.4 Recreational facilities

All the relocation projects have been allotted either an open space or a park, whereas only 4 in-situ projects have any kind of open/ green spaces. But presently most of these parks are encroached upon for parking Figure 18, informal workspace, animal shelters, temporary shops, etc. In the project at Vasant Kunj sector P, development of slums and squatter settlements is observed in parks as seen in Figure 19.



Figure 18 Parking in open Space at Chak Malhauri



Figure 20 Community centre used as health kiosk at Para



Figure 19 Slums development in park at Vasant Kunj sector P



Figure 21 Community centre at Chak Malhauri

The provision of the Community centre is limited to 4 relocation projects and 2 in-situ projects. But it is observed that even in these projects the facility is used as storage space, PHC's Figure 20, or is forcefully captured by locals for residential use and is inaccessible for the project occupants for their usage. This is observed at the relocation project at Chak Malhauri shown in Figure 21 and in the In-situ project of Sugamau shown in Figure 22.



Figure 22 Community centre at Sugamau

5.3 Transportation, Roads, and Parking

Public transportation and road connectivity are mandatory physical infrastructure that links the project to various parts of the city. Further provision of dedicated parking space in affordable housing projects hinders various encroachment activities.

Table 5. Observation of various parameters in BSUP projects

Attributes	Sub- Attributes	Observations	In-situ (%)	Relocation (%)	Redevelopment (%)
Transit Stop/ Stations	Bus Stop	0-1 km	17	33	100
		1-3 km	67	67	0
		more than 3 km	17	0	0
	Auto Stand	0-1 km	83	78	100
		1-3 km	17	22	0
		more than 3 km	0	0	0
	Railway Station	0-1 km	0	0	100
		1-3 km	8	11	0

		more than 3 km	92	89	0
Access Lanes & Parking	Access Lanes	Paved	92	100	0
		Unpaved	8	0	100
	Access Lane Width	Up to 2 m	8	0	0
		2.1- 4 m	92	0	0
		4-6 m	0	100	100
	Side Walkways		0	22	0
	Cul-de-sac		0	44	0
	Encroachment	Street	17	67	100
		Parks	0	44	0
Parking	Designated	58	0	0	
	On- Street	42	100	100	
Safety and Security	Gated Community		0	56	0
	Streetlights		100	100	100
	Fire Fighting		0	0	0
	Police Station/ Chowki	0-1 km	17	33	100
		1-3 km	58	56	0
more than 3 km		25	11	0	
Communication Network	Cellular Network	Strong	100	67	100
		Weak	0	33	0

5.3.1 Transit Stop and Stations

All the projects have bus stops and auto stands within a vicinity of 3km except for two in-situ projects at Amausi and Bhakti Kheda. Due to the location of all the projects on the city periphery, even the local railway station is located beyond 3km.

5.3.2 Access lanes and Parking

All the projects have paved access lanes with their width varying from 4 m to 5m in Relocation projects as seen in Figure 23 and Figure 24 and 1.8m to 3.5m in Insitu projects and Insitu redevelopment projects as seen in Figure 25 and Figure 26. Insitu redevelopment project at Nishantganj is the single project with unpaved internal access lane, Figure 25. Access lanes, open areas, and parks are used to park the vehicles in relocation projects. The provision of side walkways was only observed in 2 relocation projects namely Rashmi Khand and Haibat Mau. . 58 percent of the in-situ projects have dedicated parking space but there is no dedicated parking space in any of the relocation projects.



Figure 23 Street view at Kharika project



Figure 24 Street view at Vasant Kunj sector P project



Figure 25 Street view of Insitu redevelopment project at Nishatganj



Figure 26 Street view of Insitu project at Rahimabad



Figure 29 Street light at Rashmi Khand Project

5.4 Safety and Security

The provision of access control (project gates) is available in 56 % of relocation projects, but in the current state, the gates are either damaged or uprooted as seen in Figure 27 and Figure 28. This has resulted in an increase in external traffic on internal roads. Lack of any boundary or gate at Nishatganj project has led to encroachment of project premise for market parking, dumping of construction waste and garbage and development of squatter settlements. All the projects are equipped with streetlights, although the quantity is less than required. There is no provision of fire hydrants, fire water tanks, sprinklers, etc. in any of the project typologies. Further, the local police support was present in the range of 4 km in all the projects.



Figure 27 Project gates missing from semra Gauri project



Figure 28 Project gates missing from Haibat Mau project



Figure 30 Street light at Bhadrak project

5.5 Communication network

The communication network in terms of network connectivity was strong in all the in-situ projects. But weaker connectivity was observed in 33% of relocation projects due to their far-off location from the city.

VI. FINDINGS

6.1 In-situ Redevelopment project

In this type of development, the land was acquired to remove slums, and dwellers having land Patta (land entitlement) were given flats in a G+3 building. The project is not complete in terms of infrastructure provision as the access lanes are not completely paved, the boundary of parks and open areas are not developed, surface drains are not completely developed, etc. Access lanes are encroached for parking and shops. The project has a major problem of waterlogging due to unavailability of surface drains. The streets are used to park loading vehicles of nearby shops and factories due to the unavailability of gates or the boundary wall. Even after the removals of slums, the place over the period has experienced the development of new jhuggi areas (slums and squatter settlements) around it. The unavailability of informal work-space has forced people to keep their thelas (vendor cart) and cattle on the street.

6.2 In-situ projects

In-Situ Project development mainly accounts for the construction of *pakka* houses for selected beneficiaries living in urban villages. The module of one room with small kitchen space and toilet is constructed. People, not having *pakka* houses were selected as beneficiaries on the recommendation of the village sarpanch. In In-Situ projects, due to relatively small project size, they are not provided with many community-level facilities such as parks, community centre, access control (Gates), and streetlights. Even the width of access lanes varies from 1.5m to 3m and in some cases are not even paved. These projects are dependent on existing village infrastructure for water supply and sanitation. Dwellers of in-situ projects have upgraded their houses by adding extra rooms and changing the façade as per their satisfaction. Few have also opted for borewells as an additional source of water supply. In the present condition, it is hard to identify such houses as most of them are completely remolded now.

6.3 Relocation Projects

In relocation projects maintenance of infrastructure was the major problem. Most of the projects have no gates despite having provisions for the same. Manholes and septic tanks are overflowing in most of the project. Few projects are equipped with fixed dome biogas digester, which is either nonfunctional or incomplete in terms of their connectivity. This has resulted in an unhygienic living environment in the project. There is a piling of solid waste in projects. Parks are marked spaces but are either encroached for parking or used as informal workspace. Open drains are choked with solid waste causing waterlogging. Encroachment of roads for parking and shops. Other problems such as crime, theft, forced inhabitation, and renting are prominent in large projects such as Vasant Kunj. The community centers are either inaccessible for use or are used as storage space. In few projects dwellers of the ground floor have illegally constructed on the common area.

VII. CONCLUSION

The development of Projects under the BSUP scheme, promises to provide housing with basic services, which in the present condition is either incomplete or non-functional in most of the projects. Selection of site for the project should be done keeping in mind the vicinity of necessary services health care & education facilities and occupation structure of end-user as they have limited income to spend on travel. Most of the projects are incomplete in terms of their interior finishing and other construction elements. The regulating authorities need to review the projects carefully before issuing the completion certificate to the developer and allotting the house to beneficiaries to curtail the substandard practices by developers. Lack of social infrastructures such as parks, playgrounds, community centres hinder the overall communal development of the occupants. This enhances the need to have dedicated planning guidelines for the development and maintenance of such infrastructure in the project. Lack of maintenance has resulted in failure of sanitation services in most of the

projects, so there is a need to develop a mechanism where both residents and authorities are responsible for the same. The developers of the project should carry out the maintenance for a stipulated period and in the meantime the authorities and residents should constitute Community Level Organisations (CSO) to carry out the works later. Further NGO,s should be invited to train the occupants for carrying out maintenance and periodic cleanliness activities.

Encroachment of land for informal activities and commercial activities suggests that there should be specific consideration for the needs of the end-user in designing the projects. Demarcating land for commercial activity and informal activity for cattle breeding, pottery, crafts, carpentry, etc.in the project will help reduce the encroachment to large extent. This will also help generating local employment opportunities for the residents.

The policy of these schemes should be brought in coordination with Rojgar (employment) yojana for a stipulated period to provide local livelihood for the occupants ensuring their social security. There is need to conduct post occupancy review by the concerned authority to evaluate the user experience and analyse it to make further improvements in the projects. These housing programmes should be designed to improve the living condition of urban poor and develop a social base for them to progress and prosper.

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