RICES'

RESEARCH INNOVATION COMMERCIALISATION & ENTREPRENEURSHIP SHOWCASE

HUMANIZING INNOVATION

2021

ENGINEERING & INDUSTRIAL DESIGN

RICES 2021: ENGINEERING & INDUSTRIAL DESIGN

MMU MULTIMEDIA UNIVERSITY | PRESS

Contents

FOREWORD

VICE PRESIDENT, RESEARCH AND INDUSTRIAL COLLABORATION AND ENGAGEMENT (RICE)

RICES 2021 with its overarching theme of Humanising Innovation was a huge success and I am extremely pleased with its outcome. This beautiful and meaningful event will not be a success without the dedication, teamwork, creative mind-sets, and hard work by many of us in the Research, Industrial Collaborations and Engagement Division. I am certain that we will be able to continuously and successfully organise this event for many years to come.

I would also like to thank all the committee members for your relentless assistance for this event. The event that marks our DNA to profoundly rethink on ways we can compete in this next-generation, more-human digital world, which is obviously an unclaimed territory. Your contributions are really valuable and precious for the new generations so called the digital natives.

With the help of your hand, we have had a strong 129 participations from various institutions, local and overseas. Personally, I believe this is a big movement to keep pushing and promoting digital, visionary innovation.

To all participants, believe in the creative vibes in you. Continue to churn out new inventions and innovations, let RICES rise to its purpose in providing the stage for the researchers and innovators to freely express your ideas.

Prof. Ir. Dr. Hairul Azhar Bin Abdul Rashid
Vice President
Research and Industrial Collaboration and Engagement
Multimedia University

FOREWORD

CHAIRPERSON OF RICES 2021

On behalf of the Committee, it is my pleasure to welcome you to the 5th Research Innovation, Commercialisation and Entrepreneurship Showcase 2021 (RICES 2021) held virtually on 16 November 2021. RICES provides a platform for the participants to showcase their latest inventions, innovations, and R&D commercialisation achievements. It also provides the opportunity for the participants to receive feedback and develop new partnerships with existing and new collaborators and investors. We are pleased to present the proceedings of the exhibition as its published record.

There are two categories of showcase under RICES 2021 - Research Project Showcase and Social Innovation Project Showcase. Despite the challenging COVID-19 pandemic situations, we received 129 submissions from different countries, representing a slight increase compared to the submissions under these two categories for RICES 2020.

This event is the result of the hard work of many people. We want to express our appreciation to the members of the Organising Committee and the external reviewers for their efforts in evaluating the submissions. We also thank our event sponsor, Keenon Robotics and Prof. Fabian Kung (FOE, MMU), for sharing their robots with us for the opening ceremony. The event would not be possible without the excellent inventions contributed by the participants. We thank all the inventors for their contributions and participation in RICES 2021!

We hope this event will further inspire technological innovations that will benefit humanity.

Prof. Ir. Dr. Lim Heng Siong
CHAIRPERSON of RICES 2021
Deputy Director, Research Management Centre
Multimedia University

FOREWORD

HEAD OF MMU PRESS

I am delighted to write this foreword, not only because Research Innovation, Commercialisation and Entrepreneurship Showcase 2021 (RICES 2021) has been successfully documented in this special edition, but also because the quality of the research papers, various inventions, innovations, and R&D commercialisation achievements are of a high standard. Congratulations to all the participants, and may RICES become the platform for you to achieve greater heights in the future.

It is our utmost hope that MMU Press mission will be an internationally recognised academic press. Its spirit is to connect Multimedia University (MMU) with the larger communities and institutions through innovative and inspiring writings. I believe this book can help researchers, academics, students, and industry players to further develop a shared vision and understanding of the digital world and what it offers. Kevin Colleran, one of Facebook's earliest employees who spoke about staying true to his entrepreneurial spirit says, "If you can't imagine a world different from the one you see today; you will never be able to build a better one."

I would like to humbly thank various people who made MMU Press publications a success especially in its RICES 2021 publications. All these achievements are made possible due to strong commitment by all, especially the Coordinator of Special Publication – Dr. Tan Yi Fei, chief editors, editorial team members and the project leaders, who have contributed to the publication of RICES 2021. The engagement, dedication, commitment, and effort dedicated to this book are indeed beyond words. Thank you and let's make MMU Press be the beacon of knowledge.

Assoc. Prof. Dr. Tan Siow Hooi
Deputy Director, Research Management Centre (Head of MMU Press)
Multimedia University

ENGINEERING & INDUSTRIAL DESIGN

ARTIFICIAL SUN SIMULATOR FOR SOLAR PV TESTING IN INDOOR ENVIRONMENT

Team Leader: Mr. Md. Imamul Islam*,
Team Members: Dr. Ahmed Al Mansur*, Mr. Mohammad Asif Ul Haq*, Mr. Md. Hasan Maruf*, Dr. ASM Shihavuddin*, Dr. Ratil H Ashique*
Department of EEE Green University of Bangladesh*

Abstract

Solar PV are frequently tested for power output and overall operational efficiency during the design and manufacturing process. The testing is always carried out in an indoor setting under standard test conditions. However, solar panel testing is extremely costly, and testing facilities in Bangladesh are inadequate for both manufacturers and researchers. If solar panel testing costs can be reduced, panel production costs would be lower, and academic researchers in Bangladesh will be eager to conduct various solar panel-related research and experiments. An inexpensive artificial sun simulator has designed and developed for Solar PV testing in this study.

Design & Materials

In the embodiment of the artificial sun simulator include (1) a support frame structure; (2) a plurality of halogen-based lamps connected to the support structure to illuminate a target area, wherein each lamp required a mounting structure; (3) an array configuration of mounting structure is used for multi-lamp assembly purpose; (4) in the array, in each string a parallel connection is used for connecting the lamps to provide equal electric power; (5) a portable light measuring device is incorporated for measuring light intensity at each discrete locations of the target area; (6) based on the measuring data, modifying the light output or position to maintain the uniformity of the light intensity of a target area; (7) a portable PV testing device is incorporated to measure the electrical characteristics of a PV module; (8) the target area of the test panel is adjustable & the sun simulator comprised of a 1020x660 mm test panel; (9) the light intensity of the sun simulator adjusted by varying the vertical positing of the test panel; (10) a cooling unit used to minimize the temperature of the halogen lights on a target area. The simulator can be used for the measurement of electrical characteristics of both polycrystalline and monocrystalline photovoltaic modules.

Experiment Method

The experimental method is described in the this section. A moveable tray has used to place the PV module parallel with the halogen lights. The structural frame of the artificial sun simulator is made of steel frame and laminated by color coating to avoid electric shocks. However, the experiment has performed in the laboratory at 25°C, according to IEC 60904 standard using a room air conditioning system. Besides, the high-speed exhaust fans are placed on the top of the sun simulator frame to provide faster cooling during the experimentation. According to the IEC standard a single test should be done within one minute. The output power of the PV module is measured by a digital I-V tracer, PROVA- 1011 with a data memory system. The light and temperature sensors are integrated with the portable device PROVA-1011. A computer be incorporated to analyze and process the measured data to illustrate the electrical characteristics of the experimented PV module.

Testing & Measurement Setup of Artificial Sun Simulator

Experimental Result & Discussion

A 40W Panel has been tested according to STC. Tested output power is 40.07W, Voc and Isc 20.12V & 2.60 respectively which is almost similar to manufacturer specifications.

A 40W Panel Specifications & Tested Results

Panel Configurations	Panel Specification	Measured Value
Open circuit voltage, (V)	20.31	20.12
Short circuit current (A)	2.60	2.60
Max power current, (A)	2.34	2.343
Max power voltage, (V)	17.10	17.104
Area of the module, (cm²)	2583	2583
Max power at MPP, (W)	40.014	40.07
Fill Factor (FF)	0.757	0.766
Efficiency	15.491	15.513

Output curve of tested 40W Panel
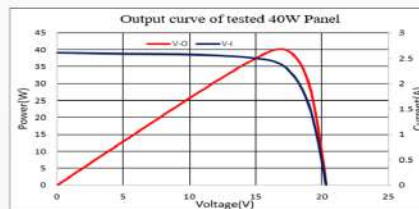
Product Specification

Items	Specifications
Lamp Spectrum	In line with IEC60904-9
Range of Line Intensity	1000 W/m² (Adjustable 100-12000 W/m²)
Light Intensity non-uniformity	±5%
Temporal Instability	±5%
Single Test Time	500ms
Effective Test Range (DxWxH)	1092x711x1193mm
Weight	70 Kg
Temperature	25~70°C
No. of Halogen Lamp	98 PCS
Power Supply	220V ±10%, 4.9KW, 50Hz
Test Parameters	Isc, Voc, Pmax, Vm, Im, FF, Eff, Temp, Rs, Rsh

Novelty

❖ Not Commercially available in the local market of Bangladesh
❖ Easier to Develop Hardware Setup
❖ Economic in Development & Testing Compared to Commercial One
❖ Can Extract Exact Electrical Characteristics of PV Panel
❖ Light in Weight, Durable & Sustainable Materials
❖ Creates Efficient, Reliable & Regulated outdoor Environment in the laboratory.

Status of Innovation

o Technology Readiness Level: 8

Benefits

➤ Ideal black body match in the infrared
➤ Minimal UV emission
➤ Relatively inexpensive & useful for indoor experiment

Commercialization Potential

❑ Photobiology: Photosynthesis, bioluminescence, light therapy, living organisms, DNA damage, skin cancer.
❑ Photooxidation: Degradation of crude oil, water treatment, Polymer degradation, free radical formation.
❑ Photodegradation: Photodegradation of food, agricultural products, pharmaceuticals, & photobleaching.
❑ Sunscreens: Sunscreens efficacy, Sun Protection Factor.
❑ Photocatalysis: Acceleration of a chemical reaction.
❑ General Applications: Plastics, coating, colour fastness of fabrics.

Achievement/Award

• Research & Development (R&D) Grant, MOST.
• Silver Medal award, GEX, 2021.

Environmental Impact

o Free from carbon emission & no air pollution occurs
o Less sound effect from high speed fan

Conclusion

A low-cost halogen-based artificial sun simulator has been conceived, modelled, and built to test solar cells and panels in an indoor setting in accordance with ASTM, IEC, and JIS solar simulator requirements. The low-cost solar simulator can create wavelengths in the UV-Vis-NIR wavelength range between 350 and 1100 nm, and its projected lifetime is 100,000 hours. Tested result validate the efficiency of artificial sun simulator. The cost of testing will be reduced by employing this device, as will the total cost of Solar PV, and researchers will be encouraged to conduct research in the field of Solar PV.

Reference

1. Investigation of PV Modules Electrical Characteristics for Laboratory Experiments using Halogen Solar Simulator, IEEE Xplore: 16 February 2021, DOI: 10.1109/STI50764.2020.935049
2. Novel LED artificial sunlight for therapy applications, The university of New castle, 2018, DOI: 10.13140/RG.2.2.29759.00167
3. Ranga Vihari Parupudi et al., 2018 (Sun Simulator for Indoor Performance), Energy Proceeding

Acknowledgment

Industrial Partner

AUTOMATIC DATA ACQUISITION SYSTEM
FOR FINGERPRINTING BASED INDOOR POSITIONING

Alvin Chong Ming Song, Dr. Yeo Boon Chin, Assoc. Prof. Dr. Lim Way Soong
Faculty of Engineering and Technology, Multimedia University, Melaka, Malaysia

Introduction

Fingerprinting based Indoor Positioning System (IPS) required to conduct site survey (data acquisition) on the selected indoor environment to obtain a fingerprint database in advance. For instance, the development of fingerprint based IPS using Wi-Fi Received Signal Strength (RSS) requires an initial site survey to obtain the Wi-Fi RSS fingerprint from the available Wi-Fi signals detected in the indoor environment. This is a lengthy process that requires a large amount of time and manpower if manually commissioned. One popular approach to obtaining a fingerprint database is by automate the data acquisition process. The available solution to automate data acquisition uses Simultaneous Localization and Mapping (SLAM) robot with a mounted data acquisition device. However, SLAM robot has high hardware requirement and employs a complex algorithm in order to update its estimated current coordinate with high accuracy. Despite this, its estimated current coordinate suffers from having accumulative errors.
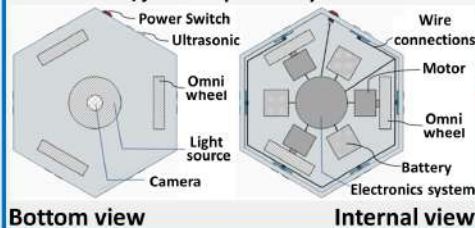
The Invention

The invention presented an automatic surveying system that utilizes tiled floor characteristics to realize automatic data acquisition. The automatic surveying system consists of a server, a WLAN, and an Automatic Surveyor. The Automatic Surveyor is capable of self-update its current coordinate whenever a grout joint is detected and self-navigating in a selected indoor environment following the surface grout.

A smartphone installed with an automatic data acquisition application to manage the whole data acquisition process, including:
❖ Request for a survey path from the server.
❖ Send motion requests to navigate the omnidirectional mobile robot.
❖ Conducts wireless features scanning, generating fingerprints, and submitting to the fingerprint database server.

An omnidirectional mobile robot capable of self-navigate based on orientation of grout lines/joints captured by camera.

Power Switch
Ultrasonic
Omni wheel
Light source
Camera
Bottom view

Wire connections
Motor
Omni wheel
Battery
Electronics system
Internal view

Market Potentials

A market survey report titled "Indoor Positioning and Indoor Navigation (IPIN) Market Outlook: 2025" from Allied Market Research provides a comprehensive analysis of wireless technologies based indoor positioning and navigation market. The global indoor positioning and navigation market trend is projected to reach $43,511 million by 2025.

Opportunity

Wi-Fi and Bluetooth are wireless technologies frequently selected to develop fingerprinting based IPS. Based on a market survey report titled "The Rise of Indoor Positioning" from IndoorAtlas and Vanson Bourne, Wi-Fi and Bluetooth are the top two wireless technologies used to develop IPS with a percentage of 47% and 26%, respectively.

The Prototype, Patent and Publication

The invention had filed a patent in September 2021.
- Patent ID: PI2021005462.
- Patent Title: System and method of data acquisition for fingerprinting based indoor positioning.

A Wi-Fi RSS fingerprinting based IPS had been developed using the invention. A paper had been prepared and accepted for publication.
- Journal title: Automatic Data Acquisition System for Wi-Fi Fingerprint-Based Indoor Positioning System.
- Publisher: International Journal of Innovative Computing, Information and Control.

Advantages

✓ **High efficiency** – Reduces time by deploying multiple surveyors.
✓ **High effectiveness** – Manpower reduced, and users can monitor real-time data acquisition.
✓ **Immune to accumulative error.**

Wireless anchor
Wireless anchor
Wireless anchor
Wi-Fi communication
Wi-Fi communication
Automatic Surveyor
Wireless anchor
Wireless anchor
Wireless anchor

Provide site survey paths and store fingerprints.

Wi-Fi communication

Wireless Local Area Network (WLAN)

Server

Establish long-range communication to allow information exchanges between devices.

AUTOMATIC HANDOVER ALGORITHM IN 5G AND BEYOND NETWORKS

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Abstract

Handover (HO) is an essential process in mobile wireless networks to ensure that the user equipment remains connected to the network while moving within the coverage of evolved nodes. The main challenge of HO is to provide a robust and seamless process. This challenge becomes crucial in Fifth Generation and Beyond (B5G) systems utilizing millimeter-waves and ultra-dense small cells. This condition is because this characterization increases the HO probability (HOP), which may lead to an increase in the HO ping-pong (HOPP) effects. This project proposes a self-optimization HO algorithm based on fuzzy logic controller (FLC) to reduce the HOP and HOPP effects. This project is conducted through simulation on Matlab software. Simulation results show that the proposed algorithm significantly decreases the HOP and HOPP probabilities compared with the state-of-art algorithms, thereby improving the network performance.

Simulation Set Up

The simulation environment is developed on Matlab 2020b to simulate a real B5G network. The simulation parameters (Table 1) are adjusted in accordance with the 3GPP Releases 16 and 17 [1].

Table 1 Simulation Parameters

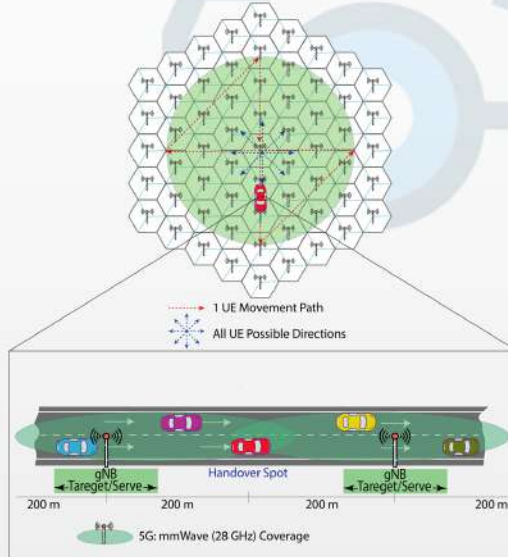| Parameter	Assumption
Simulation area	(3000×3000) m
Number of eNBs	61
Number of sectors	3
Measured no. of users	20 UEs
Cell radius	200 m
Carrier frequency	28 GHz
System bandwidth	500 MHz
Path loss	3GPP UMi Model
UE speeds	[20, 40 ,80, 120, 160] km/h
Mobility model	8 Straight Directions [45°]

Fig1. B5G network deployment

System Model

FLC system (Fig. 2) comprises three essential stages: fuzzification, fuzzy inference system, and defuzzification. In the fuzzification stage, the input data are converted into linguistic values. In the fuzzy inference system stage, the rules (*if-then*) are applied to all input data, and these data are combined as fuzzy output sets. In the defuzzification stage, the output sets are defuzzified to crisp outputs.

We propose a self-optimization algorithm by using FL to mitigate the HOPP rate and HOP. The proposed algorithm is designed to automate the HO decision and adjust the time-to-trigger (TTT) and HO margin (HOM). The system consists of 48 rules for three input parameters, which are UE velocity, RSRP, and RSRQ, and two outputs (TTT and HOM).
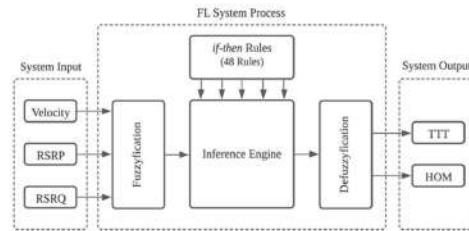

Fig. 2 FLC system architecture of the proposed system

Results

Fig. 3 illustrates the HOPP probability with different mobile speed scenarios. The HOPP probability is significantly reduced. The proposed algorithm decreases the HOPP probability approximately by 0.5% compared with 50%, 10%, and 20% in Silva et al. [2], FLC [3], and Conventional, respectively.

Fig. 4 presents the average HOP under different mobile speed scenarios. A significant reduction is achieved by the proposed algorithm. The proposed algorithm provides the lowest HO rate by 3.6%, whereas the benchmark algorithms offer higher HO rates of 73%, 25%, and 36% by in Silva et , FLC, and Conventional, respectively.
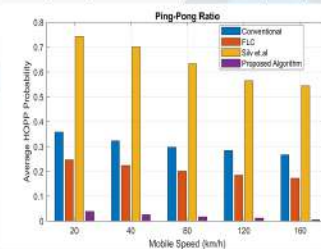
Fig.3 HOPP probability
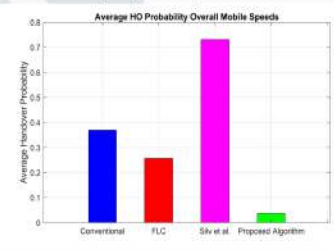
Fig. 4 HOP

Conclusion

This project proposed a self-optimized algorithm based on FL to improve the HO performance in B5G networks in terms of the HOPP effect and HOP. The proposed algorithm tuned the HCPs in accordance with RSRP, RSRQ, and users' speed. The simulation results show that the proposed algorithm significantly reduces the HOPP probability and HOP compared with other algorithms. The average HOP achieved by the proposed algorithm, in Silva et , FLC, and Conventional method are approximately 0.5%, 50%, 10%, and 20%, respectively. This work can be extended by including several performance metrics, such as radio link failure, interruption time, outage probability, and spectral efficiency.

References

[1] 3gpp, "Study on channel model for frequencies from 0.5 to 100 GHz," in "Release 16," 2020.[Online].Available: https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3173

[2] K. D. C. Silva, Z. Becvar, and C. R. L. Frances, "Adaptive hysteresis margin based on fuzzy logic for handover in mobile networks with dense small cells," IEEE Access, vol. 6, pp. 17178-17189, 2018.

[3] P. Muñoz, R. Barco, and I. de la Bandera, "On the potential of handover parameter optimization for self-organizing networks," IEEE Transactions on Vehicular Technology, vol. 62, no. 5, pp. 1895-1905, 2013.

DEEP LEARNING-BASED PREDICTION MODEL TO REDUCE GRAIN DAMAGE AND ENERGY WASTAGE IN AGROINDUSTRY

Multimedia University: Dr. Yip Sook Chin · Dr. Tan Wooi Nee · Mr. Gan Ming Tao · Miss. Teo Yar Lee
Plus Xnergy Holding Sdn Bhd: Mr. Oh Zhi Kang · Mr. Alvin Tan Wan King · Mr. Koay Beng Guan · Mr. Isaac Wan Philip

Project Highlights

- This is a collaboration project with Plus Xnergy Holding Sdn Bhd (previously known as Plus Solar Sdn Bhd), which is working closely with local rice mills.

- To mitigate the problem of under-dried and over-dried paddy in the rice mill, which causes the degradation of paddy quality.
- With the prediction of the stopping time of the drying process, not only the quality of the dried paddy can be maintained, but the energy consumption can also be optimized.

Figure 1: Industrial Inclined Bed Dryer (IBD) in local rice mill

Abstract

- A Long Short-Term Memory (LSTM) based prediction model that tracks the grain moisture content (MC) level throughout the drying process to control the stopping time of an industrial inclined bed dryer (IBD).
- When evaluated against the validation dataset, MC value prediction from 2 hours to 10 hours ahead of time, with a RMSE of just 1.5 units.
- The optimum drying time provided by prediction model eventually forms a practical agriculture solution that helps the agroindustry operators to avoid excess energy consumption and manage manpower efficiently for the unloading process while preserving the final quality of dried grain.

Methodology

Data collection (21 drying batches)
- Temperature, humidity and MC collected at S1 to S12
- Temperature and humidity readings of input drying air as well as ambient environment are collected

Data preprocessing
- Combine all 21 batches of data
- Scale the data from 0 to 1 for training
- Reshape the data into samples to train the prediction model

Development of prediction model
- 17 drying process data were used to train the model
- LSTM neural network was trained to predict the grain moisture content

Performance evaluation of the prediction model
- 4 drying process data were used as validation data to provide an unbiased evaluation of the performance of the prediction model
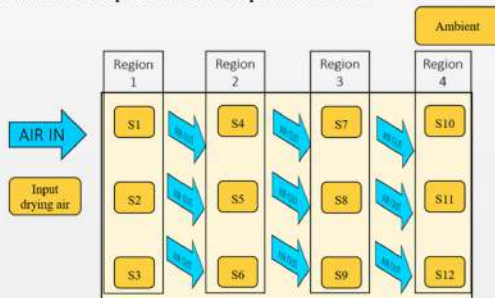

Figure 2: Plane view of dryer bed with sensor location
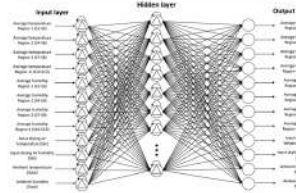
Implementation

Figure 3: Network Architecture of Prediction Model 1

Feed in 2 hours of temperature and humidity data in order to produce the future 2 hours of temperature and humidity data.
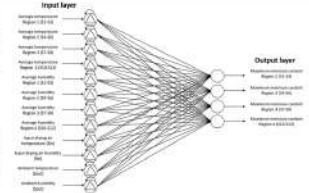

Figure 4: Network Architecture of Prediction Model 2

Feed in 1 hour of temperature and humidity data in order to produce the future 2 hours of MC level data.
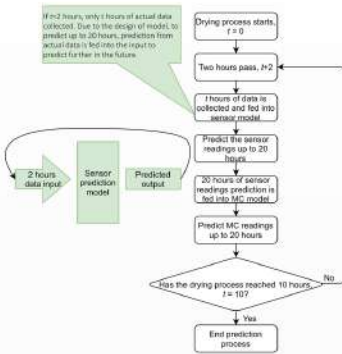
Figure 5: Flowchart of the prediction process

- The prediction is performed every 2 hours after the drying process starts.
- Real-time data are collected and fed into the prediction model.
- Each prediction will produce 20 hours of MC data.
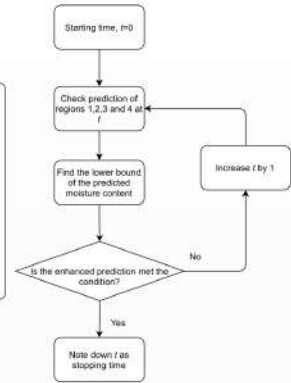
Figure 6: Flowchart to determine the drying time

- The drying time can be determined after predicted MC data are obtained.
- The time t when the predicted MC drops below the desired level is deemed the suggested optimum drying time.

Result and Discussion

(a) Prediction with 2 hours of real-time data
RMSE: 2.0195

(b) Prediction with 6 hours of real-time data
RMSE: 1.4259

(c) Prediction with 10 hours of real-time data
RMSE: 1.5505
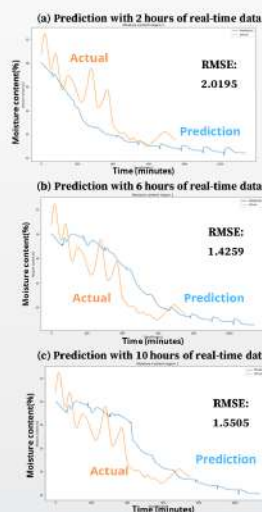
Figures 7(a)(b)(c): Graphs of prediction vs. actual MC

- On average, the prediction deviates from actual MC by 1.5 to 1.6 units, allowing for reliable decision making.
- Of the 3 underdried batches in the validation dataset, our system proposed lengthening the drying time for 2 of them. More significantly, it successfully prevented 12 out of 14 batches from overdrying. Cumulatively, the drying time was shortened by up to 30 hours.
- By deploying IoT sensors, our system can record temperature and humidity readings in higher resolution (i.e., sensor readings in minutes vs. manual measurement in hours).
- System automation significantly reduces the need for manual labour. Physical measurement by workers may only be required intermittently for calibration.
- Precise sensor reading and MC predictions suppress overt fluctuations caused by human error.
- Our system not only estimates the current MC but is also capable of predicting future MC up to 10 hours ahead of time.
- The ability to predict overdrying and underdrying in advance allow the agroindustry operators to take proactive (as opposed to reactive) measures, mitigating potential grain damage/energy wastage before they even have a chance to occur.

DESIGN AND DEVELOPMENT OF AN INNOVATIVE MMU EXAM TABLE AND CHAIR

1. JEE KIAN SIONG (MULTIMEDIA UNIVERSITY)
2. CHUA HOR YAN (MULTIMEDIA UNIVERSITY)

1. Introduction / Problem Statement
   - Current design is not ergonomic.
   - Current design taking up too much space when being stored.
2. Objective
   - Design an exam chair & table according to ergonomics and space saving principles.
3. Methods & Materials
   a. Survey – students, academicians, ERU staff and FMD staff (Total 75 respondents)
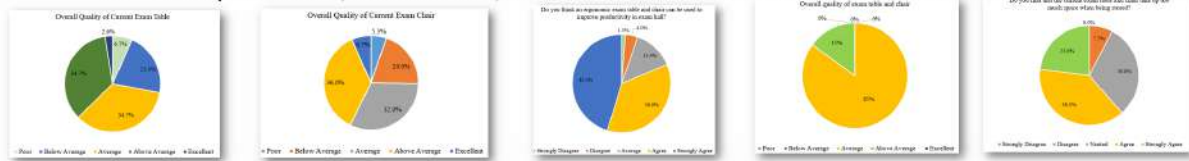
   b. Design
      - Benchmarking
      - Proposed Draft Designs
      - Design Selection Matrix

4. Results
   a. Anthropometric Measurements
   b. Pre-Final Design
   c. Computer Simulation
   d. Final Design

5. Discussion
   a. Survey – same focus groups
   b. Positive feedback on new design
6. Conclusions
   a. More ergonomic and space-saving
   b. Table RM97.28, Chair RM66.98 & Footrest RM52.27
7. Acknowledgement to FYP Co-Supervisors:
   - Dr. Em Poh Ping (FET)
   - Mr. Low Kean Ong (FET)
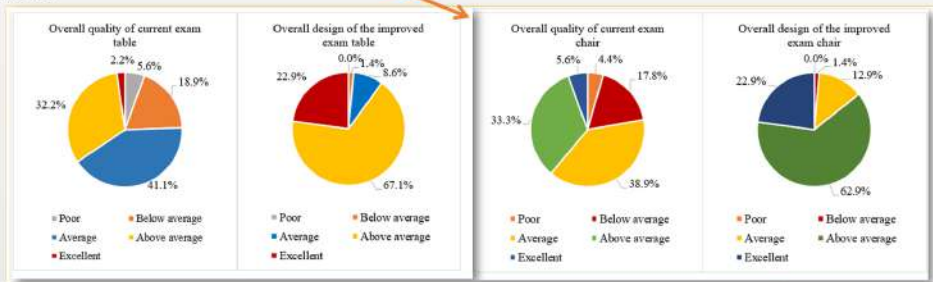
DESIGN OF IOT HEALTH AND SOCIAL DISTANCING MONITORING SYSTEM

Muhammad Akmal bin Nasir, Assoc. Prof. Ir. Dr. Pang Wai Leong, Ir. Dr. Wong Sew Kin,
Assoc. Prof. Ir. Dr. Chan Kah Yoong, Dr. Chung Gwo Chin, Dr. Lee It Ee
Faculty of Engineering, Multimedia University

Abstract

Since the outbreak of the COVID-19 pandemic, many companies have to deploy working from home. As the pandemic recovers, companies slowly start to adapt to the situation by making the workers work from the office. This is an effort to reduce the risks of spreading diseases in the workplace. This project aims to support that initiative and introduce a system that can control the risks of infection among workers. The proposed system monitors the health condition of the users and controls the social distancing at the workplace by using IoT technology and machine learning.

Problem Statements

- Expensive Covid-19 Test Kit. Can be a burden to the company's financial.
- Poor health monitoring system with only body temperature parameters.
- No control on social distancing in the workplace.

Proposed Solutions

- Design a low-cost health device that can monitor the daily health data of the users.
- Design an IoT system is used to monitor the health parameters, i.e. body temperature, SpO2, heartbeat rate, cough, etc.
- Design a social distancing monitoring system algorithm.

Literature Review

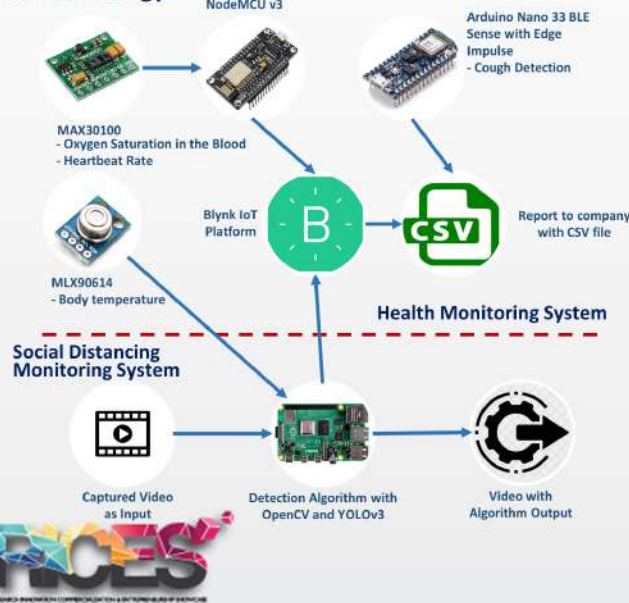| No.	Author	Title	Year	Contribution
1	Veena Tripathi, Faizan Shakeel	Monitoring Health Care System Using Internet of Things – An Immaculate Pairing	2018	Took advantage of the mobile application to create a health report
2	Rinto Priambodo, Trie Maya Kadarina	Monitoring Self-Isolation Patient of COVID-19 with Internet of Things	2020	Measuring oxygen saturation in the blood to prevent silent hypoxemia
3	Hasan K. Naji, Nicolae Goga, Ammar J. M. Karkar, Iuliana Marin, Haider A. Ali	Internet of Things and Health Care in Pandemic COVID-19: System Requirements Evaluation	2021	Determining the most used conventional health devices during pandemic at home
4	Mudit Sharma	OpenCV Social Distancing Intelligent System	2020	Create a social distancing detection algorithm with OpenCV
5	Abdalla Gad, Gasm ElBary, Mohammad Alkhedher, Mohammed Ghazal	Vision-based Approach for Automated Social Distance Violators Detection	2020	Using inverse perspective mapping for its social distance violators detection

Methodology

NodeMCU v3

Arduino Nano 33 BLE Sense with Edge Impulse
- Cough Detection

MAX30100
- Oxygen Saturation in the Blood
- Heartbeat Rate

MLX90614
- Body temperature

Blynk IoT Platform

B

CSV

Report to company with CSV file

Health Monitoring System

Social Distancing Monitoring System

Captured Video as Input

Detection Algorithm with OpenCV and YOLOv3

Video with Algorithm Output

Result and Discussion

Extensive experimental works were carried out to evaluate the performance of the following modules. 1) Body temperature, 2) Oxygen Saturation level, 3) Heartbeat rate, 4) Cough detection, 5) Social Distancing Monitoring System, 6) CSV report and 7) Mobile app for the system proposed.

IoT Health and Social Distancing Monitoring System

1 Body Temperature

High accuracy - 99.81%

The body temperature readings measured by MLX90614 are accurate with an accuracy of 99.81% compared to a medical thermometer.

2 Oxygen Saturation in the Blood

Calibration factor of 5 is added to the SpO2 values measured by MAX30100.

The calibrated SpO2 values are equal to the values measured by the medical SpO2 meter.

3 Heartbeat Rate

	MAX30100	Oxitech Pulse Oximeter	MAX30100	Oxitech Pulse Oximeter
	Before Breakfast		After Breakfast	
Average BPM in 30 seconds	73	73	88	83
	When Relaxing		Before a Test	
Average BPM in 30 seconds	82	80	83	86
	Before Working out		After Working out	
Average BPM in 30 seconds	74	75	78	76

High accuracy - 4.97% differences

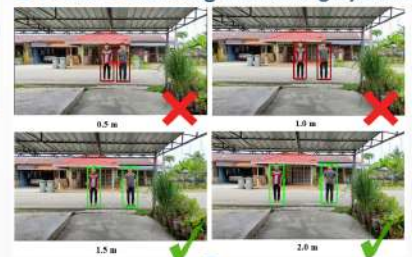Less than 5% heartbeat rate readings differences between the system proposed and the commercial product.

4 Cough Detection

(a)   (b)

High accuracy – 90%

90% accuracy in real-time cough detection

5 Social Distancing Monitoring System

0.5 m ✕   1.0 m ✕
1.5 m ✓   2.0 m ✓

6 Report in CSV
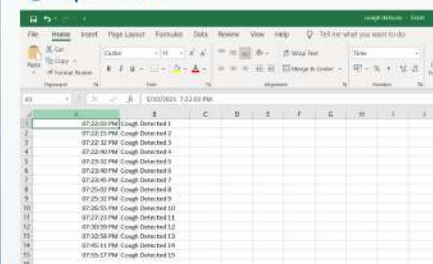
7 Mobile App

Conclusion

✓ Developed a low-cost health monitoring system to monitor the health condition and social distancing among the users.
✓ Implemented IoT on Health monitoring system.
✓ Implemented machine learning to monitor social distancing.

Special Highlights

✓ Machine learning and IoT are used in this project to perform the health and social distancing monitoring system.
✓ This project support the Sustainable Development Goal 3 (SDG3) – to Establish Good Health and Well-Being.
✓ This project also contributed to strengthen and provide better Medical and Healthcare especially during the pandemic through the Advanced Intelligent System that specified in the 10-10 MySTIE framework.

Acknowledgement

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TM Group

DESIGN OF MULTIBAND ENERGY HARVESTING SYSTEM FOR WIRELESS POWER COMMUNICATIONS

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INTRODUCTION

Radio frequency energy harvesting (RFEH) is a microwave technique that uses available electromagnetic (EM) energy in the surroundings to provide direct energy or to charge and recharge batteries. With Tesla's discoveries on electrical energy transformation from an EM wave in the 1990s, the idea of energy harvesting (EH) emerges. A rectifying antenna (rectenna), which consists of two main parts, an antenna and a rectification unit, is used to transmit the RF energy. This work's RF spectral study reveals potential RF power density for harvesting in the GSM-900-1800, UMTS-2.1 Wi-Fi/2450, and LTE-2.6 spectrums.
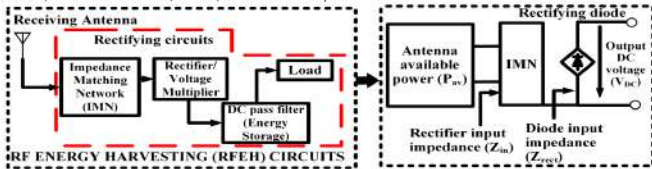

Figure. 1: The basic RFEH architecture block diagram.

SIGNIFICANCE

Wireless Power Transfer
Additional source of energy through (WPT) for low-power RF devices.

Economical value
Can be deployed in some areas to replace battery which in turn reduces maintenance cost.

Longer operational life of device
Increase the device life cycle through simple integrable RFEH module for Body Area Network (BAN) for implantable devices and security surveillance.
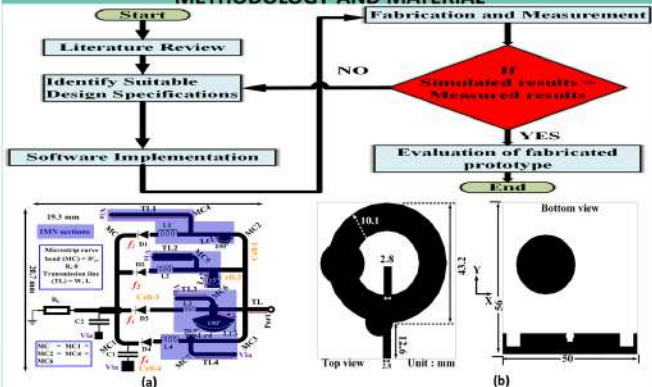
METHODOLOGY AND MATERIAL

Figure. 2: (a) RF-rectifier EM circuit configuration (b) Wideband Circular slot antenna Geometry.
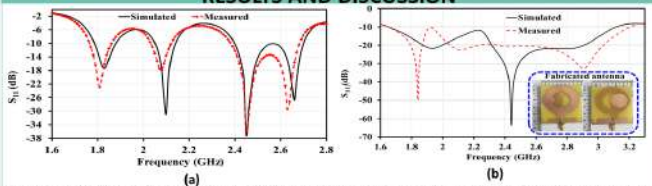
RESULTS AND DISCUSSION

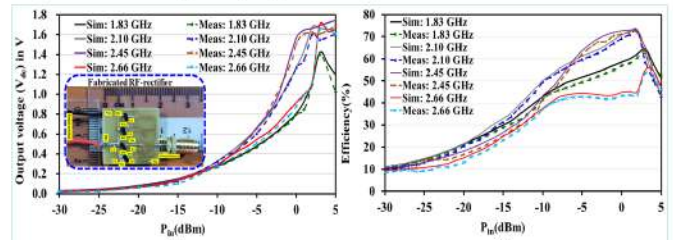Figure. 3: Simulated and measured reflection coefficient (S_{11}) of the proposed (a) RF-rectifier (b) Antenna.

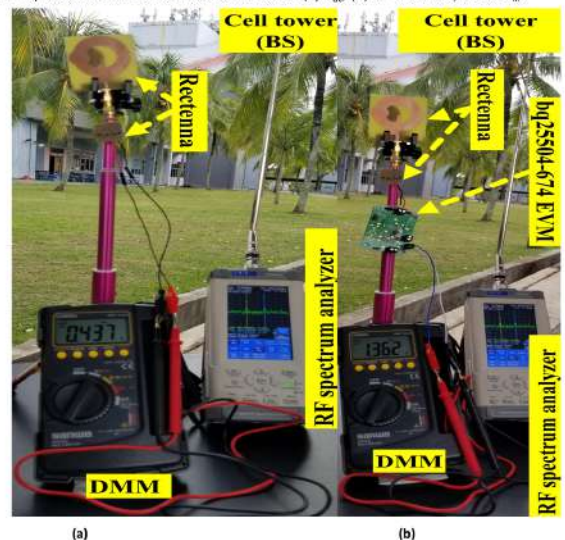Figure. 4: Proposed rectenna simulated and measured: (a) V_{dc} (b) RF-to-dc PCE, versus P_{in}.

Figure. 5: Rectenna ambiance measurement setups (a) Rectenna only (V_{dc} = **0.437** V) (b) Rectenna with the bq25504-674 EVM (V_{dc} = **1.362** V).

CONCLUSION

A four-band compact rectenna based on λ/8 L-shunt ITx MN is proposed for harvesting RF energy from GSM-1800, UMTS-2100, ISM2.4&Wi-Fi-2.45, and LTE-2600 spectrums. The rectenna system is achieved by introducing a broadband circular slot source antenna to the RF-rectifier. The proposed harvester realized a high measured RF-to-dc PCE and V_{dc} of 73% and 1.61 V for an RF power of 2 dBm at 2.10GHz, respectively. The rectenna's outdoor performance delivers a V_{dc} of 0.440 V and activates a low-power bq25504-674 evaluation module (EVM) at 1.362 V. The dimensions of the RF-rectifier and source antenna on the FR-4 PCB board are 0.27λg × 0.29λg and 0.60λg × 0.65λg, respectively. With the capability to harvest RF signals across four operating bands, the design shows portability with enhanced PCE

PUBLICATIONS

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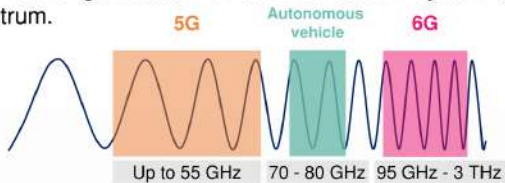
DESIGN OF TRANSFERRED ELECTRON DEVICES (TED) FOR THz APPLICATIONS

Project Leader: Prof. Dr. Ong Duu Sheng

Project Member: Siti Amiera binti Mohd Akhbar

Faculty of Engineering, Multimedia University

Motivations

- High demand for THz wave sources as IoT technology continues to progress rapidly.
- The rapid expansion of data-centric applications that require THz frequency might surpass the capabilities of 5G networks.
- Autonomous vehicle generates up to 300 TB [1]; high data rates need operating frequencies up to 300 GHz [2].
- The future generation of communication system [3] 6G spectrum.

5G — Up to 55 GHz
Autonomous vehicle — 70 - 80 GHz
6G — 95 GHz - 3 THz

Aims

- To design GaAs-based transferred electron devices (TED), also known as Gunn diode capable of operating at frequencies in the THz range (300GHz - 3THz).
- To optimize the TED with delta-doped structures for the enhancement of RF output power and operating frequency in THz spectrum.

Transferred Electron Effect in Gunn Diodes
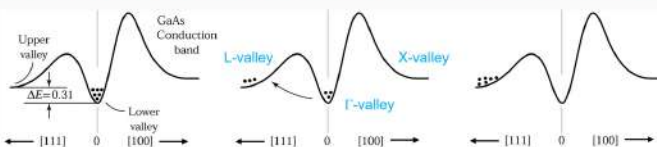
- Under a DC bias, electrons in GaAs n-type semiconductor will transfer from Γ-valley with a small effective mass to the higher valleys, where the electrons' effective mass are much larger.
- This will reduce the electron mobility leading to a negative differential resistance for generating current oscillations through the Gunn effect.

TED Delta-doped Structure

contact | notch | δ | active region | contact

2×10^{18} cm^{-3} | undoped notch | Delta-doped : 1×10^{18} cm^{-3} | Transit region : 8×10^{16} cm^{-3} | 2×10^{18} cm^{-3}

Monte Carlo Simulation of Gunn Effect

- An in-house developed self-consistent analytical-band Monte Carlo model [4] is used to simulate the electron dynamics in the delta-doped TED.
- The delta-doped layer increase the electric field in the notch region effectively, resulting in a faster transfer of electrons from Γ to L- & X-valleys as compared to conventional structure.
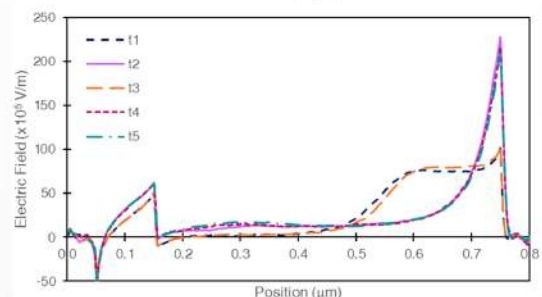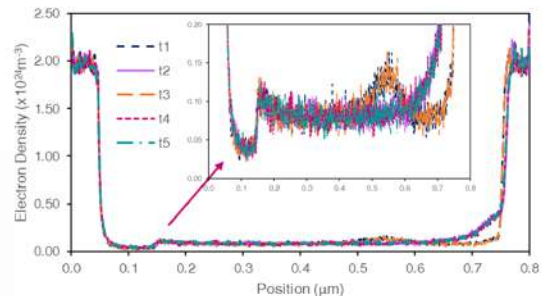
Optimized TED Performance

- The GaAs delta-doped TED with a 100 nm notch is capable of generating current signals with a fundamental frequency of **262 GHz** and a current amplitude of **30×10^7 A/m^2**.
- The significant second and third harmonic signals are found in the THz range at 512 GHz and 769 GHz.

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Developing A Fun and Engaging Virtual Class by Implementing the "Sandbox" Method

Mr. Vincent Chan & Ms Cheryl Chan

Problem: Student lost their interest, easily lost focus and were demotivated due to virtual learning. This is based on the survey we did, which shows **more than 70%** of students stated their sadness and demotivation

Impact:
1. No engagement in class.
2. Students & lecturers demotivated.
3. Students are unable to learn effectively.

Sandbox Method

Building a sandbox is the first essential step that individuals must take in order to implement it in their learning environment. Sandbox can be identified as the place to gain information and the meaning of the information (Ho, 2021). Eliason (2017) stated that by building a sandbox students will be able to try out new skills. Students will feel **empowered** as they realise that they 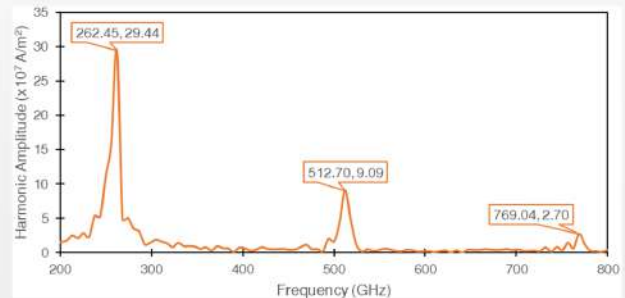are in control of their own learning. When they are put in "sandbox" they will be able to "play" with each other, and this when the engagement starts.

Sandbox border: This will be referring to the support system of the class. We will be using team-based learning as the fundamental support of the sandbox method:

Tools in sandbox:
1. Collaborative tools (eg: Jamboard)
2. Real scenarios cases
3. External collaboration projects.
4. Hit the mole, gartic phone, kumospace

The Sand: Metaphorically it represents the educator. They play an important role in preparing a conducive platform for the students to bring the best in themself. Besides that, they need to understand the importance of building a relationship with the students.

After the Sandbox method is implemented **4 out 5** students:
1. enjoy, felt happy & engaged in the virtual class.
2. feel appreciated and acknowledge
3. students feel empowered and show self initiatives
4. Students show creativity & dare to voice out their ideas

Indrianti (p.850, 2017) says that 'student empowerment significantly influences well-being'. It will create an interactive online learning environment that motivates students to have the courage to move forward in their academic journey

DEVELOPMENT AND INVESTIGATION OF SMART PARKING SYSTEM BASED INTERNET OF THINGS TECHNOLOGY

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Abstract

Recently, the rate of vehicles used in cities grows up and the need for space and modern parking systems increases as well, so car parking is a major problem in urban areas. Thus, to overcome this problem, several technologies have been created. This project aims to develop a mobile application for smart car parking system and decrease the security issues by monitoring and controlling the access of vehicles in the parking area. The users of this application can locate their cars and check the parking fees.
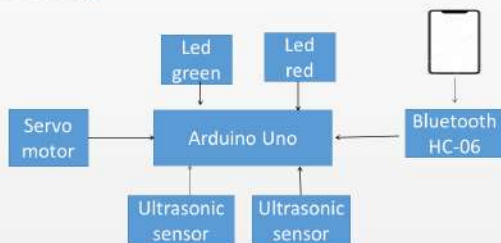
Problem statement

The urban and big cities surround the world will mostly suffer from traffic jam congestion which causes air pollution, accident, and waste of time and fuel to find parking. This project will focus on the solution to this issue by utilizing ultrasonic signals integrated with Bluetooth.

Flow chart
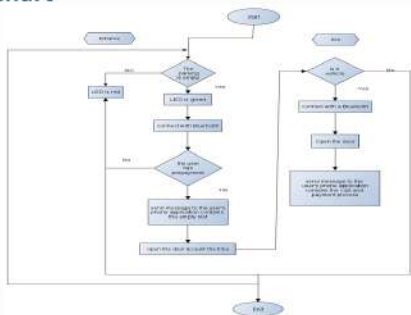
Methodology

First of all, when the driver is coming to the entrance of parking, he must check if the light at the entrancing green which means the parking is empty or red which means there is no parking. If it is green, the driver must turn on his phone Bluetooth and open the application that he had an account in it previously.

The developed application will send a message about an empty space (slot number). After that, the door of parking will open. However, at the exit, the driver must connect with Bluetooth to sign out and the door will open thus the user will receive information message of cost and payment.

Implementation

By this project, we implemented the main idea, so when the vehicle is so close to the ultrasonic sensor which is placed at the slots of parking, the sensor will send a signal to Arduino Uno about the full slot, the Arduino Uno will process this signal and display a red led. Otherwise, the process, if there is no vehicle at the slot sign will be green.

Results

1. In the case the user starts running the application, the smart parking system process is configured. Users are required to turn on their phone Bluetooth and enter their password as a Fig (3).
2. Once the user registered, he will take to the next window where the location of the empty slot is shown in Fig (4).
3. From the moment that the user presses the enter bottom the counting process will begin so when he left the parking he will receive a message about the cost and time that he spent at parking as demonstrated in Fig (5).

Fig(1) prototype of system   Fig(2) at entrance the led is green   Fig(3): Message of password of user   Fig(4): massage about location slot   Fig(5): massage about time and cost

Advantage

1. No need to get a ticket so this project provide more flexibility and saving the time with phone application access .
2. Easy payment process.

Novelty

1. QR code support for more security.
2. Provide Face detection technique for automated identification.

Conclusion

This project make the process of parking very simple just one press on your smart phone that will help to save the time and provide more security.

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10

DEVELOPMENT OF IOT BASED SMART INDOOR HOME GARDENING SYSTEM

Hammad, Anas Edris Moh, Dr. Azwan Mahmud, Dr Azlan Abd. Aziz

Multimedia University, Malaysia

INTRODUCTION

- The growth of the IoT technologies allowed devices all around the world to be connected, monitored, and controlled in real-time via application program interfaces (APIs).
- The system proposed here utilizes the advancement of the IoT technologies to automate the task of caring after houseplants.
- The system is able to monitor different parameters that could be useful for the growth of the plant such as soil moisture and light intensity, has its own customized cloud platform to process data and take actions based on the readings of the parameters, and has its own cross-platform smartphone application to allow the user view real-time and historical data, and control the actuators from anywhere in the world.

Methodology

The system consists of three main parts hardware part(the circuit), the customized cloud platform, and the cross-platform smartphone application. Those parts can be described as following:

1. The circuit consists of two ESP-32 microcontrollers, one microcontroller to connect the sensors and another one for the actuators. Sensors' ESP-32 will measure the parameters and send them to the cloud using HTTP POST request, while actuators' ESP-32 sends HTTP GET request to the cloud to get the states of the actuators.
2. The cloud platform which handles the data received from the sensors' ESP-32. the cloud is responsible on making decisions on either to turn on/off any of the actuators, send data to be displayed on the smartphone application, send notifications to the user when certain events occur, as well as handling override requests from the user.
3. Smartphone application that has three main pages; The first page to display the readings of the sensors and the states of the actuators, second page is to allow the user to override the server's decisions on turning on/off the actuators (meaning the process is no longer automated), and third page to display historical data of the plant.
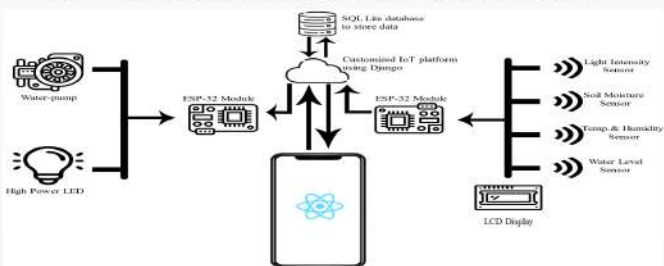
Making all decisions based on the server allows the system to be more reliable and flexible for any future upgrades. The application keeps the user updated about the plants parameters no matter where they are, all they need is Internet connection. Also, the all sensors and actuators are connected to the PCB using grove connectors, so that the user can replace any sensor/ actuator, if after a long time it stops working, instead of throwing the whole thing and buying a new system. Same goes for the ESP-32, as they are not soldered onto the PCB, both ESP-32 are connected to the it via headers, so that they can be replaced easily.

Flowcharts below describe the working principle of the server's endpoints, process of sending notifications, and calculating the actuators' values
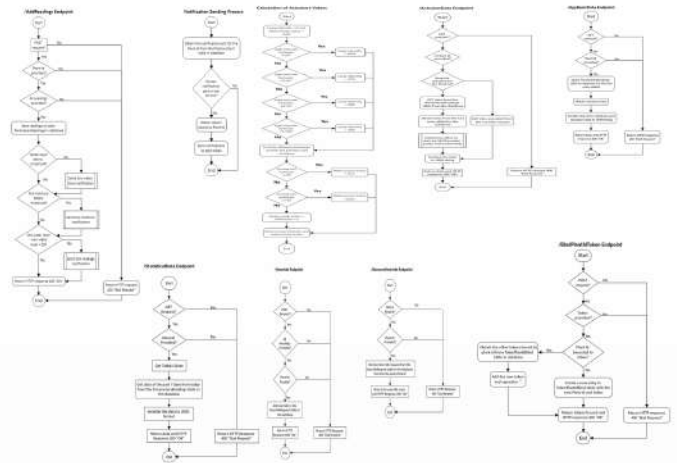
RESULTS & DISCUSSION

Figures of the prototype, and smartphone application working on both IOS and Android are shown below

As can be seen in the figures above, the application works perfectly on both IOS, and Android

The UI is almost identical between the two platforms which is the main feature of using single code-base granted by React Native. The last figure shows the prototype with one pot for the plant, an integrated water-tank, light-bulb, and the PCB.

CONCLUSION

The system proposed here eases the task of caring after houseplants. As the procedure may be difficult for some people, this system takes an advantage of the IoT technology not to only automate the process, but also to keep the user updated via the smartphone application. The system also allows the user to stop automating the process and override the server decisions if the user felt that the plant requires his attention. Thus, the system eases the task of caring after houseplants on the users, helps saving electricity and water bills, as the actuators will only be on when they are needed

TM Group

DEVELOPMENT OF MULTI-TASK STREET FEATURES BASED AN INTELLIGENT WIRELESS CONTROLLING SYSTEM

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Abstract

Most people undergo many problems in the streets on a daily basis, such as traffic signals and street congestion in cars, and energy consumption. Therefore, the use of new technologies is highly demanded to control the street with fast, auto controlling, and auto-notifications of the overall results to the controlling unit. In this project, we developed a system to control the street automatically by controlling the traffic lights and lights of the street. In addition, to detect suspects and suspicious cars which can pass the street and send a message using GSM to the control unit to specify the location by GPS and to take as appropriate safety action. This project suggests a developed system that can control the street performance automatically in several tasks as following: First of all, it uses automatic traffic light controlling system when there is a car across the road. Secondly, streetlights control which can be extinguished day, and running at night when there is a car in the street and when there is no car turn off the lights. Thirdly, water level control in case of heavy rain. Fourthly, to detect if there is a fire in this street using flame sensors. Moreover, to send urgent notification about the street status when it is closed, open, crowded, empty, or polluted by gases by showing all the details in the liquid crystal display which is placed at the beginning of the street. In addition, to measure and detect the current temperature and humidity in the street prior to being displayed using a certain monitor. Furthermore, this system will be used to control the traffic light signal in the case of kids are crossing the street and automatic registration of infringers. Finally, the street is totally controlled when an emergency or security cars use it by enforcing stop movement of all vehicles in the desired direction.

PROJECT SCOPE

Drivers generally — Children — The people in general — blind man — First aid Cars — Security Cars

Problem Statement

The most people in life is undergo from many problems in the street, such as: A traffic signal and street congestion in cars and energy consumption. Therefore, using the available technologies is needed in control by the street by fast and auto controlling, and auto notify the results to control unit.

In our lives today, there are many problems that faced in the streets led to the selection of this research, such as:
1) Consumption large of electrical resources.
2) Frequent accidents, especially at intersections, and knowledge of accidents in the late.
3) Overcrowding in cars, which hampers the traffic movement of ambulances and emergency then patient delivery in the late.
4) Disease outbreaks and air pollution because of (due to) vehicle exhausts.
5) Accidents more, and the inability of police sometimes to arrest suspects.

OBJECTIVES

In this project, we have developed a unique mechanism of the traffic signals, which facilitates the movement of vehicles with much ease ways and provides an appropriate approach to control the streetlights with the aim to reduce power consumption, save time, effort, and money. The objectives can be summarized as follows:
1- To optimize traffic regulation by controlling the traffic signals based on several purposes and targets.
2- To enhance the use of traffic signals and street lighting.
3- To save human life during accidents by controlling the street traffics without causing any harm.
4- To enable police vehicles and ambulances and facilitate their tasks.
5- To fulfill the safety of individuals from accidents or sudden pollution by showing all details in LCD with certain alerts.

MOTIVATION

Here, we developed a system to control the overall street performance automatically by controlling the traffic lights and streetlights. In addition, to detecting suspects and suspicious cars which are passing the street and send a message to identify their location.

Novelty

By this research project, a comprehensive smart system is developed for the safety purposes of people during the use of streets, highways, ..etc.
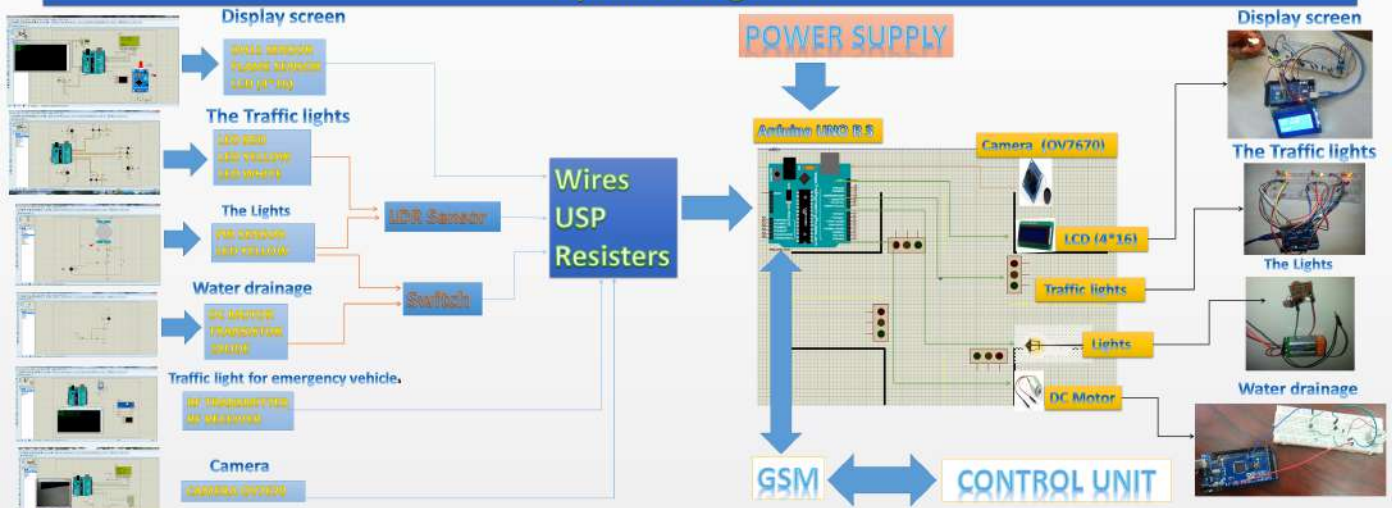
Conclusion

The main purpose of this project is to have a sufficient and comprehensive system to control the street in a more efficient approach. The proposed system has been compared with other existing systems in the reported literature and it can be concluded that: the proposed system can provide more important information on the state of the selected street especially for emergency situations. It can give positive feedback to the effect of the surrounded environment. Many sensors have been used to overcome the faced difficulties such as congestion, power reduction, helping the kids and blind people, and for more saving life.
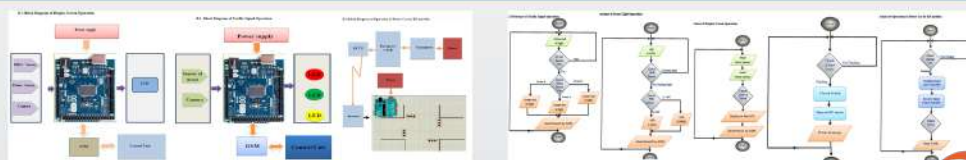
Reference

❖ Abdullah Ali Abdullah, (2013), " All about Arduino Simulation", 1edition
❖ Traffic Light Control System for Emergency Vehicles Using Radio Frequency, N. M. Z. Hashim.
❖ What is RF Module?], [online], [Accessed March 2018], Available on world wide web [https://www.elprocus.com/rf-module-transmitter-receiver/]
❖ [Light Emitting Diode (LED) What is light?], [online], [accessed July 2018], Available on world wide web : [http://www.physics-and-radio-electronics.com/electronic-devices-and circuits/semiconductordiodes/lightemittingdiodeledconstructionworking.html]

System Configuration

Display screen — The Traffic lights — The Lights — Water drainage — Traffic light for emergency vehicle — Camera — LDR Sensors — Switch — Wires USP Resisters — POWER SUPPLY — Arduino UNO R3 — Camera (OV7670) — LCD (4*16) — Traffic lights — Lights — DC Motor — GSM — CONTROL UNIT — Display screen — The Traffic lights — The Lights — Water drainage

Block diagram and flowchart

DRONE BASED HYPERSPECTRAL IMAGING SYSTEM FOR PRECISION AGRICULTURE

Assoc. Prof. Ir. Dr. Chan Yee Kit, Prof. Ir. Dr. Koo Voon Chet, Assoc. Prof. Dr. Lim Tien Sze, Ir. Dr. Wong Wai Kit, Dr. Lim Kian Ming, Dr. Tee Connie, Dr. Lim Chee Siong

Purpose – To design and develop a drone based hyperspectral imaging system for disease detection and nutrient extraction of plantation

Methodology – A customised multirotor drone has been designed and developed for longer endurance (30-40 minute per flight mission) as well as to carry the non-standard payload i.e. hyperspectral imaging system. Preliminary testing has been performed in laboratory and oil palm plantation to verify both multirotor drone and hyperspectral imaging system. AI based algorithm has been developed for classification of hyperspectral images.

Findings – Initial results show that the hyperspectral data are suitable to be used for differentiation of the healthiness level of the oil palm plantation. In order to achieve the target of disease detection and nutrient extraction, timely ground truth data will be collected together with the field experiment using the developed drone based hyperspectral camera.

Value – A drone based hyperspectral imaging system has been designed and developed in Malaysia for precision agriculture. This research work will greatly enhance the current precision farming practice in Malaysia as well as benefit the agriculture community.

IP – 2 Conference papers (presented), 2 journal papers (submitted), 1 workshop paper (presented), 1 Industry Design (submitted)

Mechanical Drawing of Drone Based Hyperspectral Imaging System

Actual Developed System

Field Measurement at Oil Palm Plantation

Sample of RGB raw image

Sample of Hyperspectral Raw Image (at 730 nm) captured

| Specifications	Actual
Total weight w/o payload	18kg
Max payload	Up to 19.2kg (Total weight of 80% max thrust)
Total weight with current payload (HSC camera & gimbal)	21.42kg
Max flight time with current payload	42.29 minutes @ 80% = 33.83 minutes (battery tapped to HSC camera)
Flying height	Max 500m (DJI flight controller)

Hyperspectral Raw Image
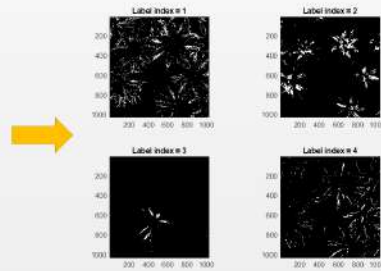
Different Cluster of Hyperspectral Images

Unique Signature of Hyperspectral Image of Different Cluster
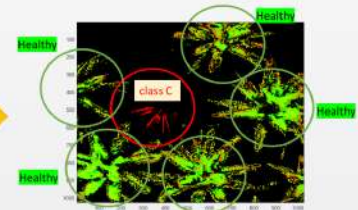
Classification of oil palm plant

TM Group

13

Dynamic Indoor Positioning Using Deep Belief Network and Wi-Fi Fingerprinting

Project Leader: Ts. Dr. Ng Yin Hoe
Member: Assoc. Prof. Dr. Tan Ai Hui, Dr. Tan Chee Keong
Graduate Research Assistant: Aina Nadhirah binti Nor Hisham
Funding: Fundamental Research Grant Scheme
Duration: 1 September 2019 – 31 May 2022

Problem Statement

In recent years, indoor positioning systems have gained significant attention due to the surge of needs on location based services. However, the performance of the conventional geometric positioning schemes is poor because of the effects of non-line-of-sight (NLoS) in indoor environments. Fingerprinting based positioning emerges as an attractive solution due to its applicability in NLoS environments and minimal environment information requirement. Despite these advantages, the received signal strength variation caused by environmental changes, device heterogeneity, and people presence effect can negatively affect positioning accuracy of the fingerprinting techniques. In the literature, miscellaneous machine learning techniques have been investigated for fingerprinting based positioning. Inspired by the superior modeling power of the deep learning architecture, a few works have begun to consider deep learning for indoor positioning recently. However, the deep learning based indoor positioning schemes incur a very high computational cost. Thus, these approaches are impractical to be implemented on mobile devices.

Objectives

1. To design a low-complexity fingerprinting based positioning scheme that attains high positioning accuracy in hostile indoor environments.
2. To proposed an improved dimensionality reduction method for positioning in dynamic indoor environments.
3. To investigate the effects of obstructions on the accuracy of positioning accuracy.
4. To compare and analyze the performance of the proposed technique with existing ones by carrying out extensive real-world experiments in multi-floor buildings.

Expected Outcomes

Real-world fingerprint datasets and a novel low-complexity indoor positioning technique that is suitable to be implemented on mobile platforms.
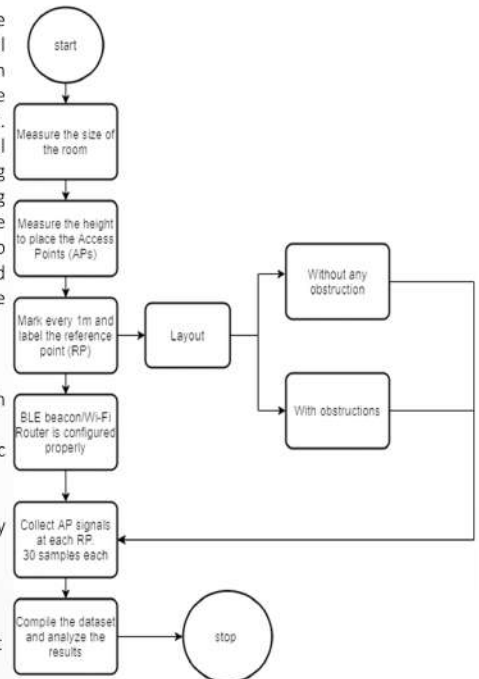
Bluetooth low energy transmitter

Application used to measure the strength of the received signal

Effect of Lithium Transference Number in Solid Polymer Electrolyte for Polymer Battery

C. C. Sun, K. W. Eric, Y. L. Yap, P. L. Cheang and A. H. You

Objective

To study the effect of inorganic fillers, Al_2O_3 and SiO_2 in PMMA polymer electrolytes by determining the lithium transference number.

Research Methodology:

Poly(methyl-methacrylate) (PMMA) samples were prepared using solution cast method with Ethylene Carbonate (EC), Lithium Triflate ($LiCF_3SO_3$), Silicon Dioxide (SiO_2) and Alumina Oxide (Al_2O_3).

The PMMA samples were characterized using Electrochemical Impedance Spectroscopy (EIS), Chronoamperometry, Linear Sweep Voltammetry (LSV) and Cyclic Voltammetry (CV).

The lithium transference number of PMMA solid polymer electrolytes (SPEs) were calculated using the Bruce-Vincent equation.

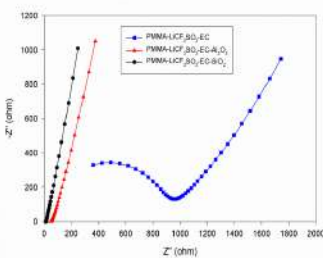Fig. 1. Samples of PMMA SPE film trimmed out from the dried electrolytes film.

Fig. 2. Nyquist plot of PMMA-$LiCF_3SO_3$-EC (Blue), PMMA-$LiCF_3SO_3$-EC-Al_2O_3 (Black) and PMMA-$LiCF_3SO_3$-EC-SiO_2 (Red).
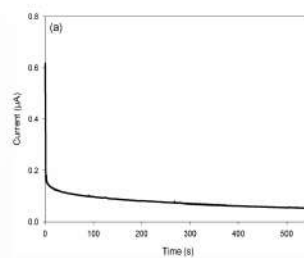

Fig. 3. Initial current and steady-state current is obtained from chronoamperometry curve for the calculation of lithium transference number employing Bruce-Vincent equation.

Table 1: Ionic conductivity of PMMA-based solid polymer electrolytes.

Sample ID	Sample Composition	Filler	Filler Size	Ionic conductivity (S/cm)
SPE1	PMMA-$LiCF_3SO_3$-EC	-	-	1.22×10^{-5}
SPE2	PMMA-$LiCF_3SO_3$-EC-Al_2O_3	Al_2O_3	10 µm	1.83×10^{-4}
SPE3	PMMA-$LiCF_3SO_3$-EC-SiO_2	SiO_2	10 µm	2.30×10^{-4}

Table 2: Transference number of PMMA-based polymer electrolytes.

Sample ID	Io (µA)	Is (µA)	Transference number (t⁺)
SPE1	0.617	0.055	0.088
SPE2	0.834	0.180	0.215
SPE3	1.010	0.266	0.263

✓ Addition of inorganic fillers enhances ionic conductivity and Lithium transference number at room temperature, from 1.22×10^{-5} S/cm and 0.088 up to 2.30×10^{-4} S/cm and 0.263.

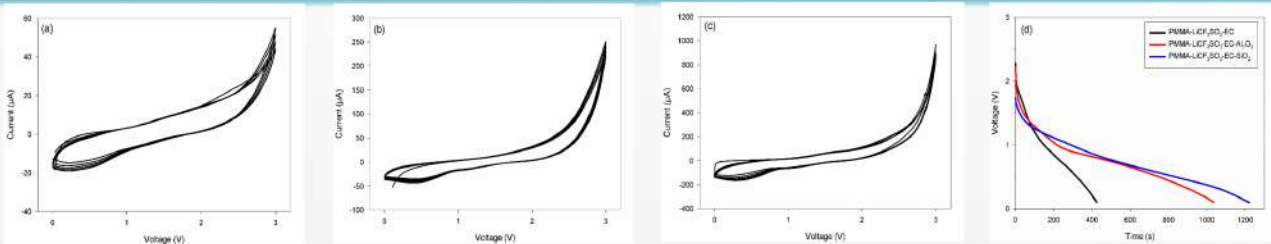✓ The electrochemical stability is > 3.0 V for all samples, with the highest at 3.2 V for SiO_2 samples

Fig. 4. Five cycles of cyclic voltammetry curve versus stainless steel electrodes with a scan rate of 20 mVs⁻¹ for (a) PMMA-$LiCF_3SO_3$-EC, (b) PMMA-$LiCF_3SO_3$-EC-Al_2O_3 and (c) PMMA-$LiCF_3SO_3$-EC-SiO_2 (d) Discharge curve of samples.

Conclusion

➢ Incorporation of inorganic fillers into PMMA SPEs can improve the ionic conductivity and lithium transference number at room temperature.

➢ The highest ionic conductivity and lithium transference number achieved at room temperature at this work are 2.30×10^{-4} and 0.263 for PMMA-EC-$LiCF_3SO_3$-SiO_2 samples.
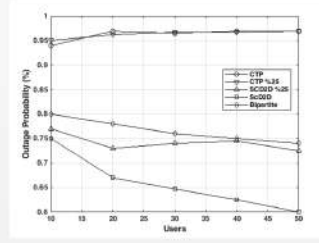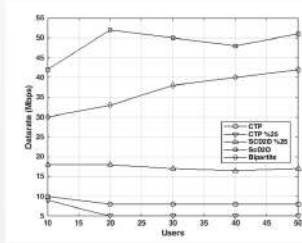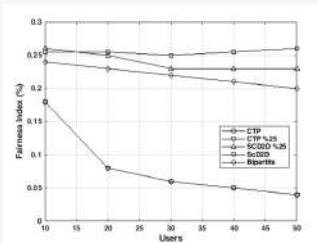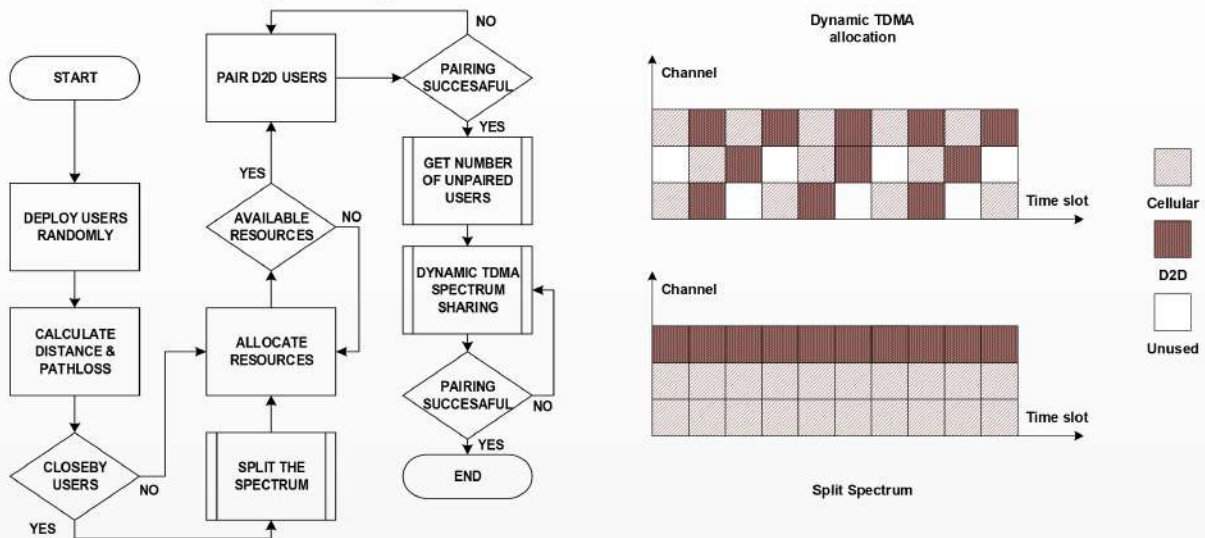
Applications

15

EFFICIENT SPECTRUM UTILIZATION ALGORITHM BASED DISTANCE OF 4G/5G D2D WIRELESS NETWORKS

ABDULLAH H. AL-QUHALI, MARDENI ROSLEE, MOHAMAD Y. ALIAS
Centre for Wireless Technology (CWT), Faculty of Engineering, Multimedia University

Fifth-generation (5G) technology plays a vital role in enhancing proximity communication such as device-to-device (D2D) and vehicle-to-vehicle (V2V) whereby the closely distant nodes communicate with each other without a need for base station. It helps in increasing the data rate, reducing latency, and increasing bandwidth far more than the expected rates. D2D communication plays a key role in next-generation wireless technology due to the features of reliability, low-latency, and the ultra-wide capacity in comparison to the existing networks. This project studies the spectrum allocation and sharing / accessing methods that enables the perfect resource utilization that can bring performance enhancements. Up to this level, the spectrum sharing methods have been examined and analyzed considering a single-cell scenario. This sheds the light on how D2D increases spectral efficiency by utilizing the Macro-cell frequency i.e. the existing resources. The current findings demonstrate that the project has a valuable and realistic commercialization potentiality.

ACKNOWLEDGEMENTS

PUBLICATIONS:

1. Abdullah H. Alquhali, Mardeni Roslee, Mohamed B. Abdelgadir, Khaldon Kordi, Khalid S. Mohamed, Enhanced Fractional Frequency Reuse Approach for Interference Mitigation in Femtocell Networks, Buletin of Electrical Engineering and Informatics, pp1638-1645, Vol 9, No.4, 2020. (IF:1.90) (Scopus Q2, WoS)
2. Abdullah Hadi Alquhali, Mardeni Roslee, Mohamad Yusoff Alias and Khalid Sheikhidris Mohamed, D2D Communication for Spectral Efficiency Improvement and Interference Reduction: A Survey, Buletin of Electrical Engineering and Informatics, pp. 1085-1094, Vol 9, No3, 2020. (IF:1.90) (Scopus Q2, WoS)
3. Abdulraqeb Alhammadi, Mardeni Roslee, Z. Yusoff, Mohamad Yusoff Alias, Ibraheem Shayea and Abdullah Al, Velocity-Aware Handover Self-Optimization Management for Next Generation Networks, Applied Sciences (Switzerland), vol10, issue1354, pp.1-14, 2020. (WoS Q2, Scopus Q1, IF: 2.2217)

INTELLECTUAL PROPERTY

Energy-Efficient Interference Management Techniques For Multi-cell Multi-tier HetNets

Project Leader: Ts. Dr. Ng Yin Hoe
Member: Dr. Tan Chee Keong
Graduate Research Assistant: Shornalatha Euttamarajah
Funding: Multimedia University Graduate Research Assistant Scheme

Problem Statement

The growth in mobile users generates high traffic congestion, consequently the need for base stations (BSs) increases tremendously. Dense BSs installations causes signal interference among the BSs hence degrading service quality. At the same time, during non-peak hours the excess BSs lead to inefficient energy and bandwidth utilisation. In this project, the access points are considered to be powered by hybrid source, i.e. grid power and renewable energy. Additionally, the access points are able to jointly process the transmitted/received signal, i.e. coordinated multi-point (CoMP) joint processing. The network structure considered in this work is a heterogeneous based network (HetNets). Further, with the help of smart grid, the excess harvested energy can be shared among the BSs which ensures efficient harvested energy utilisation. To the best of project members knowledge, existing works on HetNets have not jointly solved the interference, energy efficiency (EE), base station switching (BSS) and power allocation (PA) problem.

Objectives

1. To design an energy-efficient joint BSS and transmit PA technique for the downlink of CoMP-enabled hybrid-powered BSs under HetNets structure.
2. To evaluate different type of BSS techniques to compare the efficiency and complexity of the techniques.
3. To efficiently utilise the harvested energy using a smart grid.

Contributions

A new joint BSS and transmit PA technique is developed by utilizing a combinatorial optimization algorithm. Advantages of the proposed scheme are:
1. Improved energy efficiency.
2. Lower grid power consumption.
3. Less complex technique without compensating efficiency of the system.

System Model

Methodology
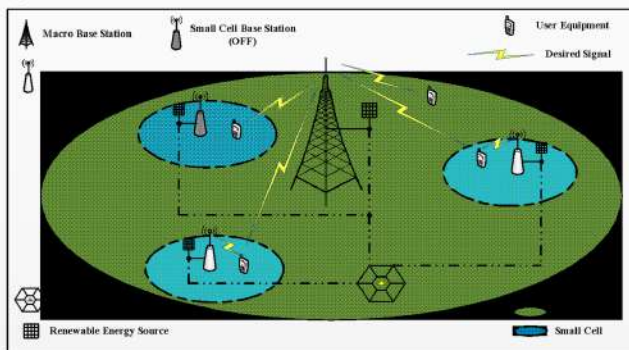
Conclusion

While more BSs installation is crucial to cater the increasing user demands, proposed joint BSS and transmit power allocation is proven to play an essential role in enhancing the EE of the communication system. Further, the distance based BSS which is proposed to reduce the complexity of the binomial BSS, achieves around 95% EE of the former with much less computational complexity. The system with data cooperation (CoMP) performs around 20% better than the system without data cooperation (Non-CoMP). Besides, the system with energy harvesting also achieves 20% better EE compared to the non-harvesting system. Therefore, it can be concluded that joint BSS and power allocation along with energy harvesting and data cooperation greatly improves the EE of the communication system.

Output

The technique proposed has been published in the following journal:

Euttamarajah, S., Ng, Y. H., & Tan, C. K. (2021). Energy-Efficient Joint Base Station Switching and Power Allocation for Smart Grid Based Hybrid-Powered CoMP-Enabled HetNet. *Future Internet, 13*(8), 213.
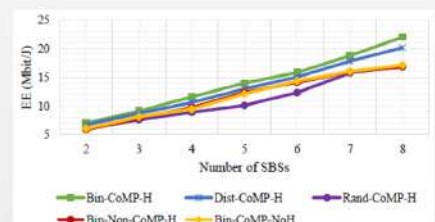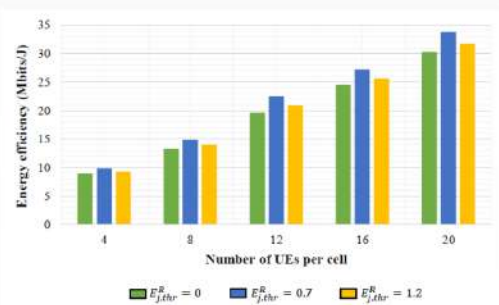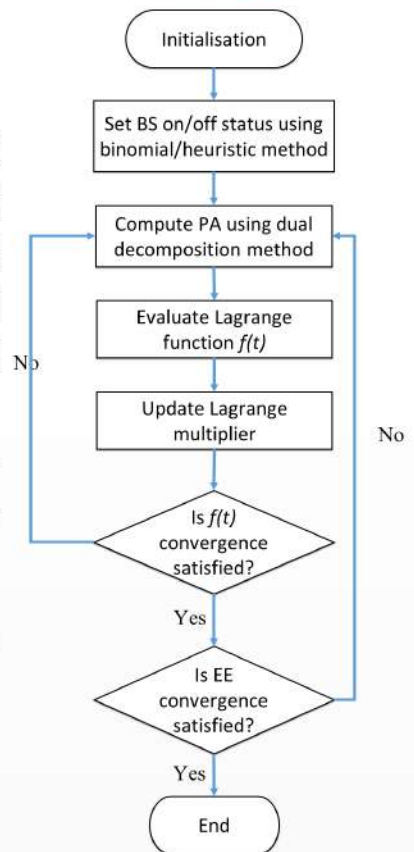
ENERGY-EFFICIENT MANUFACTURING PRODUCTION SCHEDULING FOR COST AND PEAK LOAD MINIMIZATION

Mr Lok Jia Jun, Dr Tan Wooi Nee, Dr Yip Sook Chin, Mr Gan Ming Tao[a], Dr Tan Chia Kwang, Prof Dr NA Rahim[b]

[a]Faculty of Engineering, Multimedia University; [b]UM Power Energy Dedicated Advanced Center (UMPEDAC), University of Malaya

Abstract

Energy-efficient manufacturing production scheduling is a form of demand response (DR) program for industrial users that aims to minimize both the energy costs and maximum demand (MD) penalty. The proposed day-ahead optimization model is run iteratively throughout the billing cycle to reschedule and shift the energy usage in the manufacturing production lines from peak periods to non-peak periods with lower tariffs, resulting in lower energy bills. The model is capable of stabilizing daily peak demand, which ultimately benefits utility providers by ensuring a more reliable grid.

Problem Statement

Electricity demand is increasingly rapidly as IR4.0 technology advances, and the industrial sector accounted for the largest portion of the total final energy consumptions. To ensure the stability of the electricity grid, Tenaga Nasional Berhad (TNB) of Malaysia, the largest utility provider in Malaysia have implemented the Time-Of-Use (TOU) Tariff and the MD penalty. Thus, the industrial users are eager to reduce peak demand while lowering the MD penalty in order to avoid high electricity bills. The proposed work here incorporates renewable energy into the DR program to help the industrial users to meet these targets.

Literatures Review

The challenges of industrial based demand response program:

Existing models
1. Generally developed specifically for some industriesor the parameters are subjected to the settings which are too complicated to be applied by the other users.

2. Focus on minimising the daily peak based on the single-day optimization model. Minimizing the daily peak load may not guarantee the lowest monthly electricity bill + fluctuation in daily peak demand.
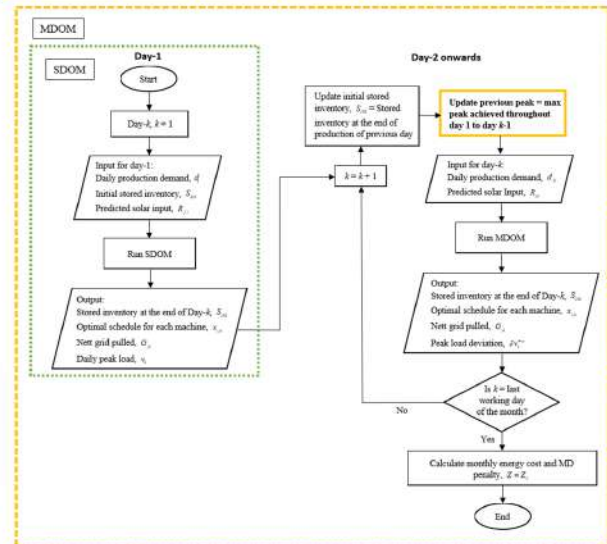MD penalty is a one-time charge based on the peak demand recorded during a billing cycle

Our proposed work:
Energy-Efficient Manufacturing Production Scheduling
1. generic optimization model to be applied to most industries with more realistic constraints (manpower constraints + storage inventories)

2. Multi-day optimization model to produce lowest monthly bill + stable daily peak demand

Methodology

INPUTS: Predicted solar energy; Production target, Manpower arrangement, Storage inventories

Energy-Efficient Manufacturing Production Scheduling

OUTPUTS: Day-ahead optimal schedule to operate the machines in production line; Implement the optimal schedule on the production line

Flowchart

Results and Discussion

The performance of the model is tested for a sequential process flow consists of 4 machines.

Example output of optimized load schedule for one day



with solar input — without solar input

- Shaded cell indicates the optimal time slot to operate the machine, numbers indicate the storage inventories .
- The model works well with/without the solar input

Comparison of our work with single-day optimization (one month simulation)

Daily energy cost — Daily peak demand
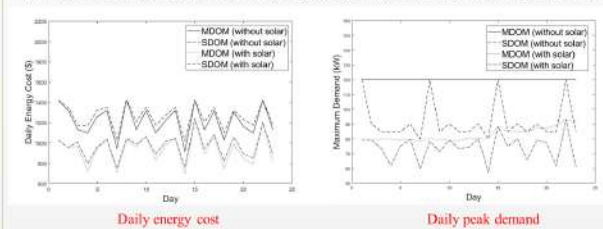
The proposed work gives the lowest monthly cost, and provides more stable peak demand across one month
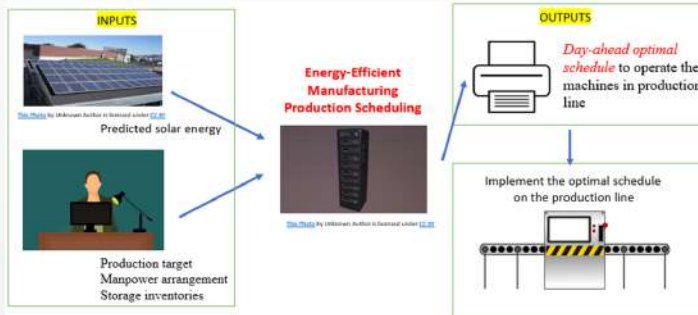
Conclusion

1. The model works well even when the PV panels cannot generate any electricity on a cloudy day since it can accommodate the manufacturing facility with or without renewable energy inputs.

2. The proposed model is relatively flexible and compatible to be deployed in most industry sectors at any scale. Users just need to configure the required parameters according to their industrial processes (varying daily production target, varying number of daily manpower to satisfy the staff leave rotation, varying number of hourly manpower to meet the meal break schedule)

3. The proposed model minimize the deviation of the peak, which outperforms the typical approach on single-day optimization.
4. Create a win-win situation for both industrial users and utility providers.
- to the benefit of industrial users: convexity ensures that the exact minimum monthly bill in an environment that implements the TOU tariff and MD penalty
- to the benefit of utility providers: minimize the daily peak demand deviation, resulting in a more stable grid

Energy-Efficient Resource Allocation With Interference Mitigation for Cognitive Heterogeneous Cloud Radio Access Network (CH-CRAN)

Project Leader: Ts. Dr. Ng Yin Hoe
Member: Dr. Tan Chee Keong
Graduate Research Assistant: Prabha Kumaresan
Funding: Multimedia University Graduate Research Assistant Scheme

Problem Statement

Non-orthogonal multiple access (NOMA) is an effective approach that has aroused great interest from researchers due to its broad application prospects in fifth-generation (5G) networks. In conventional user clustering techniques, the number of clusters and users for each of the clusters formed is fixed. This results in poor throughput performance as the channel heterogeneity and diversity are not fully exploited.

Objectives

1. To formulate a new user clustering problem for the downlink of NOMA systems.
2. To determine the optimum user clustering for throughput maximization in the downlink of 5G NOMA systems.
3. To design scalable machine learning based user clustering techniques that can attain near-optimal throughput performance.

Contributions

Three novel adaptive user clustering (AUC) techniques have been devised. Specifically, a B-FS strategy is proposed to find the optimum user clustering. Next, to support scalable number of users machine learning based UC schemes that leverage on deep neural network (DNN) to attain near optimal throughput performance and extreme learning machine (ELM) with fast speed of learning are developed.

Publications – Journal Papers

The techniques proposed have been published in the following journals:

1. S. P. Kumaresan, C. K. Tan and Y. H. Ng, "Extreme learning machine for fast user clustering in downlink non-orthogonal multiple access (NOMA) 5G networks", IEEE Access, vol. 9, pp. 130884 - 130894, Sep 2021.
2. S. P. Kumaresan, C. K. Tan and Y. H. Ng , "Deep Neural Network (DNN) for Efficient User Clustering and Power Allocation in Downlink Non-Orthogonal Multiple Access (NOMA) 5G Networks ", MDPI Symmetry, vol. 13, 1507, Aug 2021.
3. S. P. Kumaresan, C. K. Tan, C. K. Lee, and Y. H. Ng, "Adaptive User Clustering for Downlink Non-Orthogonal Multiple Access (NOMA) based 5G Systems Using Brute Force Search", vol. 31, ETT, Aug. 2020.

Proposed clustering techniques
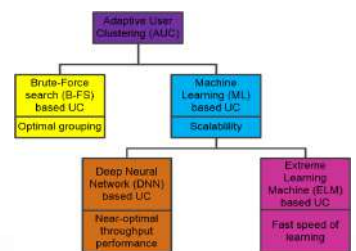
Results
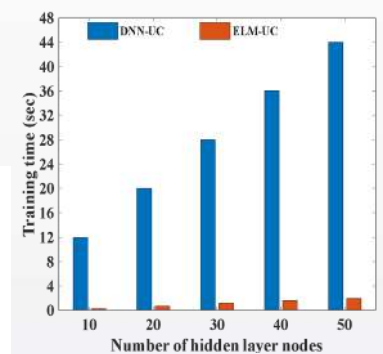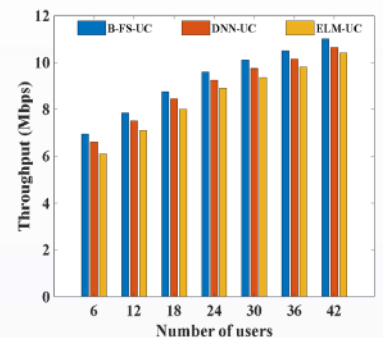
Proposed DNN based UC

Proposed ELM based UC

ENHANCEMENT OF INTERFERENCE REDUCTION TECHNIQUES FOR FEMTOCELL NETWORKS

MOHAMAD YUSOFF ALIAS, KHALID SHEIKHIDRIS MOHAMED ABDELGADIR, MARDENI ROSLEE

Centre for Wireless Technology (CWT), Faculty of Engineering, Multimedia University

Problem Statement

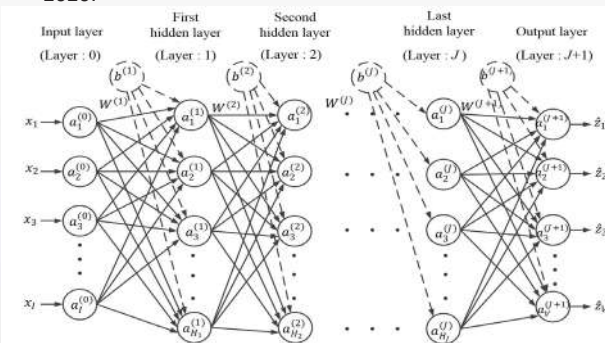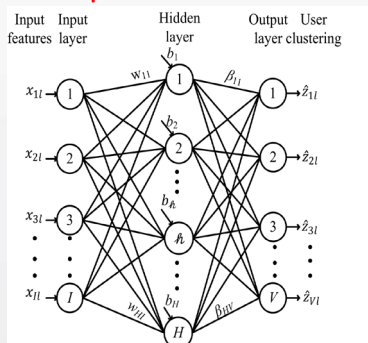The use of small cells become eminent when realising that most of future data exchange is expected to originate from indoor premises as well as the impressive signal quality improvements as shown in **Figure 1**. In addition, the high penetration and propagation losses of macrocell high frequency signals caused by heavy constructions, and/or areas with minimal communication demands. However, concerns of interference related issues were raised due to the arbitrary deployment of femtocells. Although interference can be mitigated using power control methods, interference alignment, and resource allocation approaches; the complexity, rapid development, and increasing demands of cellular networks set a limit to these classic approaches.

(a) Cross-tier Scenario   (b) Co-tier Scenario
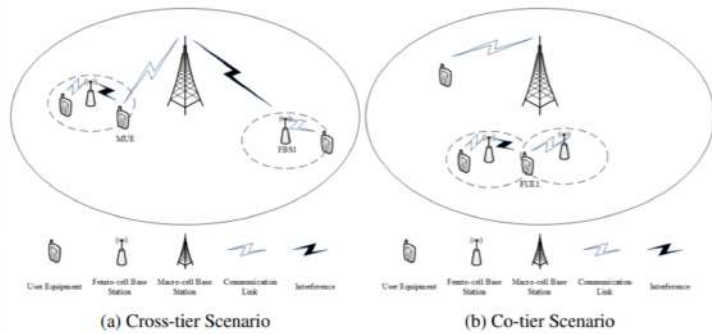
Figure 1: Interference Examples In Cross-tier And Co-tier Femtocell Networks
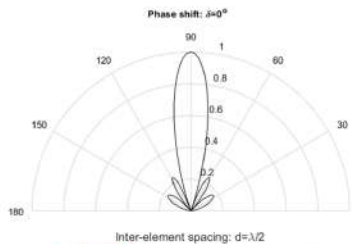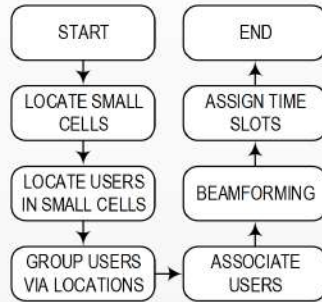

Figure 2: Narrow beamwidth

Objectives

This project proposes a beamforming with timed division multiple access (TDMA) approach that limits the transmissions to the desired users at different time slots in-order to mitigate the probability of interference occurrence. This is obtained by narrowing down the beamwidth to achieve higher directivity towards the desired users while the TDMA technique reduces the concurrent reception possibility of nearby users as shown in **Figure 2**.

Process Flow

The transmission for users is defined using the association index and the time slot index whereby the latter is set by analysing the locations of all users and assigning the different time slots to users withing proximity zone to reduce the interference probability as shown in **Figure 3**.
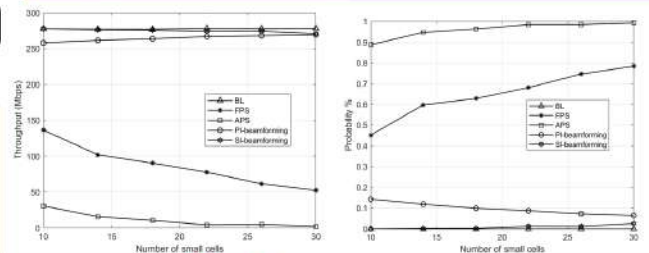

Figure 3: Process Flow

Results

The performance of the TDMA beamforming guarantees excellent performance in comparison to the normal beamforming even in the highest small density withing an area. The proposed approach achieves a maximum throughput of about 255 Mbps and an outage probability suppression to less than 5% as shown in **Figure 4**. These results promote the project to be an efficient interference mitigation paradigm for suitable for next generation communication systems.

Figure 4: Simulation Results

Conclusion

The analytical and numerical evaluations show that the network performance can fairly be improved in terms of interference and outage reduction, spectral efficiency and throughput enhancement which makes the project a catalyst in the area of small cells networks and could be utilized in applications of future everything-to-everything (E2E) communication etc.

Journal papers
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2. Mohamed, K. S., Alias, M. Y., & Roslee, M. (2020) Interference Management Using Beamforming Techniques For Line-Of-Sight Femtocell Network. IEICE Transactions on Communications, Vol.E103-B,No.8,pp881-887 Aug. 2020.
3. Mohamed, K. S., Alias, M. Y., & Roslee, M. (2019). Interference Avoidance Using TDMA-Beamforming in Location Aware Small Cell Systems. Applied Sciences, 9(23), 4979.

Collaborator
1. **PhD Graduate:** Dr. Khalid Sheikhidris Mohamed, Assistant Professor, Faculty of Telecommunication and Space Technology, Future University - Sudan, Khartoum, Sudan
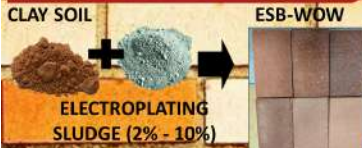
Complete References

Complete list of publications

ESB-WOW: ECO-FRIENDLY ELECTROPLATING SLUDGE BRICK AS WEALTH OUT OF WASTE ALTERNATIVE

AP TS. DR. AESLINA ABDUL KADIR , AZINI AMIZA HASHIM , NUR JANNAH ABDUL HAMID , NURUL NABILA HUDA HASHAR , NUR FATIN NABILA HISSHAM

PRODUCT DESCRIPTION

CLAY SOIL + ELECTROPLATING SLUDGE (2% - 10%) → ESB-WOW

Electroplating sludge is classified as **Scheduled Waste (SW 105)** and need to be disposed at secure landfill.

The recycling of ES into fired clay brick has adequate quality to be used in **Loading Bearing 4** application based on Malaysian Standard MS:76.

Electroplating sludge-brick (ESB) **improved** physical and mechanical properties, reduce the **heavy metal leachability and emission** to the environment.

KEY FEATURES OF INVENTION

Utilize **waste** produced from electroplating industry as partial replacement in brick production.

Manufactured through a **systematic methodology** and **appropriate design mixture.**

Act as **green construction material** with **adequate quality** based on brick standard and environmental regulations.

Possesses **high strength** of fired clay brick to be used in various load-bearing application.

NOVELTY AND INVENTIVENESS

ESB is produced through a **systematic methodology** to **immobilize toxic heavy metal** and **reduce its emission** to the environment.

This product could act as the **environmentally sustainable method** to minimize problems related to the **disposal of electroplating sludge** in industry.

IP / COPYRIGHT

COPYRIGHT:
Immobilization Of Heavy Metal In Electroplating Sludge Incorporation Into Fired Clay Brick (LY2019004479)

PATENT:
Fired Clay Brick Incorporated With Recycled Toxic Waste (PI2015703938

RESEARCH METHODOLOGY

STAGE I: RAW MATERIAL PREPARATION → STAGE II: BRICK PRODUCTION → STAGE III: TESTING OF PRODUCT

Mixing | Moulding | Drying | Firing

RESULT AND DISCUSSION

		Conventional brick	ESB 4% (optimum)
✔	Mixture	100% clay	4% electroplating sludge
			96% clay soil
	Density	1920 – 2000 kg/m³	1809.66 kg/m³ (5.7% lightweight)
	Shrinkage	8%	0.930% (88.4% improved) (within the recommended range 2– 4%)
	Initial rate of suction	5 g/mm².min	3.77 g/mm².min (24.6% improved) (comply with suggested value 2 g/mm².min – 5 g/mm².min)
	Water absorption	18.3%	16.1% (reduce water infiltration into brick by 14%)
	Compressive strength	15 – 18 MPa	41.53 MPa (improve strength value more than double, suitable to be used in Loading Bearing 4 application based on MS:76)

Heavy metal	Leaching concentration (ppm)		Reduction (%)	USEPA limit (ppm)
	Raw electroplating sludge	ESB		
Cu	862.0	0.0754	100.0	100
Pb	57.5	0.0015	100.0	5
Zn	230.0	0.1080	100.0	500
Mn	235.0	0.0304	100.0	-
Ni	402.0	0.0133	100.0	1.34
Al	844000.0	0.1825	100.0	-
Cr	152.0	0.0019	100.0	5
Fe	4160.0	0.1450	100.0	-
As	6.0	0.0033	99.9	5

Parameters	Unit	Indoor Air Quality		Industry Code of Practice on Indoor Air Quality (ICOP-IAQ 2010)
		Control brick	ESB	
TVOC	ppm	0.667	0.723	3
CO₂	ppm	381	340	1000
CO	ppm	0.200	0.018	10
O₃	ppm	0.011	0.012	0.05
PM₁₀	ppm	0.015	0.136	0.15
PM₂.₅	mg/m³	0.001	0.005	0.10

USEFULNESS

Promote **waste-to-resource** alternative that reduce the dependency on secured landfill and impact of waste towards environment.

Enhance the feasibility of the fired clay brick incorporated with waste in Malaysia to be used as **green building material** .

COMMERCIALIZATION POTENTIAL

Provide **alternative disposal** method for electroplating sludge.

Adequate quality in accordance with the brick standard.

Comply with the **heavy metal leaching** and **indoor air quality regulation**.

TALENT DEVELOPMENT

POSTGRADUATE
Master by Research: 2

UNDERGRADUATE
Bachelor Degree: 3

CONCLUSION

ESB could be used as **waste-to-wealth** alternative for the heavy metal sludge disposal. This product has potential to be utilized as **green construction material** since it possesses improved strength and compliance with **environmental regulations**.

RESEARCH PAPER PUBLICATION

- A Review of Recycling Electroplating Sludge in Fired Clay Bricks: Properties and Heavy Metal Leaching Behaviour (Scopus Journal).
- A Review on Immobilization and Leachability of Heavy Metal in Clay Precursors (Scopus Journal).
- Effect of Different Heating Rate on Properties of Fired Brick Produced from Industrial Waste and Natural Clay (Scopus Conference).

PREVIOUS/EXISTING INDUSTRIAL COLLABORATORS

- Great Peers (M) Sdn. Bhd.
- Hap Seng Clay Products Sdn. Bhd.
- SWCorp Malaysia
- Premier Bleaching Earth Sdn. Bhd.

RESEARCH FUND

- **Fundamental Research Grant Scheme (FRGS) K336** (MOHE Malaysia)
- **Postgraduate Grant Scheme (GPPS) H558** (Universiti Tun Hussein Onn Malaysia)

DEPARTMENT OF WATER AND ENVIRONMENTAL ENGINEERING, FACULTY OF CIVIL ENGINEERING AND BUILT ENVIRONMENT

TM Group

ESS-IoT – THE SMART WASTE MANAGEMENT SYSTEM FOR GENERAL HOUSEHOLD

Project leader: Assoc Prof Ir Ts Dr Wong Shen Yuong[1]
Members: Huo shuo Han[1], Cheng Kin Meng[2], Prof Dr Salman Yussof[3], Assoc Prof Dr Koo Ah Choo[2]

Introduction

Problems

Waste management has gradually become a costly issue worldwide. Waste are dumped to the landfill, sea or burned in incinerator, which are more expensive. Transportation and labor fees are increasing with the increase of waste.

The state government has given more than 100,000 free bins to households just Petaling Jaya and Ipoh (Star, 2017). However, waste disposal rate is increasing much faster than recycling rate.

3 in 1 waste disposal solution
(Collection & Classification & Reward)
1. ESS-IoT (hardware) overflow mechanism
2. Deep learning: Convolutional Neural Network (CNN) prediction model
3. Cloud-based Reward mechanism

NOVELTY

1. Other waste inside blue recycle bin
   Full? I Don't care, it's not my problem

2. Recycle bin colors doesn't improve citizen's classification of waste, judging by colors and logo needs practice and discipline. But many do not have it, ended up simply disposing their trash.

3. People still dispose their rubbish even when dustbin is fully loaded, may cause odour pollution.

A smarter waste classifier and detection system is needed to save cost and reduced unethical waste disposal due to the lack of knowledge about the waste.

4. Solid waste has also become a global issue with respect to economic sustainability and environmental pollution (Ferronato & Torretta, 2019).

5. In Malaysia, economic growth has caused burden on the environment, including waste generation, greenhouse gas emissions from the energy system, and open burning.

Overview of ESS-IoT

An Internet of Thing (IoT)-enabled waste sorting system, called ESS-IoT (electronic Smart Sorting-IoT), was proposed to assist people in better waste management. The ESS-IoT system uses Raspberry Pi 4b as the microcontroller with three modules and it was designed with three main functions which are waste collection and waste classification. Waste collection is triggered by the 'overflow alarm mechanism' that employs ultrasonic and tracker sensors. The waste classification, on the other hand, was implemented using classification algorithms, Convolutional Neural Network (CNN) prediction model. ESS-IoT includes a reward system in which household gets rewarded when they correctly dump waste. The reward will only be received when waste collector verifies the waste are dump correctly with their detector machine. Reward points earned can be redeemed for physical prizes, such as cashback or vouchers.

Estimate Cost Saving Measure for the next 10 years for two municipalities without and with ESS-IoT

A Current cost estimates for two municipalities (Ipoh and PJ) without ESS-IoT

Minimal Estimated spending on labor fee in average per Year for two municipalities
60 drivers* 1800 + 60 collector* 1600 =
108,000*12 months + 96000*12 months 4
RM 1.45 million (recurring yearly)

Minimal Estimated distance from different areas of the household to landfill for one truck
Per year
50 km *6 trips per week* 52 weeks = 15600km
60 trucks* 15600km = 936000 km

Fuel consumption Estimate for 443ECE stock per year –
RM0.21/1km * 936000km = RM 98280 (recurring yearly)

Minimal Estimated: Expenditure on bins in two Municipalities (A color recycle bin for 240 litre cost RM125 ringgit)
RM225*100,000 =
22.5 million + RM2.45 million = RM 98290

Estimated total expenditure for two cities: RM26 million

B Future cost estimate for two municipalities with ESS-IoT

Estimated 100,000 x ESS-IoT hardware for each household
RM 300* 100,000 = RM 30 million

Cloud service and maintenance (Recurring yearly) = RM 50,000

Cost in 5 years = 30.05 million

Cost in 10 years = 30.5 million

A
Cost in 5 years = 35.05 million
Cost in 10 years = 47.5 million

Cost Saving & Commercial Potential

A − **B**

Difference (without and with ESS-IoT) is
47.5 − 30.5 = 17 million saved

ESS-IoT Saves up to 30-50% of waste collection trips, which is equivalent to RM170 million from the fuel & labor fee in 40 municipalities in Malaysia in 10 years.
(17mil/2 *50%*40 = 170million)

How do we do it?

The ESS-IoT system mainly has three main functions. The first is to improve existing waste collection procedures to minimize the hazards of hazardous waste accumulation and reduce the cost of waste collection as the system will only collect the waste when the capacity is up to 80%. The system also functions as a reminder for waste sorting/ cleaning/ clearing the waste before it overflows (N.Sathish Kumar, 2016). Secondly, to help residents to sort and classify waste types when they discard waste through visual imagery analysis with machine learning and deep learning. This feature can also help to reduce the workload of waste collection staff when sorting waste, and different types of waste can be handled in different ways more efficiently. It also saves waste management costs when the waste is separated at source before going to landfills. Third, the reward scheme. The data of the waste correctly dumped (with the verification from the waste collector) will be sent to the cloud, enabling each participating household to earn the reward points successfully. They can redeem points for prizes and voucher based on their rank in the residential community.

Detect overflow (Collection) - IoT

Tracker Sensor → Infrared emission → Detection of distance → Analogue output → Calculation of Depth of waste → Overflow? → Yes → Alarm starts / No → No alarm

Microcontroller- Raspberry Pi 4b + Camera, touch screen + power supply modules + dustbin

Fig 1 - Flowchart of the ESS-IoT system algorithm for waste collection

Deep learning Prediction (Classification)

Fig. 2 Convolutional Neural Networks (CNN)

Data analyzed will send to the cloud system and participants who is using this system will get rewarded once waste collector come and collect the waste.

Predict the correct material and dispose Waste smarter.

Google Cloud services

Analyze data stored and turned Points are taken for correctly disposed waste. Waste collector need to verify for points to be collected

points   Ranking in leaderboard   Reward

Detect overflow-> analyze waste type -> Get rubbish sorted and get rewarded!

A sustainable environment for our future

Findings

Product & Technology Readiness

Results from Overflow detection from ESS-IoT system

Table 1 Results of Overflow alarm mechanism (distance of waste to the cover of the dustbin)

Distance	Test count	Number of alarms	Accuracy
Greater than or equal to 7cm	20	0	100%
6cm	20	0	100%
5cm	20	18	90%
4cm	20	20	100%
Less than or equal to 3cm	20	20	100%

Images of waste taken by ESS-IoT is analyzed with CNN classifier

Readiness

To detect the material with imagery through CNN, ESS-IoT has four dustbins with their types in their own distinctive colors. Kitchen waste (green), recyclable (blue), hazardous waste (red) and other waste (grey)

CONVOCATIONAL NEURAL NETWORK
AVERAGE CLASSIFICATION ACCURACY IS 83 - 95.5 %.
AVERAGE RESPONSE TIME IS 1.50 – 1.80 seconds

Table 2: Comparison of Classification result of recyclables with CNN classifier hazardous waste

Type		Test count	Classification using CNN classifier			
			Number of successful recognitions	Accuracy	Average	Average Response Time (s)
Used batteries	Button batteries	100	79	79%	83.3%	1.77
	Lithium battery	100	89	89%		1.72
	Power bank	100	82	82%		1.64
Expired drugs	Capsule	100	93	93%	89.7%	1.79
	Pill	100	85	85%		1.58
	Medical gauze	100	91	91%		1.65
End-of-life mercury measuring instruments	Mercury thermometer	100	94	94%	95%	1.69
	Mercury sphygmomanometer	100	96	96%		1.70
Waste fluorescent tube	Fluorescent tube	100	89	89%	95.5%	1.63
	Halogen lamp	100	94	94%		1.71

APPLICABILITY & IMPACT

We want to make our environment better by

1. Expect to reduce the cost of waste collection by 30 – 50%, with lesser waste collection trips that could reduce the cost of petrol and labor.

2. Improve decision making when disposing waste (without the identifying the color and logo from the bin) with accuracy up to 95.5% with deep learning classifier.

3. Reduce overflow rubbish in dustbin. Our solution detect it and inform the user and the waste management company.

4. Educate the people with the type of waste they dispose, convenience brings awareness.
Environmental Awareness & "Waste as Value" Mentality
Knowledge Transfer

5. Low budget IoT powered smart modules, and cloud network enable social network and ranking system. Incentive system can be claimed online. Suitable for long term used with less maintenance fees.

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TM Group

GREEN ZnO NANOPARTICLES FOR DYE DECOLOURISATION

PRODUCT DESCRIPTION

The current project addressed the application of zinc oxide nanoparticles (ZnO NPs) synthesized by green method using *Corriandrum sativum* leaf extract. The ZnO NPs were used degrade Basic Red (BR51), a type of xenobiotic organic compounds (XOCs) found in hair dye products in bathroom greywater (BGW). The current project present alternative solution technology for a sustainable environment and provide an alternative solution to degrade dyes and others pollutants.

NOVELTY & INVENTIVENESS

The green synthesis method using C.sativum leaf extract as a stabilizers/reducing agents in the current work found to be very effective in stabilizing the ZnO NPs.

Photocatalytic degradation of BR51 by green synthesized ZnO NPs reported for the first time

This green nanotechnology established to be most auspicious and environmental friendly for the NPs synthesis. This route is eco-friendly and nontoxic.

IP PROCTECTION / COPYRIGHT LY2020000777

Dr. G.YASHNI

TEM AND FESEM ANALYSIS
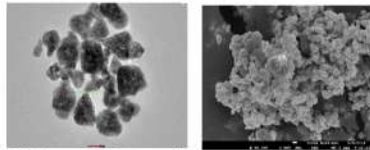
TEM image of internal structure and size of ZnO NPs

FESEM images of external morphology ZnO NPs

RESULTS

Before Treatment

After Treatment

PHOTOCATALYTIC DEGRADATION KINETICS OF BR51
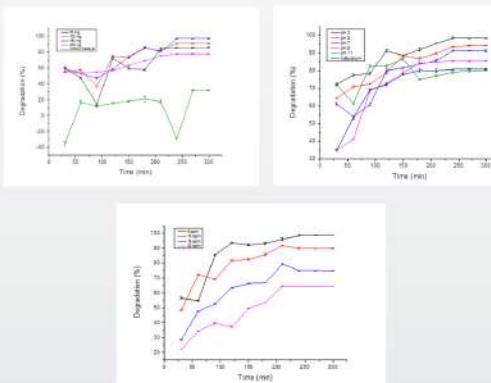
RESEARCH PAPER PUBLICATIONS

Yashni, G, Al-Gheethi, A. A., Mohamed, R. M. S. R., M. M., AL-Sahari (2021). Reusability performance of green zinc oxide nanoparticles for photocatalysis of bathroom greywater. Water Practice & Technology, 16(2), 364-376 (Q3, ISI, IF 0.510)

Yashni, G., Al-Gheethi, A., Mohamed, R., Arifin, S. N. H., & Salleh, S. N. A. M. (2020). Photodegradation of basic red 51 in hair dye greywater by zinc oxide nanoparticles using central composite design. Reaction Kinetics, Mechanisms and Catalysis, 130, 567–588. https://doi.org/10.1007/s11144-020-01792-x (ISI, IF 1.52)

Yashni, G., Al-Gheethi, A., Mohamed, R., Hossain, S., Kamila, A. F., & Abirama, V. (2020). Photocatalysis of Xenobiotic Organic Compounds in Greywater using Zinc Oxide Nanoparticles: A Critical Review. Water and Environment Journal. https://doi.org/10.1111/wej.12619 (ISI, IF 1.426)

Yashni, G., Al-Gheethi, A., Mohamed, R., Arifin, S. N. H., & Salleh, S. N. A. M. (2020). Green ZnO Nanoparticles photocatalyst for efficient BR51 degradation: Kinetics and mechanism study. Environmental Progress (ISI, IF 1.73)

Yashni, G., Al-Gheethi, A. A., Mohamed, R. M. S. R., Arifin, S. N. H., & Hashim, N. H. (2019). Synthesis of nanoparticles using biological entities: an approach toward biological routes. Desalination and Water Treatment, 169, 152–165. https://doi.org/10.5004/dwt.2019.24666 (ISI, IF 1.32)

Yashni, G., Al-Gheethi, A. A., Mohamed, R. M. S. R., & Hashim, N. H. (2019). Green synthesis of ZnO nanoparticles by *Coriandrum sativum* leaf extract: structural and optical properties. Desalination and Water Treatment, 167, 245–257. https://doi.org/10.5004/dwt.2019.24584 (ISI, IF 1.32)

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Yashni, G., Al-Gheethi, A., Mohamed, R., Shanmugan, V. A., & Bakar, J. A. (2021). Characterization of Coriandrum Sativum leaves as a sustainable green biosorbent. Materials Today: Proceedings (SCOPUS INDEXED PROCEEDING)

Yashni, G., Al-Gheethi, A., Mohamed, R. M. S. R., Nor Hidayah Arifin, S., Abirama Shanmugan, V., & Hashim Mohd Kassim, A. (2020). Photocatalytic degradation of basic red 51 dye in artificial bathroom greywater using zinc oxide nanoparticles. Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2020.01.395 (SCOPUS INDEXED PROCEEDING)

Yashni, G., Willy, K. B., Al-Gheethi, A. A., Mohamed, R. M. S. R., Mohd Salleh, S. N. A., & Amir Hashim, M. K. (2020). A Review on Green Synthesis of ZnO Nanoparticles Using Coriandrum Sativum Leaf Extract for Degrading Dyes in Textile Wastewater: A Prospect Towards Green Chemistry. IOP Conference Series: Materials Science and Engineering, 736(4), 042003. https://doi.org/10.1088/1757-899X/736/4/042003 (SCOPUS INDEXED PROCEEDING)

APPLICATIONS

Catalysis
Opto-electronics
Gas sensing
Agricultural
Electrochemical sensor
Medical devices

TARGET USER / MARKET

Water and wastewater treatment for
Hair dyes industry
Textile industry
Palm oil industry
Pharmaceutical

INDUSTRIAL COLLABORATION

IMPLEMENTATION OF AN IOT-ASSISTED TESTBED WITH RFID TRACKING FOR BABY INTENSIVE CARE SYSTEM

Dr. Chung Gwo Chin, Mr. Ruven Sundarajoo, Dr. Lee It Ee, Dr. Pang Wai Leong
Faculty of Engineering, Multimedia University

Abstract

Nowadays, 80% of the parents are working, which requires most of the time in the office. Thus, babies are send to the babysitting centre or took care by a caregiver. However, these two methods may not be commodious for parents according to demands. In this project, a low cost baby intensive care solution testbed is developed to remotely and efficiently monitoring the condition and safety of the baby with the implementation of IoT and RFID technologies.

Problem Statement

- Babies' safety is not guaranteed in the caring centre or with the babysitter.
- According to KKM, nearly 1,000 children in Malaysia are reported as victims of child abuse and neglect each year.
- During Covid-19 pandemic, babies are vulnerable to the exposure of virus infection and also the issue on absence of guardians due to quarantine.

Objectives

- Establish a baby surveillance system using sensor-based microcontroller system.
- Implement an IoT platform for long ranged monitoring and controlling.
- Construct a RFID location tracking module for baby safety purpose.

Methodology

1. Sensor-assisted baby monitoring system

Sensory devices are used to obtain real data of the behaviour (crying, awakening and comfortless of environment such as mattress moisture, room humidity/temperature, motion detection). A microcontroller is used to collect & analyse data and generate control signals to output devices such as LEDs, speaker, and camera.

2. IoT-enabled platform

To remotely monitor and control the system, IoT technology is used to send notification to remote users and allow them to activate basic output function of the system using any smart devices that are interconnected WIFI connection.

3. RFID location tracking module

RFID technology is used to track the location of the baby within the room or house for 24-hour safety detection. A wearable RFID tag is placed on the baby and several RFID readers are installed in the house. Whenever the baby trespass a specific area, an alarm and alert notification is triggered without the needs of human inspection.
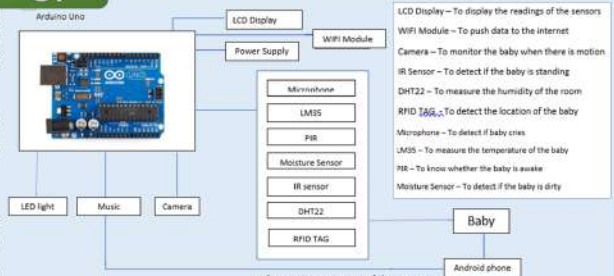

LCD Display – To display the readings of the sensors
WIFI Module – To push data to the internet
Camera – To monitor the baby when there is motion
IR Sensor – To detect if the baby is standing
DHT22 – To measure the humidity of the room
RFID TAG – To detect the location of the baby
Microphone – To detect if baby cries
LM35 – To measure the temperature of the baby
PIR – To know whether the baby is awake
Moisture Sensor – To detect if the baby is dirty

Fig. 1 System Architecture

Results & Discussion

Developed Prototype

Camera
Speaker
Power supply
Sound sensor
Wi-Fi module
Motion sensor 1
LED light
Temperature & humidity sensor
Moisture sensor (under the mattress)
Motion sensor 2

Fig. 2 Prototype of the system

Motion: YES
Moisture
Temperature
Humidity
Sound: YES

Fig. 3 Real-time data collected

Apps Demonstration

Fig. 3 displays the values of mattress wetness, environment temperature & humidity, and also motion & sound detection. Fig. 4 shows the notifications of changing diapers and baby crying on the Apps. Fig. 5 presents the live video of the baby and also the counting of movement and crying of the baby.
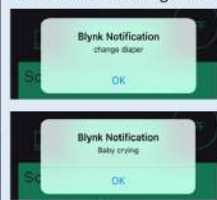

Blynk Notification
change diaper
OK

Blynk Notification
Baby crying
OK

Fig. 4 Notification alerts

Baby Moves: 6
Baby Cry: 3

Fig. 5 Display of live feed video

Conclusion

This project is successfully completed with an actual prototype to remotely and efficiently monitor the real-time behaviour of a baby and the environmental factors that influence the baby by sending notifications via the smart devices. It can also locate the baby for 24-hours to ensure the safety of the baby. Future development such as machine learning can be applied for data analysis.

Achievement

- Successfully obtained the approval of IRFund from MMU for year 2021.
- Published a ICCST21 conference paper.
- Accepted for LNEE journal publication.

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INTELLIGENT SMART-HOME ADVISORY SYSTEM

Project Leader: Assoc. Prof. Ir. Dr. Chan Kah Yoong, Mr. Mohamed Feroz Bin Mohd Ashrap Khan,
Dr. Lee Chu Liang
Faculty of Engineering, Multimedia University

Abstract

Home is a safe haven for many. The idea of healthy living has received much attention as many are concerned with their health. Many known products are being marketed. Nevertheless, such solutions are always plagued with minor nuisances that have detracted the adoption of the systems. Issues such as security/pricing, have always lingered in the mind of potential users. Hence, we propose a simple low-cost smart home system that leverages on IoT and the smartphone, which could give valuable suggestions to the users to improve their living environment conditions, while saving their energy consumption by using only what they need.

Objectives

Monitor:
- Temperature and Humidity
- Ambient Light Level
- Dust Level

Display and Feedback the data to the user with suggestion

Discussion

WHY IOT SO POPULAR NOW?

- Readily available
- Affordability
- Possibilities
- Connectivity

FACTORS ESSENTIAL FOR HEALTHY LIVING

Temperature
Why? → Energy Consumption / Comfort → Caused by? → Air Temperature / Body Metabolism Rate / Air flow

Humidity
Why? → Healthy Risk / Comfort → Caused by? → Relative Humidity / Air Flow

Light Intensity
Why? → General Behaviour / Health → Caused by? → Natural Light / Light Source

Design/Methodology

HARDWARE BLOCK DIAGRAM
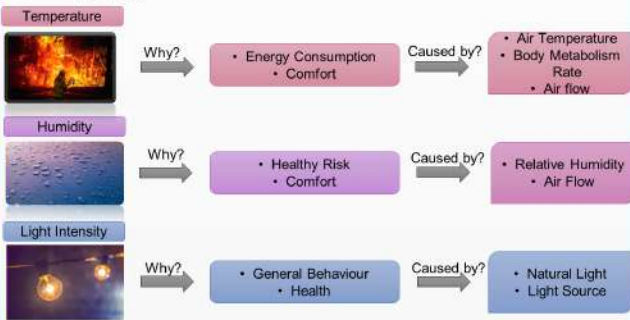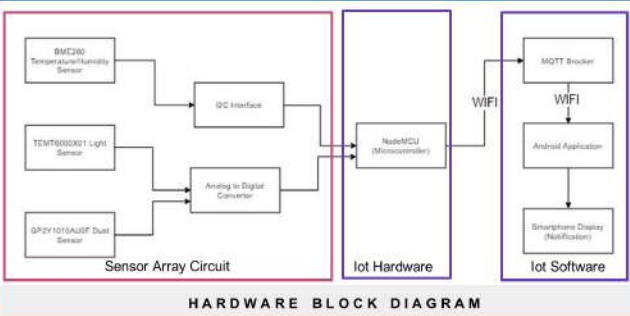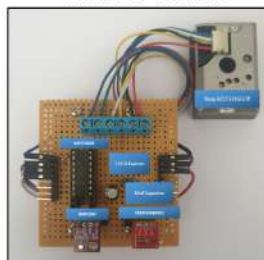
Result

CIRCUIT BOARD

3D-PRINTED PACKAGE

MOBILE APPLICATION OUTPUT
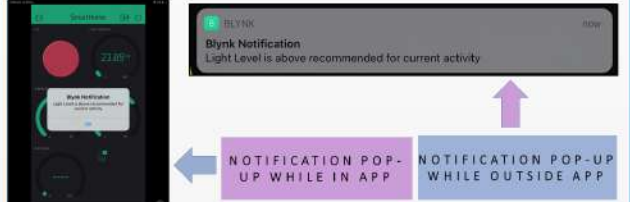
MAIN PAGE | TEMPERATURE PAGE | HUMIDITY PAGE | LIGHT-LEVEL PAGE

NOTIFICATION POP-UP WHILE IN APP ← NOTIFICATION POP-UP WHILE OUTSIDE APP

Conclusion

WE HAVE ACHIEVED:

- 3D Packaged Home Advisory hub with IoT connection
- Android App real-time monitoring for Temperature, Humidity, Light Level and Dust Level
- Smartphone alert system and suggestion

IOT THERMAL DETECTION SYSTEM

Project Leader: Dr. Lee Chu Liang,
Team Members: Assoc. Prof. Ir. Dr. Chan Kah Yoong, A'risya A'ina Binti Abdullah

PROJECT OBJECTIVES

1. To develop a low-cost IoT thermal detector system.
2. To apply IoT enabled thermal detector system for remote body temperature detection and data acquiesce.
3. To document data in a single document for future analysis

DISCUSSION

ADVANTAGES OF STORING DATA INTO CLOUD

1. **Cost-** Purchasing and installations of physical storage can be expensive. Hence, cloud storage exceptionally cheaper per GB used.
2. **Accessibility -** Cloud storage can be accessed anywhere with Internet connection.
3. **Recovery-** Cloud has been used as a back-up storage in cases where there is a hardware malfunction.
4. **Syncing and updates -** changes on a file or document can be immediately updated across all devices.

DESIGN/ METHODOLOGY
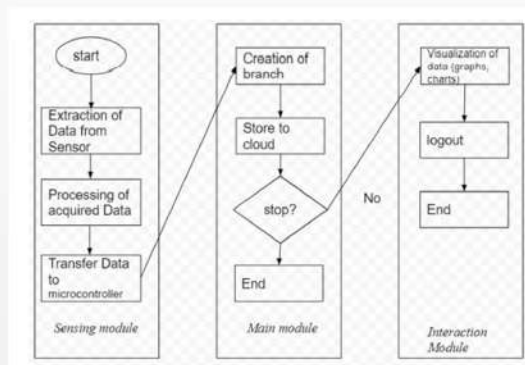
Figure 1: Illustrate the basic flow of the system.

RESULTS

Developed Proto-type
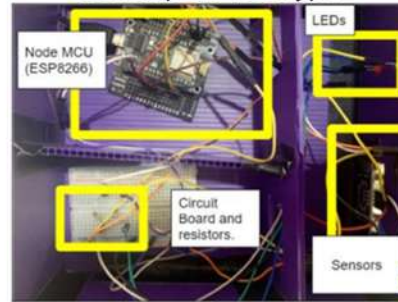
Figure 2: Illustrate the circuitry system implemented.
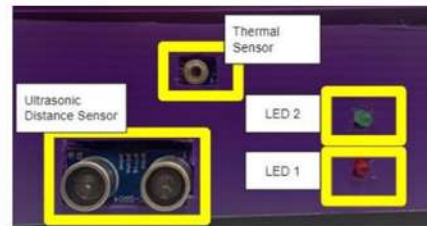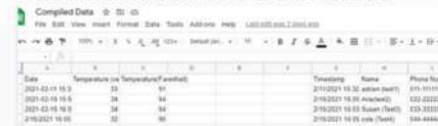
Figure 3: Illustrate the front view of the proto-type.

Documentation of Data in Cloud

Figure 4: Illustrate documentation of temperature and personal data with time stamp.

Adafruit IO widgets

Figure 5: Illustrate Adafruit IO widgets which are the monitoring widget in real-time, whole day documentation and graphical format data.

CONCLUSION

Strength of the system:
-The temperature of human body is taken via contactless implementation.
-Data of temperature and personal identification was taken and documented in real time.
-Both data was compiled in a single document.

Mean Gain, Excess Noise and Response Time in GaN/4H-SiC Thin Heterojunction Avalanche Photodiodes

P. L. Cheang, E. K. Wong and L. L. Teo

Objective:

To simulate mean multiplication gain, excess noise factor and response time for both electron- and hole-initiated multiplication of various multiplication widths GaN/SiC heterojunction avalanche photodiodes (APDs) incorporating the dead space effect and hetero-interface effects.

Research Methodology:

Monte Carlo (MC) method is employed to develop a model using random ionization path lengths to simulate the carrier transport properties such as drift velocity, energy, occupancy and the impact ionization coefficients of holes (β) and electrons (α) in GaN and 4H-SiC under high electric field.

The model is used to study the avalanche characteristics of GaN/4H-SiC and 4H-SiC/GaN heterojunction APDs for different multiplication width ratio of GaN to 4H-SiC in the multiplication region incorporating the dead space and hetero-interface effects.

It is shown that hole-initiated process gives higher multiplication gain than that of electron-initiated at the same applied voltage, at increasing multiplication width.
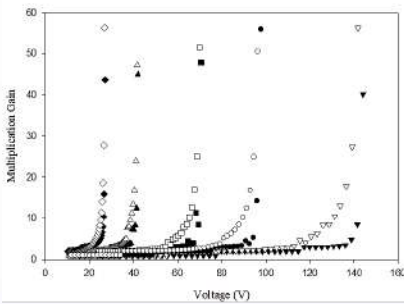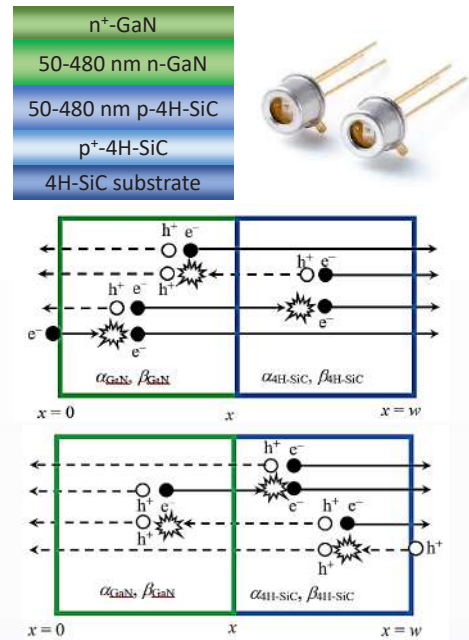
Fig. 2. Electron- (filled symbol) and hole- (open symbol) initiated multiplication gain as a function of reverse-biased voltage in GaN/4H-SiC APDs with 0.1w GaN and 0.9w 4H-SiC in w = 0.05 μm (diamond), 0.1 μm (up triangle), 0.2 μm (square), 0.3 μm (circle) and 0.48 μm (down triangle).

Fig. 1. (a) Electron-initiated impact ionization and (b) hole-initiated impact ionization with dead space and band edge discontinuity at junction in GaN/4H-SiC APDs.
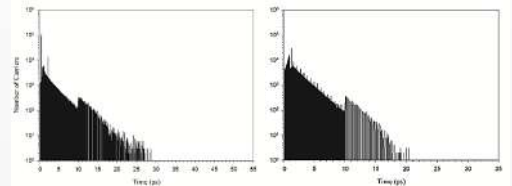

It is noticed that hole-initiated impact ionization generates lower noise than the electron-initiated impact ionization, compared to 0.2 < k < 0.4 calculated from McIntyre's theory (McIntyre 1966) even at higher gain. In electron-initiated device, most electrons just traverse through the 0.1w GaN with few impact ionizations.

Fig. 3. Electron- (filled symbols) and hole- (open symbols) initiated excess noise factor as a function of mean multiplication gain in GaN/4H-SiC APDs with 0.1w GaN and 0.9w 4H-SiC in w = 0.05 μm (diamond), 0.1 μm (up triangle), 0.2 μm (square), 0.3 μm (circle) and 0.48 μm (down triangle).

Fig. 4. Distribution of carriers versus time for (a) electron- and (b) hole-initiated multiplication in GaN/4H-SiC APDs of 0.10 μm with <M> = 20 incorporating of dead space.

Hole-initiated GaN/4H-SiC heterojunction APDs has shorter response time than that of the electron-initiated GaN/4H-SiC heterojunction APDs and also GaN and 4H-SiC homojunction APDs due to the restriction of most holes in 0.50w 4H-SiC layer.

Conclusion:

The hole-initiated GaN/4H-SiC heterojunction APDs demonstrate higher gain, lower excess noise factor and shorter response time than that of the GaN and 4H-SiC homojunction APDs.

Commercial and Civilian Applications: *Sensing ozone for environment, detecting radiation, flames in harsh environment, astronomical studies etc.*

METAMATERIAL INSPIRED ANTENNA FOR 5G COMMUNICATION TECHNOLOGIES

Md. Shabiul Islam*, Md. Mushfiqur Rahman*, Hin Yong Wong*, Mohammad Tariqul Islam**, Samir Salem Al-Bawri***,
*Faculty of Engineering, Multimedia University (MMU), Cyberjaya
**Department of Electrical, Electronic and Systems Engineering, University Kebangsaan Malaysia (UKM), Bangi
***Center for Space Science, Institute of Climate Change, Universiti Kebangsaan Malaysia (UKM), Bangi

Abstract

Metamaterial inspired compact circularly polarized antenna for 5G sub 6 GHz band has been presented. The conventional circularly polarized antenna structures are very complex and not compact enough to fit into a micro portable device. Single negative metamaterial can achieve a high level of miniaturization than half wavelength resonators. In addition these loop structures, with the presence of split, will need very simple modification to achieve circular polarization. However, the compact dimension of the proposed prototype is $0.26 \lambda_L \times 0.26 \lambda_L \times 0.017 \lambda_L$, where λ_L is the free space wavelength at the lowest frequency. The antenna has an operating bandwidth of 19.74% for |S11| <-10 dB where the gain of 1.15 dBi is realized. In addition, the radiation pattern is omnidirectional in the horizontal plane and dumbbell shaped in the elevation plane. The cross-polarization levels in both planes are less than -12 dB.

Methods and materials

- A single unit cell of electric inductive and capacitive i.e. ELC structure is utilized to excite low frequency resonance by cutting a split in the middle of the structure

- The balanced position of the split does not give circular current moment of the electric current vector for a complete phase. The addition of a strip inside the structure and the placement of the split bearing strip in an unbalanced position to cause circular polarization (CP).

- The rectangular strips at both sides of the feed line improves the value axial ration over the entire bandwidth. In this way, this novel technique can be a potential alternative to other complex circularly polarized antenna structure for future micro portable device applications.

- RT Duroid 5880 substrate of dielectric constant 2.2 and loss tangent 0.0009 with a thickness 1.52 mm is used as the dielectric material of the antenna. The copper is used as the metallic component of the system.

Key features

- Cost effective single negative metamaterial with the utilization of low loss dielectric material is used.

- Simple modification to achieve circular polarization.

Commercial potential as 5G mMTC applications

Wearable IoT devices

Small IoT modules

IoT devices for Future healthcare applications

Discussions

- Strong electric polarization along the split causes compactness
- Increases the width of the split enhances the bandwidth
- Addition of strip inside the structure and the unbalanced position of the split bearing side introduces circular polarization

Conclusions

A metamaterial Inspired antenna is presented where the prototype is compact and exhibit wider bandwidth in the 5G sub 6 GHz band. Another attractive feature of this state of art is that it is circularly polarized which needs very simple methodology thus increases its acceptability in future micro portable device applications.
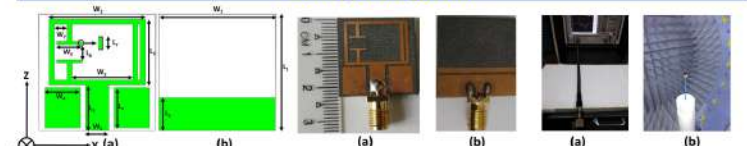
Prototype configuration

Figure 1: (a). Front side and (b) Back side of the proposed antenna

Figure 2: Fabricated (a). Front side and (b) Back side of the proposed antenna

Figure 3: Measurement setup of (a) Vector network analyzer and (b) Satimo near-field chamber

Compact, Narrowband structure and no CP

Wideband and Circularly polarized (CP)

Improved Axial ratio

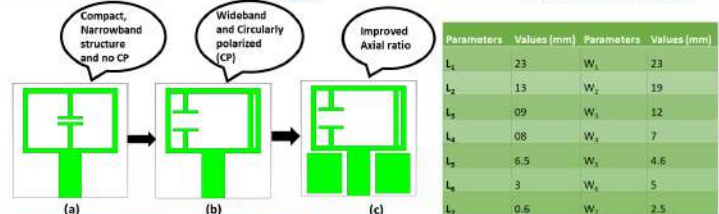| Parameters	Values (mm)	Parameters	Values (mm)
L₁	23	W₁	23
L₂	13	W₂	19
L₃	09	W₃	12
L₄	08	W₄	7
L₅	6.5	W₅	4.6
L₆	3	W₆	5
L₇	0.6	W₇	2.5

Figure 4: Design evolution of the proposed antenna. (a) Antenna 1 (b) Antenna 2 (c) Proposed antenna
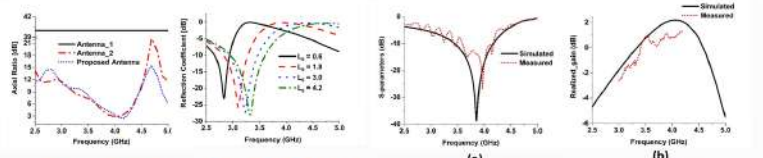
Results

Figure 5: Comparison of Axial ratio of different stages of Antenna

Figure 6: Parametric analysis of Reflection coefficient for different values of split width

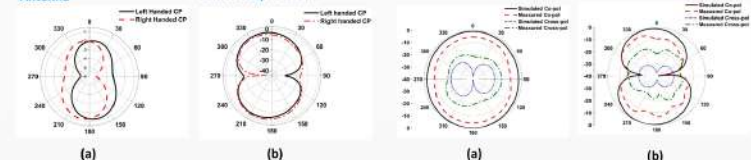Figure 7: Simulated and Measured (a) Reflection Coefficient and (b) Realized gain

Figure 8: Simulated and Measured radiation pattern in the (a) XY-plane and (b) YZ plane

Figure 9: Simulated and Measured radiation pattern in the (a) XY-plane and (b) YZ plane

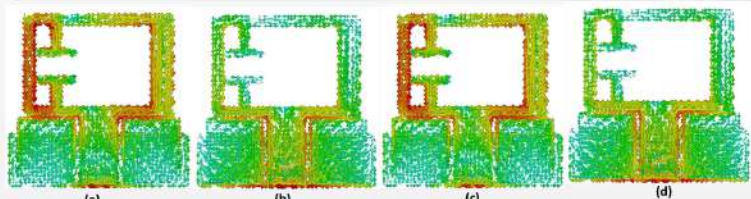## Current Distribution at different phases

Figure 10: Current distribution at different phases. (a) 0°, (b) 90°, (c) 180° and (d) 270°

References

[1] (Ullah, U., Koziel, S., & Mabrouk, I. ben. (2019). A Simple-Topology Compact Broadband Circularly Polarized Antenna with Unidirectional Radiation Pattern. *IEEE Antennas and Wireless Propagation Letters, 18*(12), 2612–2616. https://doi.org/10.1109/LAWP.2019.2945543

[2] Wen, L. H., Gao, S., Luo, Q., Yang, Q., Hu, W., Yin, Y., Wu, J., & Ren, X. (2020). A Wideband Series-Fed Circularly Polarized Differential Antenna by Using Crossed Open Slot-Pairs. *IEEE Transactions on Antennas and Propagation, 68*(4), 2565–2574. https://doi.org/10.1109/TAP.2019.2951994

[3] Hu, X., Yan, S., & Vandenbosch, G. A. E. (2019). Compact Circularly Polarized Wearable Button Antenna with Broadside Pattern for U-NII Worldwide Band Applications. *IEEE Transactions on Antennas and Propagation, 67*(2), 1341–1345. https://doi.org/10.1109/TAP.2018.2885210

[4] Lu, J., Zhang, H. C., Wei, C., Hong, J. S., & Cui, T. J. (2020). Design of Compact Circularly Polarized Antenna Using Sunshine-Shaped Slotted Patch. *IEEE Transactions on Antennas and Propagation, 68*(9), 6800–6805. https://doi.org/10.1109/TAP.2020.2999663

[5] Ullah, U., Mabrouk, I. ben, & Koziel, S. (2019). A Compact Circularly Polarized Antenna with Directional Pattern for Wearable Off-Body Communications. *IEEE Antennas and Wireless Propagation Letters, 18*(12), 2523–2527. https://doi.org/10.1109/LAWP.2019.2942147

Mobile Robotic Platform for Research and Security Industry

By
Fabian Kung Wai Lee
Multimedia University

- This is an experimental machine, a work-in-progress that aims to provide partial solutions to an important challenge facing robotic systems – A reliable, adaptive and self-learning machine architecture that can work along side humans in an unstructured environment.

- The machine is constructed from the ground up, with most of the hardware and system designed in house. Certain part of the software (real-time control, RTOS) is also developed in-house, with open source software used wherever possible, such is in the machine vision and machine learning.

- When completed, it is the aim of the inventor to make it open source so that interested parties can help to improve on the design.

https://fkeng.blogspot.com/2019/03/theory-and-design-of-two-wheels-self.html
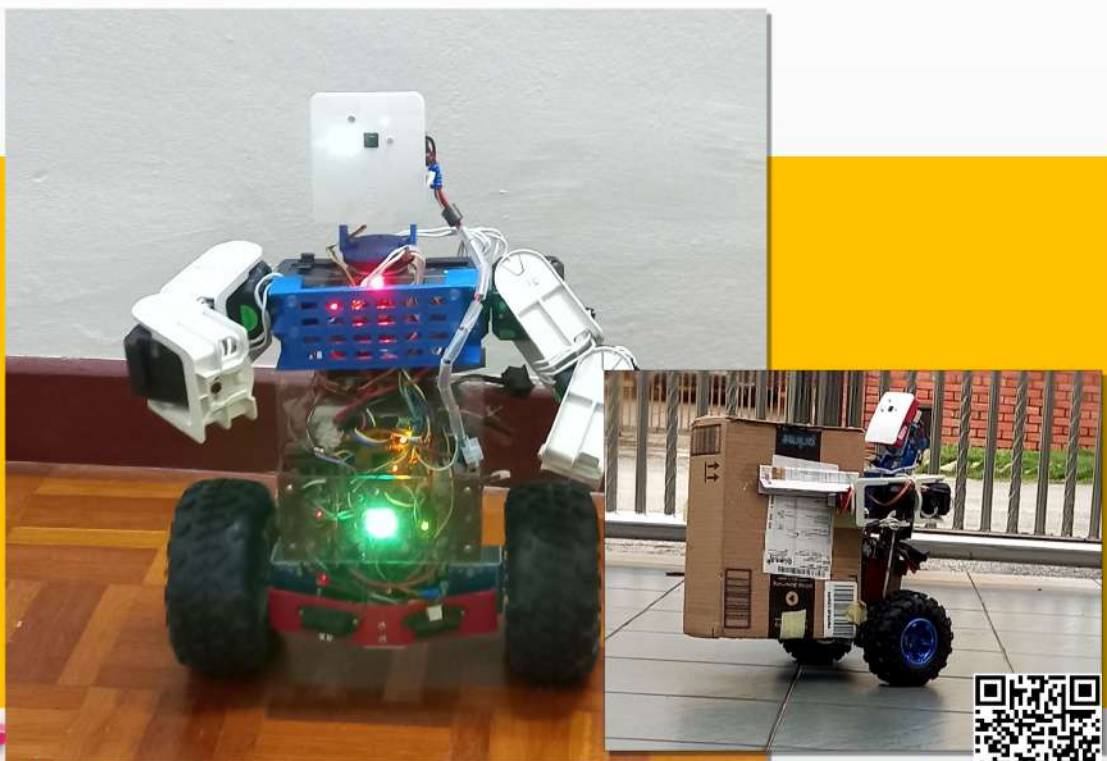
MODELLING AND ALGORITHM FOR RF ENERGY HARVESTING UTILIZING RECONFIGURABLE INTELLIGENT SURFACE IN VEHICLE TO VEHICLE (V2V) SYSTEM

Noor Amirah Mohd Salleh[1], Azwan Mahmud[1], Azlan Bin Abd.Aziz[1], Mohamad Yusoff Alias[1], Mardeni Roslee[1], Tan Kim Geok[1], Syamsuri Yaakob[2]
[1]Multimedia University, [2]University Putra Malaysia (UPM)

INTRODUCTION

- A scenario involving multiple energy-constrained source nodes and one fully-powered access point (AP) was investigated, in which the AP transfers power to the source nodes in phase I in down-link (DL), and the source nodes then use the harvested power to transmit their information to the AP in phase II, for up-link (UL) [1],[2].

- We investigate the reconfigurable intelligent surfaces (RIS) in WPCN, in our initial work and then in V2V, with aim to improve the longevity and utility of the rechargeability of distributed battery-powered nodes by using radio frequency energy harvesting. "Smart radio environments"; enabled by technologies that regulate the propagation environment to increase signal quality and coverage, such as reflector-arrays/intelligent walls and RIS.

- Systems' performances are measured in terms of average capacity, average secrecy capacity (ASC) and coverage probability.

METHODOLOGY & ALGORITHM
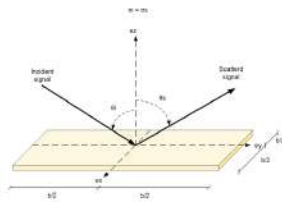
A) Metallic structures with tiny antennas to re-emit these waves and applying some math can make huge impact towards controlling the resultant waves
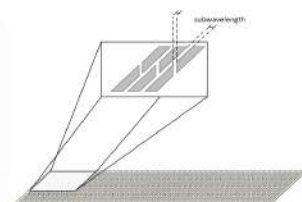
B) Scenarios that make RIS a good choice are environments with poor signal qualities, heavy constructions, hidden nodes; RIS can be deployed on walls, windows etc.
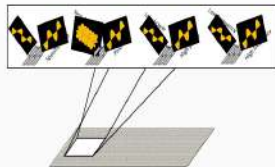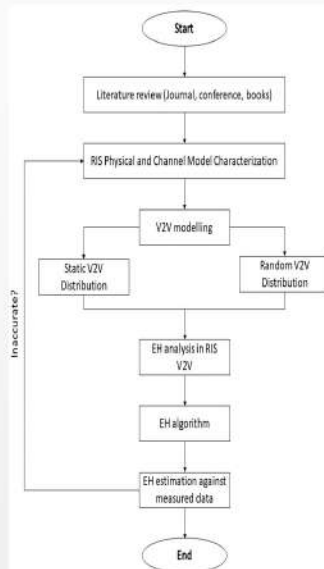

C) The constituent elements of meta-surfaces influence the resultant signals wavefronts in terms of phase, amplitude, polarization, and frequency, and even alter the beam direction (i.e. beam-steering).
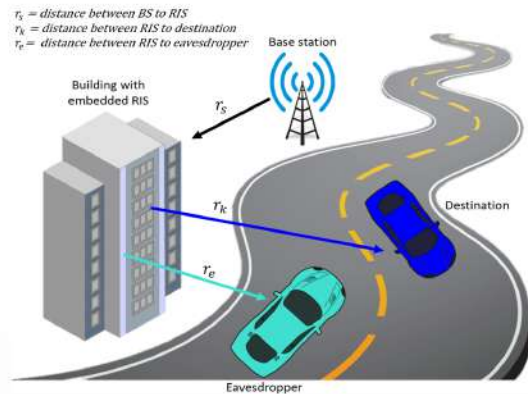
D) Methodology and algorithm to model RIS PHY and MAC layer characteristics and developed novel suitable algorithms to optimally used RIS to support EH nodes harvested energy in V2V.

- By analysing the multi-path signal component observed from a received signal, including mathematical behaviour of V2V network with RIS included as catalyst

- Using stochastic analysis and optimization theory, a new technique can be proposed to infer from the model on the information of the new setup condition on the RIS physical behaviour such as phase shift, multipath signals, angle of attack, randomly distributed behavior and line-of-sight (LOS)/non-LOS V2V network.

E) Algorithm flow chart

SYSTEM MODEL

r_s = distance between BS to RIS
r_k = distance between RIS to destination
r_e = distance between RIS to eavesdropper

- Base station (S), **transmits** classified messages to a Destination vehicle (D).

- Eavesdropper (E) vehicle **disrupts** the relay and tries to decipher the transferring messages.

- E and D are **situated** within a distance from vehicle S, the **gap** particularly between the V2V connections are **vague**.

- S is assumed to be operating on **RIS-based** scheme through an **Access Point (AP)** to communicate over the system.

- An AP coupled with the RIS is assumed to **comprise all of the information** about the relay channels.

PRELIMINARY RESULTS

Simulation and Analytical Results show that RIS provide capacity and coverage improvement to the cellular systems.
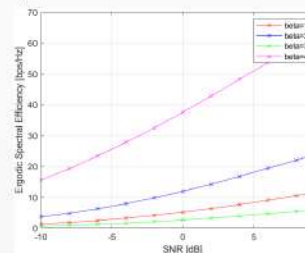

Fig. 1. Average Spectral Efficiency against SNR[dB] with different path loss exponent, without interference in the system
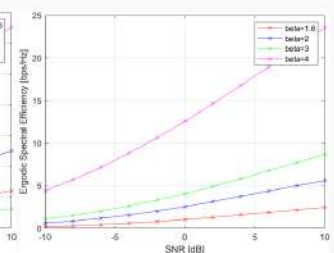
Fig. 2. Average Spectral Efficiency against SNR[dB] with different path loss exponent, with interference in the system

CONCLUSION

This research offers novel study of RF energy harvesting utilizing RIS, for 5G and 6G communications. Still in infancy, simulation and mathematical analysis need to be perform in various conditions. Moreover, the understanding of RIS system will enable hardware manufacturer reduced their time required for fundamental study and potentially used for mass deployment.

References:

[1] H. Yang, X. Yuan, J. Fang, and Y.-C. Liang, "Reconfigurable Intelligent Surface Aided Constant-Envelope, Wireless Power Transfer," Jun. 2020, http://arxiv.org/abs/2006.01696

[2] A. U. Makarfi et al., "Reconfigurable Intelligent Surfaces-Enabled Vehicular Networks: A Physical Layer Security Perspective," Apr. 2020

MODELLING THE EFFECTS OF PARTICLE MIGRATION ON THE THERMAL TRANSPORT OF A NANOFLUIDS-COOLED MICROCHANNEL HEAT SINK

Amos Loh Kok Wy, Chen Gooi Mee, Lim Boon Kian, Tso Chih Ping
Faculty of Engineering and Technology, Multimedia University, Melaka, Malaysia

Introduction
- Nanofluids are colloidal suspensions containing nanometer-sized particles for heat transfer enhancement.
- Particle migration is the diffusion of particles that disturbs the concentration profile of a flow which further affects the temperature and velocity profiles.
- This study evaluates the effect of particle migration on an asymmetrically heated parallel plate microchannel.
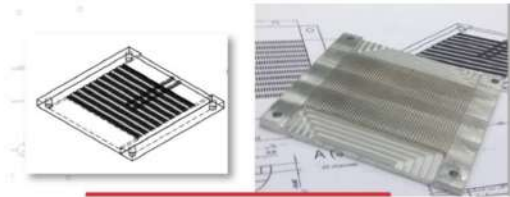
Fig. 1 A Microchannel heatsink.[1]

Methods of Investigation
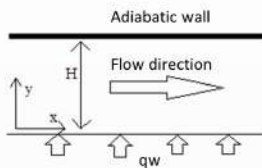
Fig. 2 Schematic diagram of the mathematical model

Objective
- To investigate the effect of particle migration on the fluid flow and heat transfer of a nanofluids-cooled microchannel heat sink

The governing equations for the mathematical model are given as the following:

Momentum equation:

$$\frac{\partial \rho u}{\partial t} + \rho u \cdot \nabla u = -\nabla p + \nabla \cdot (\mu \nabla u) \quad (1)$$

Thermal energy equation:

$$\frac{\partial \rho cT}{\partial t} + \nabla \cdot (\rho c u T) = \nabla \cdot (k\nabla T) + \mu \nabla u : \nabla u + \rho_p \left[D_B \nabla \phi + \frac{D_T}{T}\nabla T + \frac{D_S}{\dot{\gamma}}\left[\nabla \dot{\gamma} + \frac{\dot{\gamma}}{\phi}\nabla\phi\right] + \frac{D_\mu}{\mu}\nabla\mu \right] \cdot \nabla T \quad (2)$$

Mass equation:

$$\frac{\partial \phi}{\partial t} + \nabla \cdot (\phi u) = \nabla \cdot \left[D_B \nabla\phi + \frac{D_T}{T}\nabla T + \frac{D_S}{\dot{\gamma}}\left[\nabla\dot{\gamma} + \frac{\dot{\gamma}}{\phi}\nabla\phi\right] + \frac{D_\mu}{\mu}\nabla\mu\right] \quad (3)$$

[1] Lim B. K., Chen G. M. and Sia G. D., "Thermal performance of rectangular channel heat sink using water-based nanofluid," B.S. thesis, Faculty of Engineering and Technology, Multimedia University, Malaysia, 2017.

The following dimensionless variables are defined:

$$\eta = \frac{y}{H} ,\ U = \frac{u}{\frac{H^2}{\mu_w}\left(-\frac{dp}{dx}\right)} , \theta = \frac{k_w(T_w - T)}{q_w H} \quad (4a,b,c)\ [2]$$

$$N_{BT} = \frac{D_{BW} T_W \phi_W k_w}{D_{TW} q_w H} ,\ \gamma = \frac{q_w H}{k_w T_w} \quad (4d,e)\ [2]$$

By employing the above dimensionless variables, the dimensionless governing equations are found as the following:

$$\frac{dU}{d\eta} = \frac{B - \eta}{\left(\frac{\mu}{\mu_w}\right)} \quad (5)$$

$$\frac{\partial^2\theta}{\partial\eta^2} = -\frac{1}{\left(\frac{k}{k_w}\right)}\left[\frac{\rho c_p U}{\langle \rho c_p U\rangle} + \frac{7.47}{1 + 7.47\phi_w}\left(\frac{d\phi}{d\eta}\right)\left(\frac{d\theta}{d\eta}\right)\right] \quad (6)$$

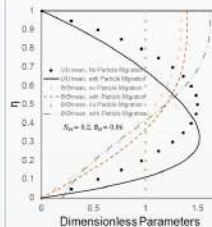$$\frac{d\phi}{d\eta} = -\frac{\phi}{N_{BT}(1 - \theta\gamma)^2}\frac{d\theta}{d\eta} \quad (7)$$

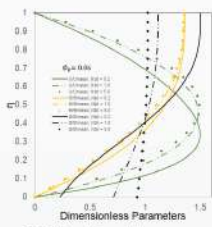**Fig. 3** The comparison between the no particle migration model and the current study's model

Fig. 4 Dimensionless velocity, temperature and concentration for different N_{BT}
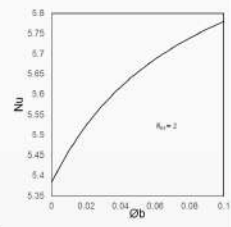

Fig. 5 The effect of bulk concentration on the Nusselt number

Results and Discussion
- The effect of particle migration is more significant for lower N_{BT} due to predominant thermophoretic diffusivity over Brownian diffusivity
- Nusselt number increases as nanoparticle bulk concentration increases due to a steeper velocity gradient

Conclusion
- Effects of particle migration have been investigated
- Effects of different N_{BT} on the profiles have been studied
- The heat transfer performance has been investigated by studying the Nu_B of the nanofluid

Acknowledgements

[2] Chen Y., Li W., Sano Y., Mochizuki M., Nakayama A., "On the anomalous convective heat transfer enhancement in nanofluids: a theoretical answer to the nanofluids controversy," *Journal of Heat Transfer*, vol. 135, no. 054504, 2013.
[3] Chen G. M., Amos L. K. W., Lim B. K., "Particle Migration of a Nanofluid flow in a Microchannel," in *7th Micro and Nano Flows Conference*, London, 2021.

ON THE IMPACT OF CASSAVA STARCH AS BINDER TO SLOW-RELEASE UREA FERTILIZER

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Abstract

Cassava starch is one of richest renewable materials, it can used as binder to slow urea fertilizer release an ammonia. Urea fertilizer can be good help for agricultural and animal feed additive but it also has side effects which is when it contacts with moisture soil or rain it will converts to ammonium and carbon dioxide. This project is to study the effect of the urea granule fertilizer which cassava starch as a binder on corn seedling growth. In the experiment, 3 types of urea granules which different ratio of cassava starch and urea fertilizer have been used. The seedling of corn plant will put urea granules in day 14. After that, the corn plant has been observed and the data of corn plant is measured and recorded in day 65. From the result, the optimum ratio of the urea granules is 48% urea concentration and 2wt% cassava starch concentration. By using UG2 it produces less ammonia release and pH value which also can be good growth of corn and promote environment health.

Objective

- To study the effects of biodegradable urea granule fertilizer on corn seedling growth.

Problem Statement

According the Figure 1 it show that in Europe, East Asia and China has ammonia over released problem comes from agricultural sources which is livestock wastes and fertilizer application. Therefore, biodegradable urea granules fertilizer plays a important role to protect our natural ecological environment.
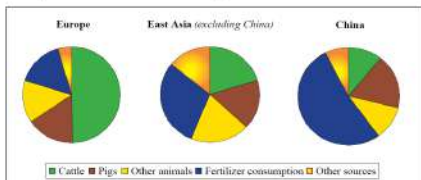

Figure 1: Ammonia Emission structure in China, Europe and East Asia (1990)

Methodology

- Figure 2 below shows the flow chart of the experiment.
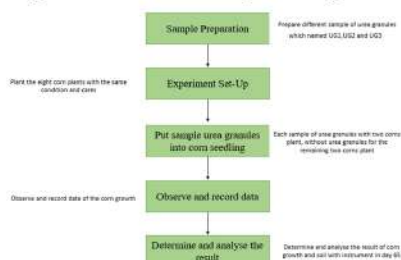- Figure 3 below shows the sample of urea granules.

Figure2: Flow Chart of the Experiment

Figure 3: UG1, UG2 and UG3

- Table 1 shows the parameters set up used in the experiment

Table 1: Parameters Set Up of the Experiment

Type of Urea Granules	Starch Concentration (wt%)	Urea Concentration (wt%)	Binder Density (g/cm³)	Binder Viscosity (cP)
UG1	1	49	1.14012	43
UG2	2	48	1.13413	164
UG3	3	47	1.12864	305

- Figure 4 shows the application of urea granules to corn planting.

Figure 4: Application of Urea Granules to corn planting

Results

- Table 2 below shows the result of growth of corn plant with 3 type of urea granules in day 65.

Table 2: Results of Corn Plant

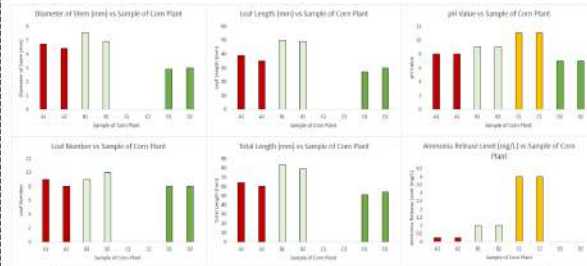| Types of Urea Granules	UG1		UG2		UG3		Without UG	
Sample Corn Plant	A1	A2	B1	B2	C1	C2	D1	D2
Diameter of Stem (mm)	4.7	4.4	5.5	4.9	-	-	2.9	3
Leaf Number	9	8	9	10	-	-	8	8
Leaf Length (mm)	39	35	50	49	-	-	27	30
Total Length (mm)	64	60	83	79	-	-	51	54
pH Value	8	8	9	9	11	11	7	7
Ammonia Release Level (mg/L)	0.25	0.25	1	1	4	4	0	0

Figure 5: Graph of Corn Growth Categorical Data with Different Type of Urea Granule

Figure 6: Sample Corn Plants in day 65

- In Figure 5, corn plant B1 and B2 with UG2 having the optimum growth in this experiment compare with corn plant A1 and A2 with UG1. However, corn plant C1 and C2 with UG3 were withered since the soil pH value and ammonia release level are highest.
- Figure 6 shows all the sample corn plants in day 65.

Conclusion

- These results indicate the application of cassava starch as binder to urea granule have residual positive effect on control the amount of ammonia release.
- The different responses between UG1, UG2 and UG3 shows that the results shows UG2 had achieved give optimum results to the corn plant growth and minimal amount ammonia release.
- Extensive studies are recommended through add more parameters and use different ratio of urea granules in the future research work.

PRE-CRIME DETECTION VIA CAR MISMARCHING SYSTEM USING DEEP LEARNING

Dr. Chung Gwo Chin, Mr. Almaswari Osamah Abdullah Hezam, Dr. Lee It Ee, Dr. Tiang Jun Jiat
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Abstract

In current era, high series of crime in the community is still a concern for residents, even with the presence of various security facilities in or around the building such as guardhouse and video cameras, since the perpetrators of crimes find loopholes to penetrate the security services. Therefore, a surveillance system is proposed for detecting pre-crime action by identifying the mismatching of car specifications and car owner using machine learning.

Problem Statement

At the guardhouse, criminal always exploits the security apparatus loopholes through the use of fake id and fake car plate numbers to enter the residence easily to do theft or murder, without earlier detection from the security guards.

Objectives

- Design a system for detecting possible pre-crime action under the surveillance of video camera.
- Develop machine learning for the identification of car specifications that are mismatched to the car owner.

Conclusion

To conclude, a machine learning based pre-crime detection system using car plate number, model and color has been developed. The performance of detecting the front side of the car images obtained a higher accuracy result of 97% and 74% for license plate and logos, which is better than back side images.

Methodology

The proposed system operates at the guardhouse by detecting the vehicle using a surveillance camera while recording the data of the visitors. The system will extract the data from car plate's number, color and logo. Through the checking of the owner's information and the car specification, the integrity of the vehicle's data is confirmed, and it is allowed to enter, or else the car is classified as illegal, and it will be blocked due to the use of fake car plate number. The guard may launch a report to the respective authorities.

Figure 1: System architecture

Figure 2: Flow chart of the detection

- At the beginning, the system will predict the vehicle in an image using the MobileNet SSD model and, then determine the vehicle's region in the image. It is able to detect the vehicle type, license plate, company logo, and colors from the car images.
- For the car plate detection, the Yolo algorithm detects the license plate region and crops the respective image on the car. Then, the OCR is used in reading and extracting the texts and numbers from the plate region only, to increase the accuracy. For logos detection, Yolo v4 Tiny algorithm can be used for detecting 21 company logos. Lastly, the colors of the car is identified using the (color2.tflite) model.
- On the other hand, video processing operates with the same models and algorithms for images detection because the videos contain a series of fix image, which can be used to predict the car from these frames and detect the car specifications.
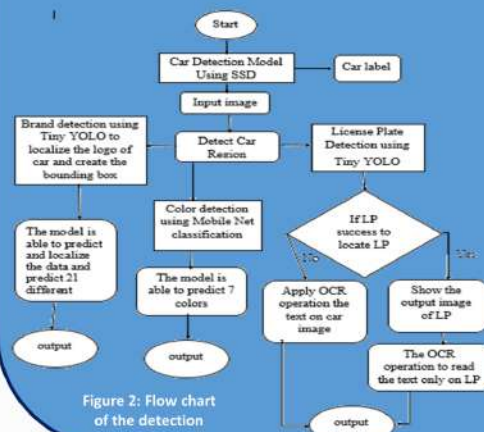
Results & Discussion

- The total images tested are 60 images, in which 35 images are categorised as front side cars and 25 images as back side cars.
- The testing results show that the license plate has a performance accuracy of 97% for front side car and 94% for back side car.
- For car logo detection, the performance accuracies are 74% for front side car and 12% for back side car.
- Hence, it is obvious that the proposed system works well for images of front side cars.

Image categories	Predefined conditions	Sample data simulated (how many images used)	Correct estimation (how many correct)	Accuracy rate
Front image of a car	Overall (no predefined condition)	35	34	97%
	High resolution (more than 1024 pixels)	35	34	97%
	Low resolution (less than 1024 pixels)	0	0	0
	Standard font characters (Malaysia)	35	34	97%
	Non-standard font characters	0	0	0%
	Perpendicular to the center of car (more than 30degree)	35	34	97%
	Other positions (less than 30 degree)	0	0	0%
	High resolution + standard font + perpendicular	35	34	97%
	success to located the car plate zone	21	20	95%
	success to read full car plate text	34		
	not success to read all car plate text	1		
	not success at all	0		

Figure 4: Part of the performance evaluation.

blue 100.0 %

Detect car plate zone success
Car plate full reading success
Car color detect success
Detect car logo zone success
Reading the logo success

Figure 3: An example of car detection.

References

1. Li Ding, Dana Steil, Matthew Hudnall, Brandon Dixon, Randy Smith, David Brown, Allen Parrish, "PerpSearch: An Integrated Crime Detection System", 26th June 2009, IEEE International Conference on Intelligence and Security Informatics, pp. 1–3.
2. Junaid Ali Khan, Munam Ali Shah," Car Number Plate Recognition (CNPR) system using Multiple Template Matching", 24th October, 2016 22nd International Conference on Automation and Computing (ICAC), pp. 1-6.
3. Sebastian Escalante, Victor Murray "Automatic Recognition of Peruvian Car License Plates", 12th October, 2020, IEEE XXVII International Conference on Electronics, Electrical Engineering and Computing (INTERCON), pp. 1-4.
4. Mohammad Wahyudi Nafi'l, Eko Mulyanto Yuniarno, Achmad Affandi, "Vehicle Brands and Types Detection Using Mask R-CNN", 06th January, 2019, International Seminar on Intelligent Technology and Its Applications (ISITIA), pp. 1-6.
5. Mohammad Nakib, Md. Sakibul Hasan, Rozin Tanvir Khan, Jia Uddin "Crime Scene Prediction by Detecting Threatening Objects Using Convolutional Neural Network", 20th September, 2018 International Conference on Computer, Communication, Chemical, Material and Electronic Engineering (IC4ME2), pp. 1-4.

Potential

- Reduce the percentage of crimes that occur in residential/commercial buildings.
- Preparing for a journal submission.
- Win an award in RICES21.

REHABILITATION USING BIOFEEDBACK SYSTEM

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Introduction

Rehabilitations are conventionally done in hospitals and are time-consuming for the patients. The patients do not feel motivated as they have to travel to the hospitals from their home. The proposed system is a **home-based, virtual reality rehabilitation** application, embedded with biofeedback. The patients can choose any rehabilitation activity at home without the need for on-site supervision by a medical caregiver. There are 4 activities programmed into the application: **Pick and place**, **Mirror Pick and place**, **Wall Climbing**, and **Hit the ball**. Each of the activities is designed for rehabilitation of **upper limb motor function**.

Objectives

- To design and develop a biofeedback system
- To design a virtual reality environment for rehabilitation
- To design and develop rehabilitation activities using virtual reality

Proposed System
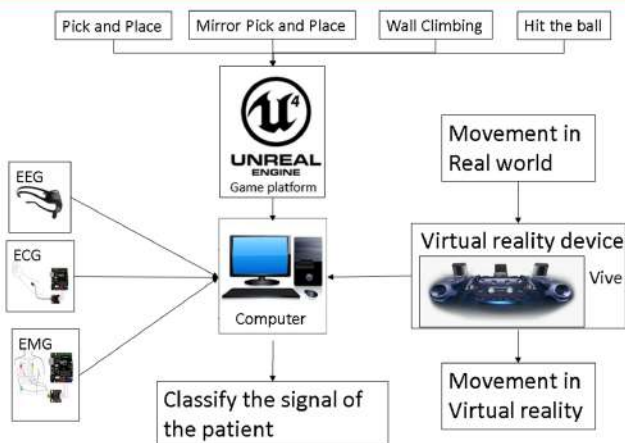
Benefits

- a home-based rehabilitation training in which the rehabilitation training can be done at any time at home.
- provides the function of analyzing condition of the patient from time to time.
- cost-effective framework for a home rehabilitation system

Project Outcome

Before starting rehabilitation exercises, the patient is required to undergo an **ECG test** to check the condition of the patient's heart.
There are **4 activities** in the application:

Throughout the rehabilitation activities, the patient is required to wear the **EEG headset** and **EMG sensor** to monitor brain wave and muscle power. Muscle power is an indicator of improvement in stroke patient.

Recognition & Award

- **Copyright**

1. CIC/IP/CR/2019-032	4. TTO/IP/CR/2020-023
2. TTO/IP/CR/2020-024	5. TTO/IP/CR/2020-049
3. TTO/IP/CR/2020-047	6. TTO/IP/CR/2020-037

- **Patent**

1. PI 2012004764   2. PI 2019006481   3. PI2021000313

- **Collaboration with**

1. Chiba University	3. Universiti Kebangsaan Malaysia
2. Hospital Melaka	4. Perkeso Melaka

- **Publications**

1. K. S. Sim et al. (2019). Development of Dementia Neurofeedback System using EEG Brainwave Signals. *IJSPS*, 7(4), 113-117.
2. K. S. Sim et al. (2019). Deep Convolutional Networks for Magnification of DICOM Brain Images. *IJICIC*, 15(2), 725-739.
3. S. Fawaz et al. (2020). Encoding Rich Frequencies for Classification of Stroke Patients EEG Signals. *IEEE Access*, 8, 135811-135820.
4. K.L. Lew et al. (2020). 3D Kinematic of Upper Limb Functional Assessment Using HTC Vive in Unreal Engine 4. *ICCCI*, 264–275.
5. C. C. Lim et al. (2021). Determination of Muscle Power Using RMS of Electromyography for Stroke Survivors, *ICISA*, 201-210.

RESOURCE ALLOCATION USING SIMULATED ANNEALING (SA) FOR NON-ORTHOGONAL MULTIPLE ACCESS (NOMA)-BASED 5G NETWORKS

Mardeni Roslee, Osama Abu Ajwa, Zubaida Yusoff

Center for Wireless Technology (CWT), Faculty of Engineering (FOE), Multimedia University

INTRODUCTION

The 5G networks demands a technology that can meet the massive connectivity, high data rate and high spectral efficiency.

The traditional orthogonal multiple access (OMA) can serve multiple users simultaneously using the available orthogonal resources that are limiting the number of users adopted in the system.

Thus, OMA is not the promising multiple access to fulfil the 5G network requirements.

NOMA has been developed currently to overcome the OMA drawback also to meet the 5G network requirements.

NOMA technologies allow signal interference cancelation (SIC) at one of the receiving ends to mitigate the interference between the multiplexed users.

NOMA technologies have enormous potential advantages in providing a low latency, supporting more devices, allowing massive connectivity also providing throughput user's fairness.
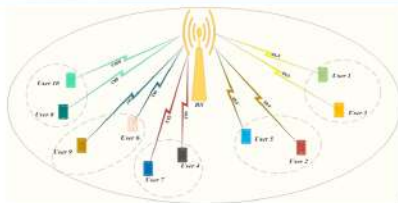
Figure 1. The basic concept of the NOMA scheme with 10 users.

METHOD

- The algorithm evaluates the objective function based on the allocated power for each subchannel P_n and the power ratio δ_n among the multiplexed users, as well as the user and subchannel matching.
- The SA design defines the parameters $a\_n = P\_n/Pmax$, as a fraction of the total transmitted power P_Max.
- The δ_n is the power ratio for the multiplexed users on the same subchannel, and the channel gain difference is the main factor for the user and subchannel matching scheme.

$$f(P_n, \delta_n) = B_{sc1,n} log_2(1 + \delta_n P_n G_{1,n}) + B_{sc2,n} log_2\left(1 + \frac{(1-\delta_n)P_n G_{2,n}}{1+\delta_n P_n G_{2,n}}\right)$$

- In this system, the SA algorithm will be applied in two configuration such as hot and cold and each have two scenarios.
- The hot configuration started the initial design by randomly multiplexing the user with high channel gain with the user with low channel gain on the same subchannel as the current best solution.
- The cold configuration established the initial design by matching the users randomly based on descending order of channel gain on the same subchannel as a current best solution [16].
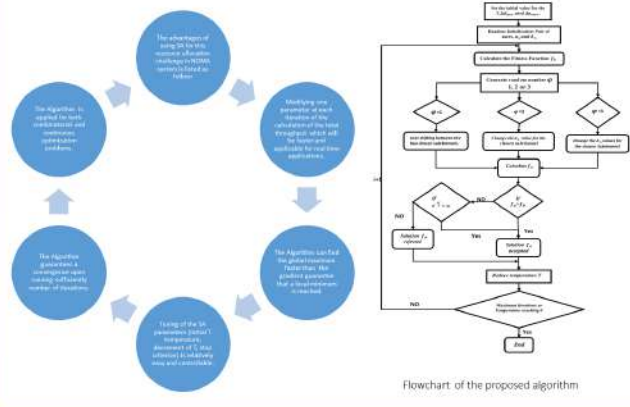
Flowchart of the proposed algorithm

RESULTS AND DISCUSSION

- The SA is used to handle the user pairing and subchannel and power allocation simultaneously that can always check the good throughput is achieved or not.

System throughput is evaluated for 10 users versus the maximum transmission power.
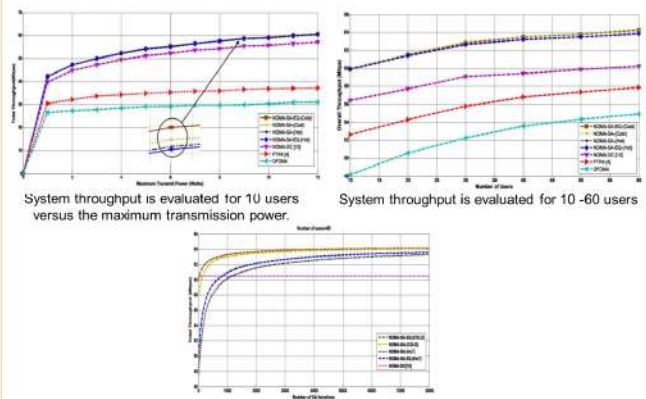
System throughput is evaluated for 10 -60 users

SA convergence for the tested scenarios

CONCLUSION

Self-optimization HO algorithm is proposed to improve the HetNets performance. The proposed algorithm periodically adjusts the values of HCPs according to UE speed and RSRP. In addition, our algorithm reduces the total rate of all performance metric by more than 80% as compared to other state-of-the-art algorithms. It is concluded that the adjusting HCPs according to UE conditions becomes more efficient and effective technique for mobility management.

PUBLICATIONS

1. Abuajwa, Osama, Mardeni Bin Roslee, and Zubaida Binti Yusoff. "Simulated Annealing for Resource Allocation in Downlink NOMA Systems in 5G Networks." Applied Sciences 11.10 (2021): 4592.
2. Abuajwa, Osama, et al. "ACO-based power allocation for throughput maximization in the downlink 5G NOMA systems." Int. J. Eng. Res. Technol 13 (2020): 3072-3079.
3. Abuajwa, Osama MS, Chee Keong Tan, and Ching Kwang Lee. "Throughput analysis for non-orthogonal multiple access (NOMA)-based 5G networks." Int J Recent Technol Eng 8 (2019): 2277-3878.
4. Benjebbour, A.; Li, A.; Kishiyama, Y.; Jiang, H.; Nakamura, T. System-Level Performance of Downlink NOMA Combined with SU-MIMO for Future LTE Enhancements. In Proceedings of the 2014 IEEE GlobecomWork, GCWorkshops, Austin, TX, USA,

ACKNOWLEDGEMENTS

INTELLECTUAL PROPERTY

System and Method For Facilitating Velocity-Based Cellular Handover for 5G Network, PI2021006229 (Patent Filed)

PI2021006229

KEY FEATURES

A novel Simulated Annealing (SA) standalone is introduced for resource allocation and user assignment to improve the throughput for the downlink non-orthogonal multiple access (NOMA) in 5G network – New

This invention has a high impact to the telecommunication providers in Malaysia.

SCALABLE COATING PROCESS OF AgNPs-SILICONE ON COTTON FABRIC FOR DEVELOPING HYDROPHOBIC AND ANTIMICROBIAL PROPERTIES

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Email: touhidtex41@gmail.com

Other members: Md. Abdullah Al. Mamun[1], Dr. Hasan Shahariar[2], MD. Mahbubur Rahman[3], MD. Monir Hossan[3]
[1]Assistant Professor, Department of Fabric Engineering, Bangladesh University of Textiles (BUTEX), Dhaka, Bangladesh
[2]Research Scientist, Diversey, Charlotte, North Carolina, United States
[3]Lecturer, Department of Textile Engineering, Green University of Bangladesh (GUB), Dhaka, Bangladesh

Abstract

Developing a scalable and cost-effective coating process is critical to manufacturing cotton based hydrophobic antimicrobial fabric for various commercial applications. This paper describes a scalable, cost-effective coating process that is compatible with the existing industrial finishing processes of fabrics. In this process, the fabric is continuously dipped in water-based silver salt and the reducing agent solution to impart silver particles on the fiber surface to produce different coated samples. The process is tuned to minimize process cost and material cost and maximize the antimicrobial effectiveness and durability of the fabric. This paper also introduces an easy protective coating technique with silicone binder of the antimicrobial fabric that improves the durability and hydrophobicity of the antimicrobial fabric without sacrificing the comfort properties of textile fabrics. In the presence of silicone binder, the samples show significant antibacterial effectiveness against two microorganisms, gram-positive *Staphylococcus aureus* and gram-negative *Escherichia coli* bacteria. Qualitative assessment is carried out to evaluate the antimicrobial properties of the silicone encapsulated silver particles-coated fabrics. Moreover, among the silver coated fabrics of different cycles, silver nanoparticles (AgNPs) are deposited in the 1 cycle of silver-coated fabric and the average particle size deposited onto the fiber surface is 65.52 ± 2.71 nm. After silicone encapsulation, among all encapsulated samples, 1 cycle of silver-coated silicone encapsulated sample shows the best result in terms of antimicrobial efficacy where silicone encapsulated 1 cycle silver-coated sample shows around the zone of inhibition 0.53 and 0.25 mm and encapsulated 2 cycles silver-coated sample shows the zone of inhibition 0.14 and 0.06 mm for *S. aureus* and *E. coli*, respectively. Coated fabrics with and without silicone encapsulation are characterized by scanning electron microscopy and energy-dispersive X-ray spectroscopy.

Applications

- Protective disposable hygiene fabrics, healthcare industry and medical applications, such as splash aprons, masks head and shoe covers, hospital surgical drapes and gowns, gloves, surgical packs, scrub suits and lab Coats.
- Special medical textile applications such as ostomy bags and devices for urine drainage containers.
- Special applications as bacterial barriers.
- Leather products.

Novelty

- Develop 100% cotton based hydrophobic antimicrobial fabric.
- Fabric shows bacterial resistivity for both Gram positive and negative bacteria.
- Can control AgNPs particle size by different coating cycles.
- Incorporate NPS into the fabric surface by In-situ process.
- Environment friendly process.
- Cost effective process.
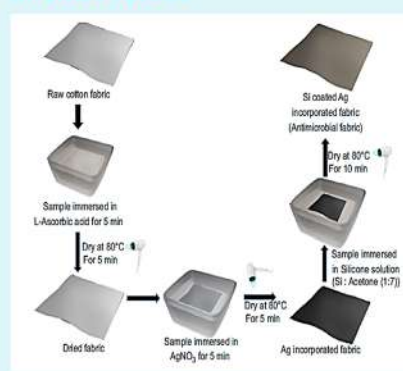- Scalable and less chemical utilization process.

Commercialization Potential

- Healthcare Industries.
- Disposable garments Industries.
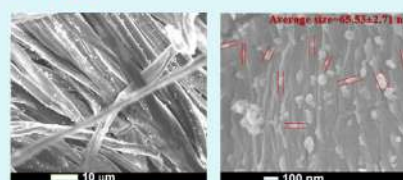
Graphic Abstract
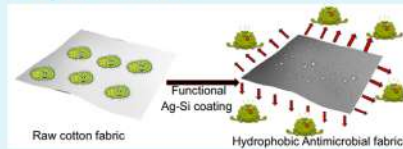
In-Situ Process

Results

Fig 1: SEM of the only silver-coated (1 cycle) fabric.

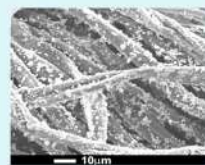**Fig 2:** Measurements of size and diameter of silver particles.

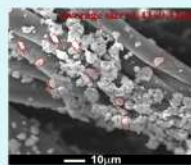**Fig 3:** SEM of the only silver-coated (3 cycles) fabric.

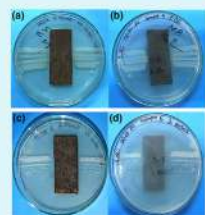**Fig 4:** Measurements of size and diameter of silver Particles.

Fig 5: Assessment of silver-coated (1 cycle) silicone encapsulated fabric for (a) *E. coli*, (b) *E. coli* (reverse view), (c) *S. aureus*, (d) *S. aureus* (reverse view)
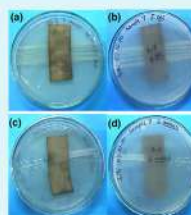
Fig 6: Assessment of silver-coated (3 cycles) silicone encapsulated fabric for (a) *E. coli*, (b) *E. coli* (reverse view), (c) *S. aureus*, (d) *S. aureus* (reverse view).

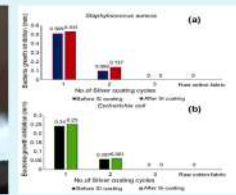**Fig 7:** Hydrophobicity of antimicrobial fabric.

Fig 8: (a & b) Graph showing inhibition of bacterial growth (mm) against different cycles of silver coating in cotton fabric as per test method AATCC 147

Discussion

- Lower coating cycle; lower particle size (1cycle coated fabric has Ag particles in nano range & 3 cycle coated fabric has micro meter Ag particles). (Fig. 2 & Fig. 4)
- Lower coating cycle sample shows best antimicrobial efficacy for both pathogens. (Fig. 5 & Fig. 6).
- Lower coating cycle sample shows best antimicrobial efficacy for both pathogens. (Fig. 5 , Fig. 6 & Fig. 8).
- Silicone encapsulated Ag incorporated fabric shows Hydrophobicity of fabric in Fig.7 .

Market Outlook(2020-2027)

Due to COVID-19 pandemic market demand forecast of antimicrobial textiles as per **Allied Market Research**-
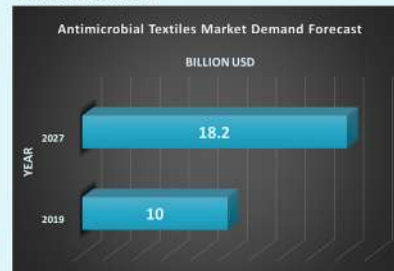
Achievement/ Award

Silver award on Research Project showcase Exhibition (GEX 2021).

Collaboration

Publication

1. Islam, M.T., Mamun, M.A.A., Hasan, M.T. et al. Scalable coating process of AgNPs-silicone on cotton fabric for developing hydrophobic and antimicrobial properties. J Coat Technol Res 18, 887–898 (2021).

SECURE AND ENERGY-EFFICIENT SYSTEM FOR MOSQUE BUILDINGS USING SWARM INTELLIGENCE APPROACH

Team members: Ms. Nur Asyiqin binti Amir Hamzah, Dr. Hadhrami Ab. Ghani, Dr. Azlan bin Abd Aziz & Dr.Nor Azlina binti Ab Aziz | FET MMU
Research assistants: Nawaid Hasan & Hatim Fahd Al-Selwi | FET MMU

INTRODUCTION

Security is very important in public locations or buildings that are visited by a large number of people, such as mosques and halls. Buildings such as mosques, which often contain a big amount of donated funds, have long been targets of criminals. Moreover, mosques' monthly utility bills are significantly higher than those of smaller buildings. Smart buildings or homes with energy-efficient approaches based on swarm intelligence are one basic way to solving building-related challenges. This project should focus on determining the image aspects that must be detected for security as well as energy conservation at properly located spots throughout the building or mosque.

RESEARCH OBJECTIVES

- To increase the security level of the building via a smart CCTV networks.
- To reduce hence save the energy consumption of the building via the image processing method implemented through the security network.

RESEARCH METHODS

START
Knowledge Acquisition (Literature review in detail)
Identify the Parameters (Find the system parameters of project)
System Modelling (Configure the security system model)
Implementation of Image Processing Algorithm
Performance evaluation for the developed system
Performance enhancement and Result Dissemination
A conference/ journal publication

Jetson Nano Developer Kit

Project Model - A 3D Top-Down View of Mosque

CCTV 2a Window n+1
CCTV 1a Window 1
Window 2n
Male section | Female section
Window n
Door 1 .... CCTV 2b | Door k CCTV 1b

SIMULATION RESULTS

Lights On:8 | Lights Off:8
Zone : 1 — 9 People | Zone : 2 — 0 People
Zone : 3 — 1 People | Zone : 3 — 0 People
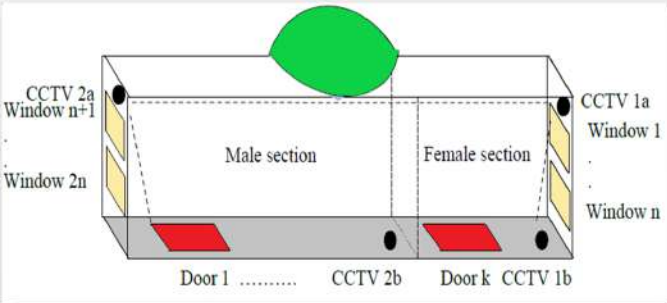
People In Side: 13 | Total Lights: 16 | Total Wattage: 720W
Max Usage: 5040 Watt | Total usage: 2340 Watt | Total Saved: 2700 Watt

Power Usage

CONCLUSION

This research perform the real-time analysis from the video stream to enhances the security issues in the building by exploiting the image processing algorithm with embedded platform of NVIDIA Jetson Nano developer kit. The results showed that the energy consumption can be saved up to 50% by detecting the peoples in the building using the embedded internet of things (IOT) features. SECURITY?

ACKNOWLEDGEMENT

SECURITY THREATS ON DATA CENTERS IN INTERNET OF THINGS NETWORKS

Lee Loo Chuan, Mardeni Roslee, Pang Wai Leong, Khairil Anuar

Center for Wireless Technology, Faculty of Engineering, Multimedia University

INTRODUCTION

The Internet of things (IoT) describes the network of physical objects—"things" or objects—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

IoT devices have many benefits which mainly include automated data gathering, monitoring and control in efficient way.
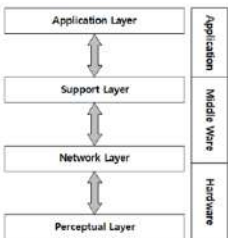
- IoT is made up of devices combining with the network. As the connected devices combining with automated systems, it will gather the information, analyse it and create an action.
- IoT devices share the sensor data they obtain by connecting to an IoT gateway or other edge system where data is either sent to the cloud to be processed or analyzed locally.
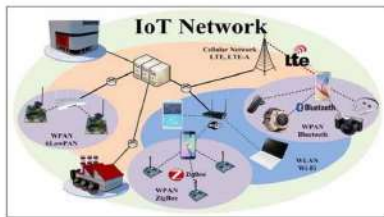
PROBLEM STATEMENT

- Security is one of the main concerns in IoT, which **not efficient and not being optimized.**
- There are **lack of analysis and algorithm** of experiment which requires a robust physical set up in order to reflect a systematic network of devices such computer networks and an IoT network.

METHODOLOGY

- Investigate the environment of data centers and IoT networking System
- Simulate, analyze and mitigate the effect of the attack environment for security purpose
- Model an algorithm and scheme, of attack on data centers and their mitigations strategy
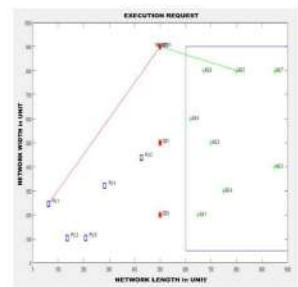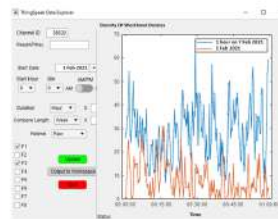

Designed Algorithm

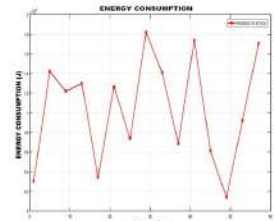## RESULTS AND DISCUSSION
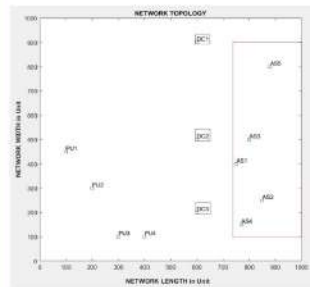
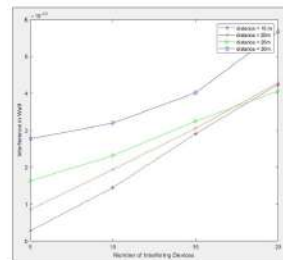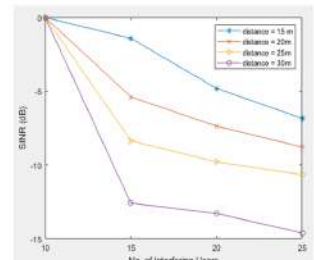Designed IoT Network Topology

Simulated Output

Data collected through IoT data explorer in Matlab

Energy Fluctuation Indicating the Presence of Attack

Power Signal Interference for various interfering nodes

SINR Against Number of Interfering nodes

Due to the rapid development of Internet of Things-based applications in the real world, the likelihood of security vulnerabilities in IoT environments is increasing. Therefore, it should be analysed and further minimised to the greatest extent feasible, and the suggested area of research examines the same situation in order to mitigate the effect of the assault environment, demonstrating how attacks on data centres are evaluated and how their mitigations are reducing for the same.

CONCLUSION

The work is concerned with the security algorithms for data efficency which is transferred to data centers for secure communications.

ACKNOWLEDGEMENTS

KEY FEATURES

This project has successfully designed a systematic set-up that can reflect the environment of DDoS Attack on an IoT network - New

SELF-OPTIMIZATION HANDOVER APPROACH FOR 5G HETEROGENEOUS NETWORKS

Mardeni Roslee, Abdulraqeb Alhammadi

Center for Wireless Technology, Faculty of Engineering, Multimedia University
Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia

INTRODUCTION

Fifth generation (5G) networks standardization efforts and its stringent coverage and capacity requirements, set to provide an unlimited user experience. Deploying ultra-dense small cells is an important approach in provisioning broadband data services for the 5G wireless systems. The implementation of 5G systems based on mm-wave bands where provides a small area coverage. That specifically will lead to hugely increased in handover (HO) Probability, HO failures, HO Ping-Pong (HOPP), radio link failure (RLF), outage probability, interruption time and throughput degradation. Thus, an efficient mobility robustness optimization is a required to provide a seamless communications over 4G/5G HetNets.


Next Generation HetNets
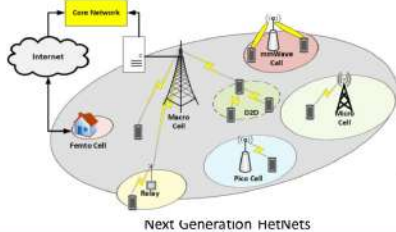
METHOD

Adjusting HO control parameters (HCPs): HO margin (HOM) and time-to-trigger (TTT) are a very important role during User equipment (UE)s mobility where improper configuration of HCPs causes HOF that leads to service interruption. The problem intend to be solved in this work is to reduce the probability of performance metrics such as RLFs and HOPP that happen during HO processes. The UEs' speed greatly impacts the HO performance, which can be used to make a proper handover decision from serving to target base station. When the user is moving at a high speed, the frequency of HO performance is high, leading to an increase in the probability of handover failure and then call dropped. To overcome this issue, this invention introduces a novel handover control parameter that able is optimized in accordance with user speed. The dependence of HO decision making on the UE performance parameters and type of the HO would help to boost up the performance of HO in the network at different user speeds and environments. The updated HOM and TTT should take place between the following range:

$$HOM = \{0,1,2,3,4,5,6,7,8,9,10\}\ dB$$

$$TTT = \{0, 40, 64, 80, 100, 128, 160, 256, 320, 480, 512, 640, 1024, 1280, 2560, 5120\}\ ms$$
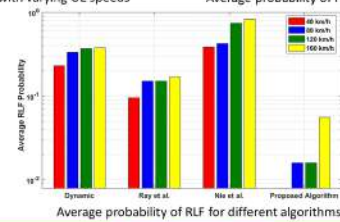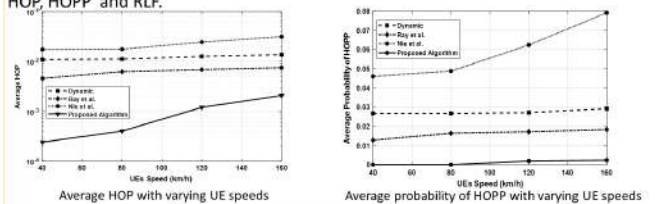
Updating means moving one step either forward (next value) or backward (pervious value) from the current value.

The novel proposed distributed algorithm automatically tunes HCPs based on UE speed and RSRP. The entity of distributed self-organizing network equips at each eNB that collects related data and periodically optimizes HCPs for each UE according to its condition. The flowchart illustrates the process of the proposed algorithm.

Framework of the proposed solution

Flowchart of the proposed algorithm
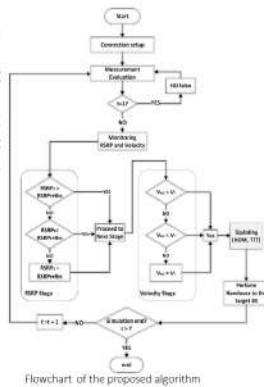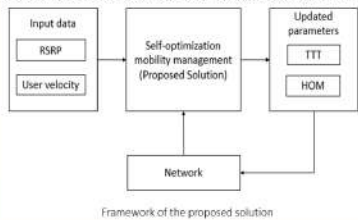
RESULTS AND DISCUSSION

The proposed algorithm was compared with different optimization algorithms: Dynamic, Ray et al. (load cell-based) and Nie et al.(speed-based). From figures below, it can be observed that he proposed algorithm provides the best performance and outperforms all the other algorithm due to it controls the HO based on RSRP and speed where able to reduce the mains KPIs: HOP, HOPP and RLF.

Average HOP with varying UE speeds

Average probability of HOPP with varying UE speeds

Average probability of RLF for different algorithms

CONCLUSION

Self-optimization HO algorithm is proposed to improve the HetNets performance. The proposed algorithm periodically adjusts the values of HCPs according to UE speed and RSRP. In addition, our algorithm reduces the total rate of all performance metric by more than 80% as compared to other state-of-the-art algorithms. It is concluded that the adjusting HCPs according to UE conditions becomes more efficient and effective technique for mobility management.

PUBLICATION

1. A. Alhammadi, M. Roslee, M. Y. Alias, I. Shayea, S. Alraih, and K. S. Mohamed, "Auto tuning self-optimization algorithm for mobility management in LTE-A and 5G HetNets," IEEE Access, vol. 8, pp. 294-304, 2019.
2. A. Alhammadi, M. Roslee, M. Y. Alias, I. Shayea, and S. Alraih,"Dynamic handover controlparameters for LTE-A/5G mobile communications," in 2018 Advances in Wireless and Optical Communications (RTUWO), 2018: IEEE, pp. 39-44.
3. E. Gures, I. Shayea, A. Alhammadi, M. Ergen and H. Mohamad, "A Comprehensive Survey on Mobility Management in 5G Heterogeneous Networks: Architectures, Challenges and Solutions," in IEEE Access, vol. 8, pp. 195883-195913, 2020
4. A Alhammadi, M Roslee, MY Alias, I Shayea, A Alquhali"Velocity-aware handover self-optimization management for next generation networks." Applied Sciences 10, no. 4, 2020.

ACKNOWLEDGEMENTS

INTELLECTUAL PROPERTY

Method And System To Manage Handover Between Base Stations For Seamless Connections, PI 2021001767

PI2021001767

KEY FEATURES

The objective of this invention is to introduce a novel velocity-aware self-optimization that able to optimize the handover control parameters such as user speed and signal strength. This is to adjust the handover margin and time to trigger in order to make appropriate handover decision to the another base station to avoid the link disconnection. This invention has a high impact to the telecommunication providers in Malaysia.

Green University of Bangladesh

Smart Inspection of Energy Installations (SIEI)

Project Leader – Dr. ASM Shihavuddin
Team Members – Md. Hasan Maruf, Dr. Ahmed Al Mansur, Md. Asif Ul Haq, Dr. Ratil Hasnat Ashique, Md Imamul Islam
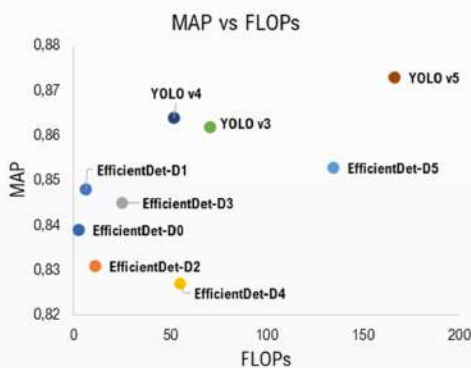
Input Images — Training steps — Applications
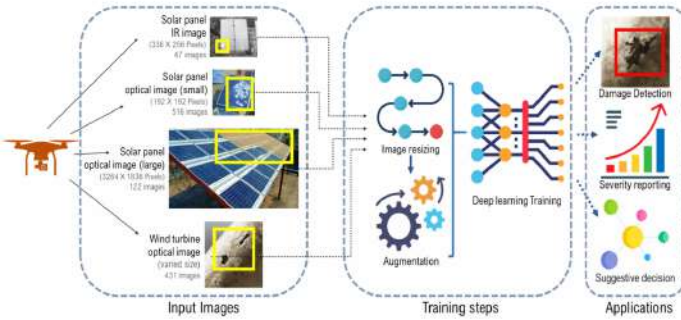
Abstract

To achieve a cost-effective structural health monitoring system, a holistic smart inspection implementation framework is required. Automated analysis of these inspection images can significantly reduce the inspection cost, provide effective detection mechanisms, shorten reporting time, as a result, reduce overall maintenance costs, and improve safety measures. We developed state-of-the-art deep learning-based inspection image analysis methods for surface damage detection of various renewable energy power plants with a single unified model. We achieved 0.79 mean average precision even where input images are of varied modalities: thermal to optical images, high- to low-resolution images, and PV panels to wind turbines.
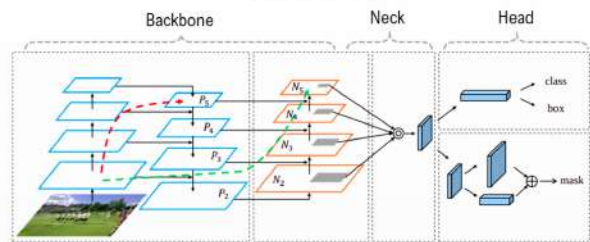
Methods

- YOLO – V5
- YOLO – V4
- YOLO – V3
- EfficientDet – D1
- EfficientDet – D2
- EfficientDet – D3
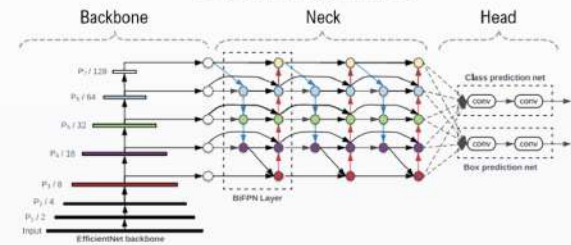- EfficientDet – D4
- EfficientDet – D5

Results

MAP vs FLOPs

YOLO Architecture

Backbone — Neck — Head

Efficient-Det architecture

Backbone — Neck — Head

Discoloration | Delamination | Corrosion | erosion | Broken VG
Glass Crack | IC failure | Hotspot | Cracks | Debris
Cell crack | Permanent soiling | Backsheet damage | Oil spillage | Damaged lightning receptor

PV Panels — Wind Turbine Blades

Highlights

- Collaborators – DTU wind, ULAB
- Green invention
- GEX 2021 - gold awarded
- Commercialization planned for future

Key points

- Utilization of drone images of PV and Wind installations for health inspection.
- Novel approach in PV and Wind turbine damage detection by object detection methods.
- Performance comparison of recent object detection techniques for damage detection.
- A trained model combining Infrared and drone imagery providing accurate results.
- A dataset of annotated damages in Solar and Wind power installations.
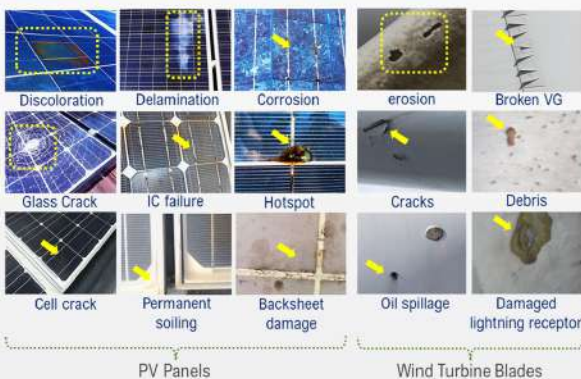
Reference

Shihavuddin, A.S.M., Rashid, M.R.A., Maruf, M.H., Hasan, M.A., ul Haq, M.A., Ashique, R.H. and Al Mansur, A., 2021. Image based surface damage detection of renewable energy installations using a unified deep learning approach. *Energy Reports*, 7, pp.4566-4576.

TM Group

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SMART STICK BASED EYETECH DIGITAL SYSTEM FOR MOVEMENT TRACKING USING ULTRASONIC TECHNOLOGY

Project Leader: Khadega Ahmed Mohammed Gubran[1]
Team members: Muna Rabea Salim Hanien[1],
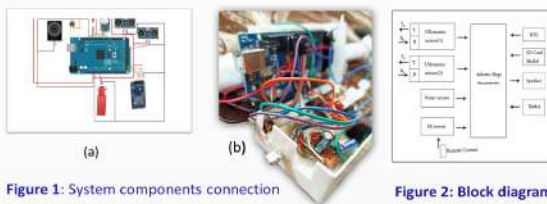Mohammed Salem Farag BinWahlan[1], Samir Salem Al-Bawri[2]
[1]Computer Science Department , College Of Applied Sciences, Seiyun University, Hadhramout, Yemen
[2]Space Science Centre, Institute of Climate Change, University Kebangsaan Malaysia (UKM), Bangi 43600, Malaysia

Abstract

There is no doubt that contemporary technology is the main factor in accelerating the growth and progress of societies worldwide. This project seeks to provide an affordable, lightweight, easy-to-use smart stick that serves the blind and helps them move from one place to another. The smart stick is developed to help the blind and visually impaired move easily in their environment. The stick is merged with a group of sensors and Arduino Mega microcontroller to receive and process sensors signals and issue an alert in a voice message that distinguishes the type of obstacles for the blind. The ultrasonic sensors have been used to detect obstacles in the way of the blind and differentiate whether they are small that can be bypass or big obstacles that are highly required to change the walking direction. The stick can also sense the water puddles; the proposed system contains a remote control and IR receiver to help the blind if it falls/lost nearby. The stick is equipped with an RTC module to easily allow the blind to know the time anywhere by clicking on the remote control.
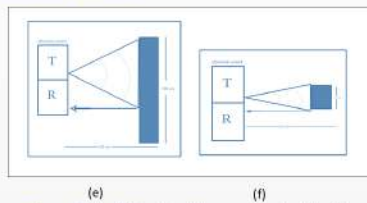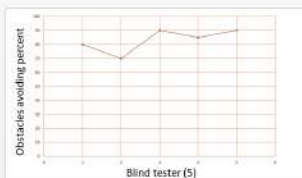
Problem Statement

Movement from one place to another is one of the most important challenges faced by the blind category, which is one of the most difficulties that hinder the practice of their daily lives, as they lose the sense of sight, and it is the bridge of communication between human and life, so they need someone to help them and provide them with much attention which they need. Finally, this project will solve several issues as follows:
1. A unique approach to utilize modern technology to serve blind people .
2. A developed technique that contributes to overcoming the expected obstacles surround blind people within freedom of movement.

Novelties

- Take the most important services in previous research and combine them into one product.

- Use the RTC module , transform the output data to voice message to give the blind people the ability to know the time easily.

System Configuration

Figure 1: System components connection
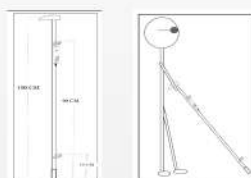(a): Circuit design (b): System prototype
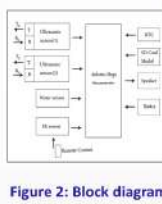
Figure 2: Block diagram

(e)   (f)
Figure 4: (e , f) Small and large obstacle detection

Figure 4:
Obstacles avoiding percent
vs blind tester

(c)   (d)
Figure 3: (c, d) Design of smart stick

System Components

Arduino Mega microcontroller - 2 Ultrasonic sensor - water sensor – IR receiver and remote control - RTC module- SD card module with memory 2GB -Speaker circuit - battery - wires - stick.

Advantages

- Sensing the obstacles in front of the blind at a distance of 1.5 meter and alerting him with a voice message specifying the type of obstacle and distinguishing it into:

1 - Small obstacles that can be overcome.

2 - large obstacles that require changing the direction of walk.

3 - There is a water puddles .

- provide a talking clock to be activated by clicking on the control device

- Locate the stick in case it falls or is lost in the surround of the blind by the remote control .

Conclusion And Future Work

Smart stick project take advantage of modern technology and adapting it to serve the blind people .It provides a reliable, easy-to-use, light-weight, and low-cost system. A real test was made for a 5 of blind people, and the results were positive, with a response rate and detection of obstacles ranging from 70 %to 90% .

To improve the aspects of the system, an IR sensor will be added in the future to sense pits and stairs . And GPS module to track the blind and lead him to new places. Solar energy will also be used to supply the system with energy to facilitate the charging process and help the blind people support their independence.

Publication

References

[1] K.S.Manikanta, T. S. S. Phani, A .Pravin "Implementation and Design of Smart Blind Stick of Obstacle Detection and Navigation System" International Journal of Engineering Science and Computing , vol.8 , number 8 , pp.18785 – 18789 , 2018.

[2] Ambika R, Dr. Sarika Raga, "VOICE ASSISTIVE SMART WALKING STICK FOR BLINDS USING GPS AND GSM TECHNIQUES" International Journal of Research and Analytical Reviews , vol.5, number.3, pp.671-677 , 2018.

[3] Ashraf Anwar , Sultan Aljahdali, "A Smart Stick for Assisting Blind People" IOSR-JCE , vol.19 , number.3 , pp.86 - 90 , 2017.
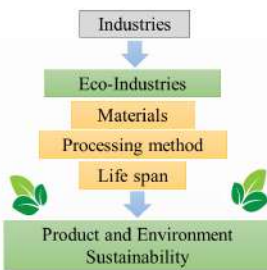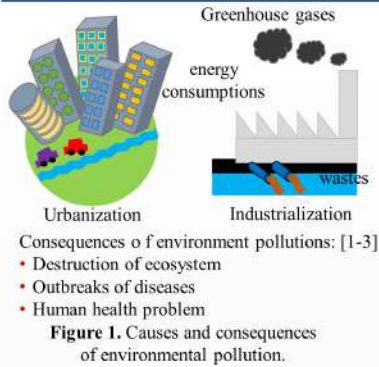
SEIYUN UNIVERSITY

TM Group

SURFACE MICROHARDNESS IMPROVEMENT AND FRICTION REDUCTION OF RECYCLED AA 6063 USING ENERGY-EFFICIENT FSP

Mr. Teo Guo Sheng, Dr. Liew Kia Wai and Dr. Kok Chee Kuang

Abstract

In this study, the surface microhardness and friction coefficient of recycled aluminium alloy 6063 were improved and reduced via an energy-efficient surface engineering technique known as friction stir processing (FSP). Different tool rotational speeds of 1200 rpm, 1400 rpm, 1600 rpm, 1800 rpm and 2000 rpm with a fixed feed rate of 30 mm/min were used to process this material. The effects of rotational speed on the microstructure, surface microhardness and friction coefficient of the samples were analysed. The results show that the samples produced at a stirring speed of 1200 rpm achieved the greatest enhancement of 25 % in surface microhardness and 33 % reduction in friction coefficient. This has significant implications for environmental sustainability as a relatively low rotational speed, hence a low energy input, is sufficient to enhance the surface properties of recycled aluminium alloy 6063. The benefits of superior tribological properties of recycled aluminium alloy afforded by such an energy-efficient surface engineering method include reduced exploitation of new resources, reduced carbon footprint, and enhanced product sustainability and durability.

Introduction

Consequences of environment pollutions: [1-3]
- Destruction of ecosystem
- Outbreaks of diseases
- Human health problem

Figure 1. Causes and consequences of environmental pollution.

Figure 2. Transformation of industries to eco-industries.

Friction stir processing (FSP)

- Energy efficient and environmental friendly surface engineering technique [4].
- Solid-state technique for surface composites fabrication [4].
- Applicable for wide range of materials such as aluminium alloy.

Recycled aluminium alloy

- Reduced 95 % of energy and 92 % of carbon footprint [5].
- Quality will not be impaired [6].
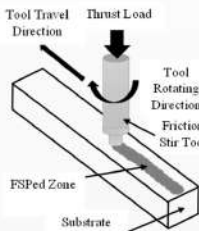- However, aluminium alloy has poor tribological performance [7].

Figure 3. FSP schematic diagram.

Methodology

- Material: Recycled AA 6063
- Method: Friction Stir Processing (FSP)
- Tool Designed: Taper Threaded FSP tool
- Rotational Speed: 1200 rpm to 2000 rpm; Feed Rate: 30 mm/min

Figure 4. Taper threaded FSP tool.

Figure 5. FSP actual process.

Results and Discussions

Microstructure

Stir Zone
- Grain refinement occurred.

Base Metal Zone

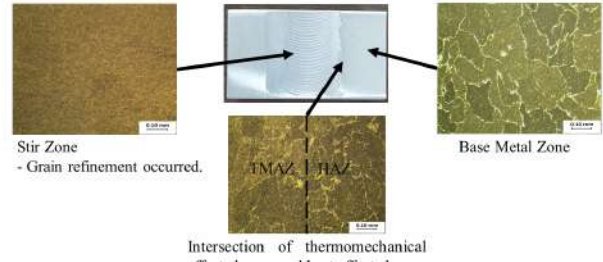Intersection of thermomechanical affected zone and heat affected zone

Figure 6. Microstructure of FSPed recycled AA 6063.
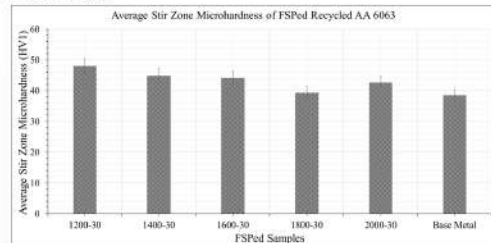
Surface Microhardness

Figure 7: Average stir zone microhardness of FSPed recycled AA 6063.

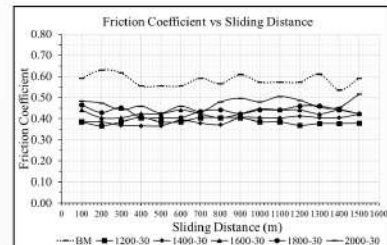### Friction Coefficient

Figure 8. Friction coefficient versus sliding distance for FSPed AA 6063 under starved lubrication conditions. (Normal contact pressure = 0.24 MPa, sliding speed = 2.88 m/s, total sliding distance = 1500 m).

Conclusions

- FSP is energy efficient and environmental friendly surface processing method and it was successfully enhanced the microhardness and reduce the friction coefficient of recycled AA 6063.
- Required relatively low tool stirring speed and feed rate (1200 rpm, 30 mm/min) to achieve maximum enhancement in FSPed recycled AA 6063
  - Microhardness: 25 % increment
  - Friction: 33 % reduction
- Pave the way to achieve Sustainable Development Goals (SDGs).

References

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[3] Appannagari R and Reddy 2017 Int J Humanit Soc Sci 3 152-60
[4] Gibson B T, Lammlein D H, Prater T J, Longhurst W R, Allun M C, Dharmaraj K J, Cook G E and Strauss A M 2014 J. Manuf. Process. 16 56-73
[5] Das S K, Green J A and Kaufman G 2010 Light Met. Age. 68 42-6
[6] Wallace G 2010 Production of Secondary Aluminium, Australia (Woodhead Publishing Limited)
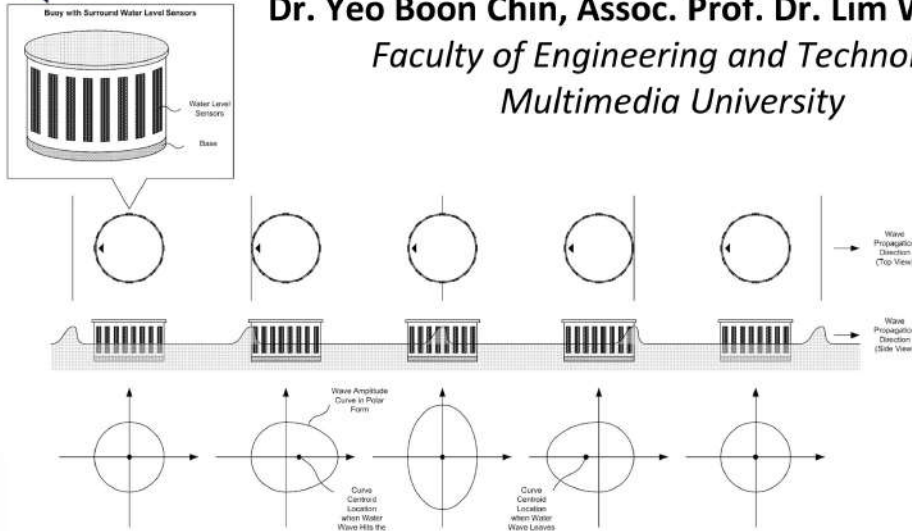[7] Devaraju A, Kumar A and Kotiveerachari B 2013 T NONFERR METAL SOC 23 1275-80

Acknowledgement

SURROUND SENSING-BASED WATER WAVE DETECTOR FOR BUOY

Dr. Yeo Boon Chin, Assoc. Prof. Dr. Lim Way Soong
Faculty of Engineering and Technology
Multimedia University
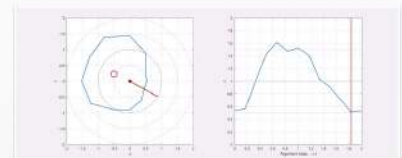
Patent Filed: PI2020002026

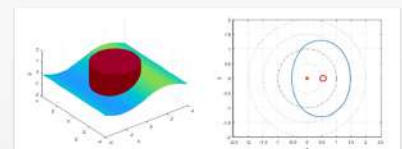## A Monitoring Device For Locating Surface Wave Source in a Liquid Body
With Surround Water Level Sensors & Shape-Shifting Oval-Shaped Real-Time Graph Generation and Analysis

The Prototype

Wave Direction Detection

Simulation

Overview

Reservoirs, dams, and lakes in Malaysia are important to provide water resources, generate hydroelectricity, and preserve biology diversity. Many illegal activities can happen around the areas such as illegal fishing, logging, swimming, wildlife crimes and illegal waste disposals into the water; and monitoring tasks can be challenging. Different water waves can be created from different activities. One of the solutions is to use the mobile floating device to monitor the activities on the water surface. Capturing the water waves will allow us to detect the abnormal situations. The floating device can also allow the monitoring process to be done at the middle of the lakes, where there is no place to mount the camera traps.

The Invention

The invention provides a monitoring device comprising a flotation body for enabling the monitoring device to float on a liquid surface. The flotation body has a plurality of sensing means disposed around its periphery such that when surface waves are propagating towards the monitoring device and contacting the plurality of sensing means along the periphery, each sensing means obtains an amplitude of the surface waves that come into contact therewith for computation by a processing means, wherein the processing means forms a pattern indicative of a first point of contact and a last point of contact between the surface waves and the periphery of the monitoring device for identifying a direction of a surface wave source.

Market Potential

A market survey report titled "Malaysia Industrial Water and Wastewater Treatment Market Outlook to 2022 - By Region (North, Kuala Lumpur, South and East, and Sabah and Sarawak) and By Industry (Agriculture and Food, Palm Oil, Oil and Gas, Electronics, and Others)" from Ken Research provides a comprehensive analysis on the Malaysia Industrial water and wastewater treatment market. The market trend for wastewater treatment will reach USD 700 million by 2022.

Awards & Exhibitions

Opportunity

- Pool Safety and Monitoring – Pool Alarm System
- Marine Monitoring – Tidal Waves and Pipeline Leakage Detection
- Water Reservoir Monitoring – Leakage and Intruder Detection
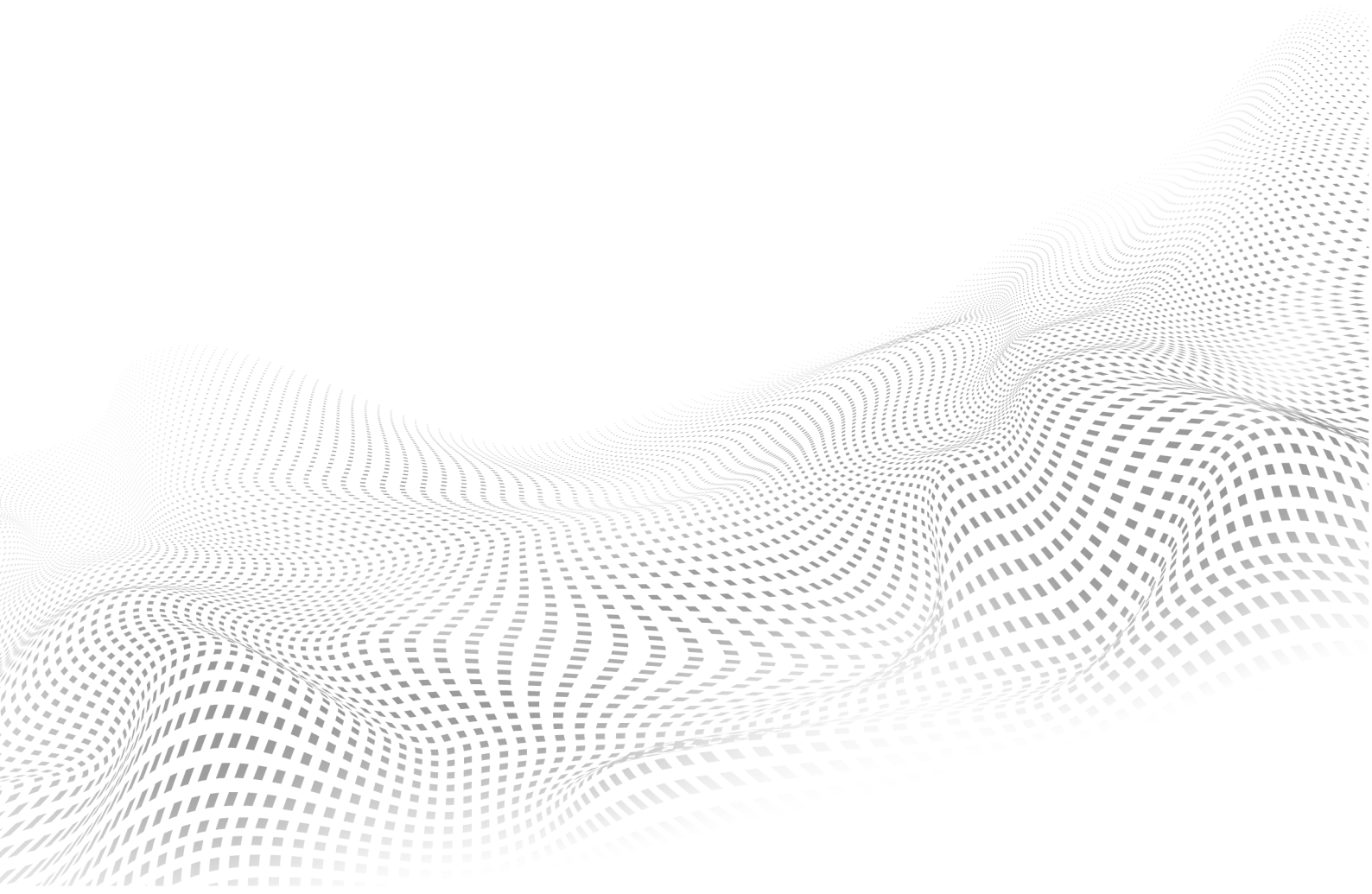- River Monitoring

Scan QR Code to View Video

ACKNOWLEDGEMENT

RICES 2021 Organising Committee
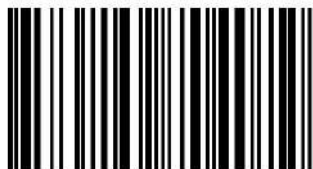
Units related:

All MMU Faculties
President's Office
VP Marketing & Communication Office
Corporate Communications Department
Network & Intelligent Campus Ecosystems (NICE)
MMU Production Team
Multimedia Product Innovation Unit
Media Support Unit
Facilities Management Department
Finance Division
Entrepreneur Development Centre (EDC)
MMU Staff Development Committee