



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Faculty of
Electrical
Engineering

**RESEARCH SIGNATURE
AT FACULTY OF ELECTRICAL ENGINEERING
UNIVERSITI TEKNOLOGI MALAYSIA**

Foreword

Welcome to the Research Signature Faculty of Electrical Universiti Teknologi Malaysia

The Faculty of Electrical Engineering has 14 research group , one Hi CoE and 3 CoEs. The research groups in the Faculty of Electrical Engineering are Advanced Control Research Group (ACRG), Acoustic Research Group (ARG), Advanced RF and Microwave Research Group (ARFMRG), Advanced Telecommunication Technology Research Group (ATT), Bio-medical Instrumentation Electronics (bMIE), Computational Nano electronics (CoNE), Digital Signal and Image Processing (DSIP) Light Communication Research Group (LCRG), Power Engineering Research Group (PERG), Power Electronics Drive Research Group (PEDG), Sonar Technology and Marine Instrumentation Research Group (STAR), VLSI-embedded Computing Architecture Design (VeCAD). Two research groups that under Research Alliance are Process Tomography and Instrumentation Research Group (PROTOM-i) and Micro Nano System Engineering Research Group (MNSE). The Hi CoE is Wireless Communication Centre and the three CoEs are Center of Artificial Intelligence and Robotic (CAIRO), Centre of Electrical Energy System (CEES) and Institute of High Voltage and High Current (IVAT). The contribution from the Research Groups and Centre of Excellences bring the faculty to stand tall in various fields of research to the Faculty of Electrical Engineering. In this phamplet the research signature of the research groups are highlighted. With this information closed collaboration and synergy between the industries and Universiti Teknologi Malaysia will be held and implemented. Lastly, I wish to thanks especially to FKE Research Manager, Facility Manager and all research groups who have contributed towards producing this phamplet and I hope this compilation will be useful to all.

Best Regards, Salam



Prof Dr Mohamad Kamal A Rahim

Deputy Dean Research Innovation Network and Community

Faculty of Electrical Engineering

University Teknologi Malaysia

2017

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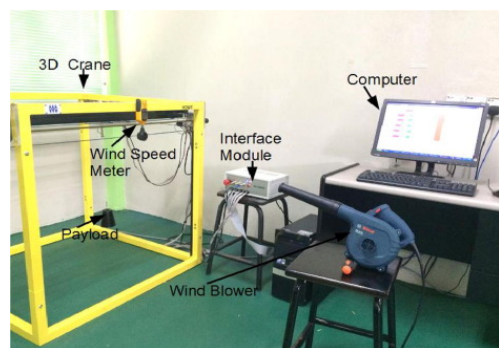


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RESEARCH AREAS

The research involves many areas in control, mechatronics, robotics and instrumentation engineering which include modeling and control of advanced mechatronics systems including robots, process control, control theory, control and automation in agriculture, intelligent control, network control and advanced sensors and actuators. The ACRG is interested in the fundamental issues on design, simulation, optimization and control of various application. Future work in the group will primarily focus on the National Key Economic Areas (NKEAs) sectors including energy, agriculture, and palm oil and rubber.

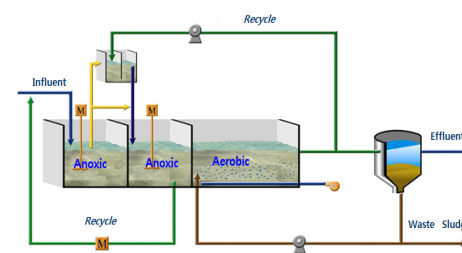


A laboratory 3D overhead crane

Sway Control of a 3D Overhead Crane with Payload Hoisting and Wind Disturbance

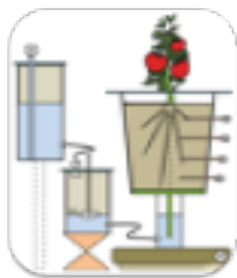
In practice, payload hoisting is a common operation and this action also generates unwanted crane motions such as load bouncing, twisting and swinging. Furthermore, an external disturbance such as wind is another factor that considerably affects the payload sway. These sways may also result in accidents and damages to the neighbouring facilities. As precise payload positioning and sways control of a crane is difficult especially with hoisting and under the influence of external disturbances, the crane operation is not automatic and continuously requires an operator to monitor the crane during operation. An effective control is required to achieve safety and effectiveness of crane operations. Development of an efficient controller for reduction of payload sway is desirable as this will reduce complexity of designing a controller for both position and sway control.

Wastewater treatment plants (WWTPs) are mainly affected by large disturbances and uncertainties related to the influent wastewater's composition. The plants naturally aim to remove suspended substances, organic material and phosphate from the water before releasing it to the recipient. Generally, there are three different steps involve in the WWTPs include mechanical treatment, biological treatment and chemical treatment. The best technology available to control the discharge of pollutants proved in biological process. In conjunction, an advanced control strategies are highly demanded in improving or at least in maintaining the effluent quality where optimization of nitrate and/or ammonium removal are stressed. Modeling and identification aspect besides selection on control variables, control structures and strategies play significant part in optimizing the control objectives and hence ensuring a good control performance.



Control of Wastewater Treatment Plants

Wastewater Treatment Plant

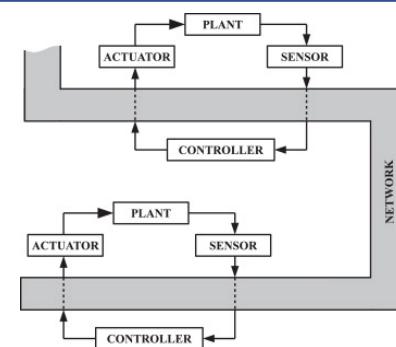


Experimental setup for the irrigation system

Adaptive Control Strategies for Infiltration Process in Fibrous-capillary Irrigation System for Water-saving Agriculture

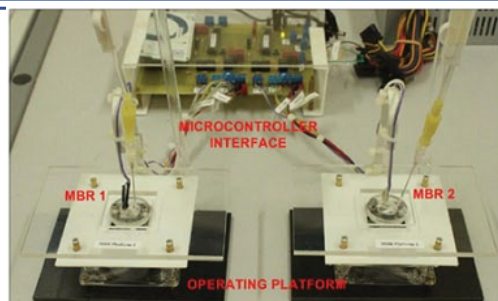
Fresh water deficit will become crucial and the world will face the crisis in the next 10 years when the world population exceeds 8 billion. Agricultural activities which consume more than 70% of the fresh water are in great threat. Thus, water saving system is becoming a key technology in irrigation management practices and practically significance to sustain the agricultural supplies in future. A site-specific irrigation system has been emphasized to meet the plant water demand sufficiently for healthy growth while minimizing all possible losses.

Networked control systems are real-time systems where sensor, controller and actuator data packets are transmitted through a shared communication network forming a closed loop system. with the advancement of high-speed low-cost micro-computing technology, the possibility of operating at very high frequency which implies higher bandwidth availability has further attracted the application of this network communication in control system development and becoming more prevalent in many high-end applications such as spacecraft, unmanned aircraft, automotive and factory automation.



Configuration of Networked Control System

Controller Area Network in Networked Control System



Low-Cost Microcontroller for Data Acquisition and Control of Microbioreactor



Quadrotor Unmanned Aerial Vehicle Laboratory Testbed

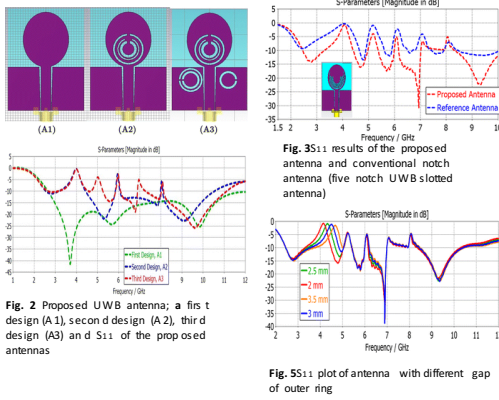


Membrane Bioreactor System Experimental Setup



Research Area

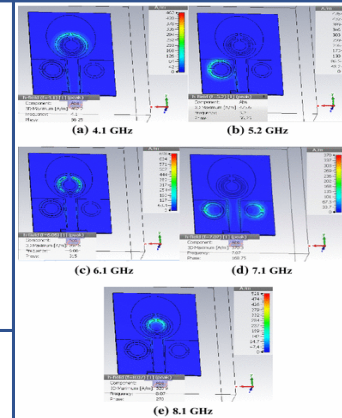
RF and Microwave, Planar and dielectric antenna, active antenna, array antenna, electromagnetic band gap (EBG), left handed metamaterial(LHM), artificial magnetic conductor(AMC), frequency selective surface(FSS) and RF Microwave devices, Reconfigurable antenna



FLEXIBLE ULTRA-WIDEBAND ANTENNA INCORPORATED WITH METAMATERIAL STRUCTURES: MULTIPLE NOTCHES FOR CHIPLESS RFID APPLICATION

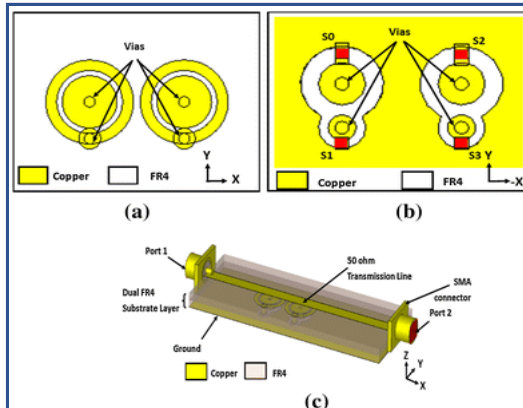
A coplanar waveguide (CPW) ultra-wideband (UWB) antenna incorporated with metamaterial—split ring resonator structure—that operates from 3.0 to 12.0 GHz is proposed for chipless RFID tag. The 30 mm × 40 mm flexible chipless RFID tag is designed on the fleece substrate ($\epsilon_r = 1.35$, thickness = 1 mm and $\tan \delta = 0.025$). A six-slotted modified complementary split ring resonator (MCSRR) is introduced into the ultra-wideband antenna to produce multiple band notches at 3.0, 4.0, 5.0, 6.0 and 7.0 GHz. The frequency shifting technique is introduced for designing a high-capacity chipless RFID tag with compact size. Each MCSRR is able to code in four different allocations (00, 01, 10 and 11). To achieve encoding of 10-bits data (10,234 number), six MCSRRs are proposed with three-slotted MCSRR in the radiator and three-slotted MCSRR in the ground plane.

A novel RF barcode tag using monopole antenna with modified complementary split ring on fleece substrate that operates between 3.0 to 12.0 GHz with 10 bits of data has been designed and analyzed. The concept of modified complimentary split ring resonator is proposed to miniaturize the size and reduce the space consumption for chipless RFID application. The compact, flexible and lightweight chipless RFID based on MCSRR has the potential to be produced for wearable application. The final designs will be measured with two reference antennas for radio cross-section (RCS) measurement and S_{21} insertion loss as future work.



Current distribution at five different frequency bands (4.1, 5.2, 6.1, 7.1 and 8.1 GHz)

Metamaterial with chipless RFID application



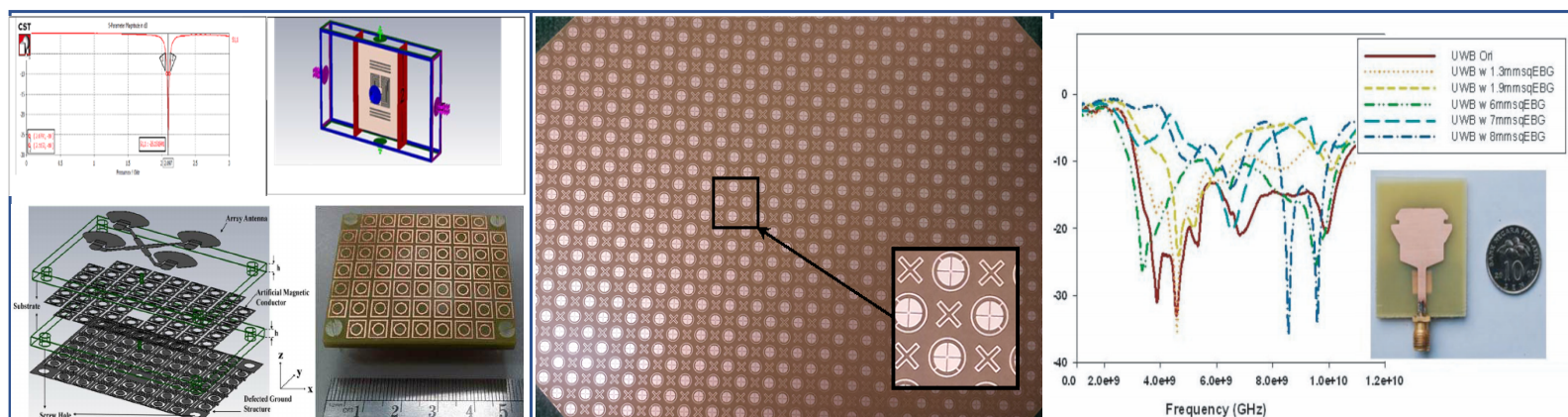
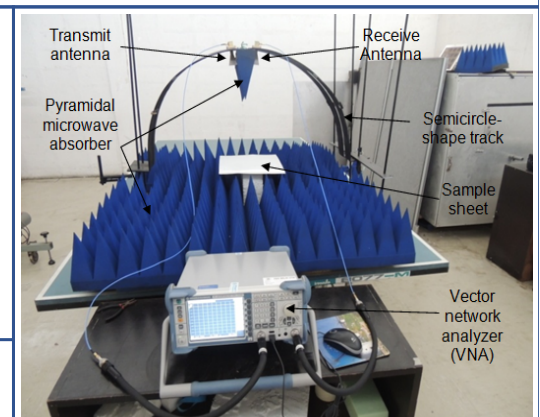
Metamaterial Devices

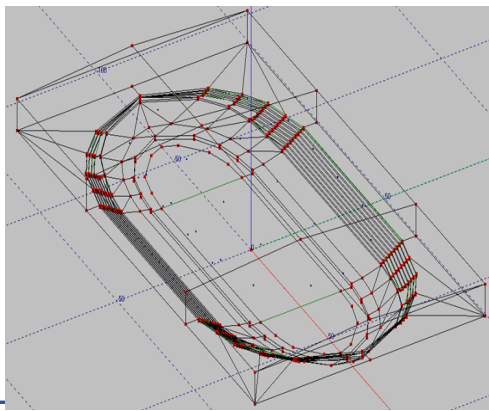
Electromagnetic wave is a kind of energy that is invisible by nature. To deal with this invisible thing, many devices have been developed to read and display its characteristics and in the same time to make use of this kind of wave for human benefit. One of the devices is metamaterials. Metamaterials are devices that have special characteristics to interact with this electromagnetic wave such as to absorb, reflect, direct, or even trap the wave. The development of metamaterials in our lab is practically “the art of design” using printed boards. From the optimized design using computer simulator software, the design is then transferred to the real substrate for fabrication process. The final products will be tested for performance validation.

Keyword: metamaterials, EBG, AMC, Left-handed, Absorber

The development of metamaterial devices is very useful in the electromagnetic field. There are four examples of metamaterial devices that are developed at our lab. Firstly is electromagnetic band gap (EBG) which is typically designed to filter unwanted signals. Secondly is artificial magnetic conductor (AMC) which is typically reflecting the electromagnetic wave in phase for development of highly efficient artificial ground planes. This device is suitable to improve the radiation pattern of antennas. Next is left-handed devices where it is typically used to focus the electromagnetic wave like a lens. This device is suitable for designing high gain antennas. Lastly is absorbers which are typically used to absorb the incident electromagnetic wave for a specific range of frequency.

Metamaterial Devices: AMC, EBG, Left-Handed, and Absorber

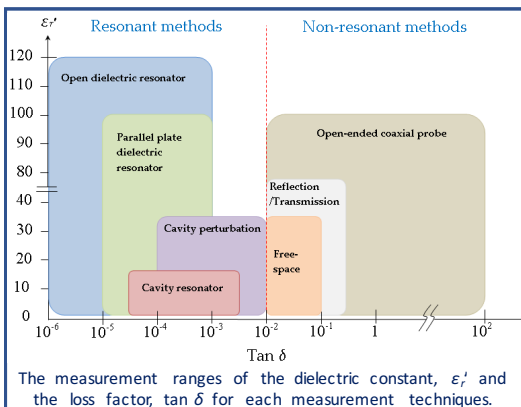
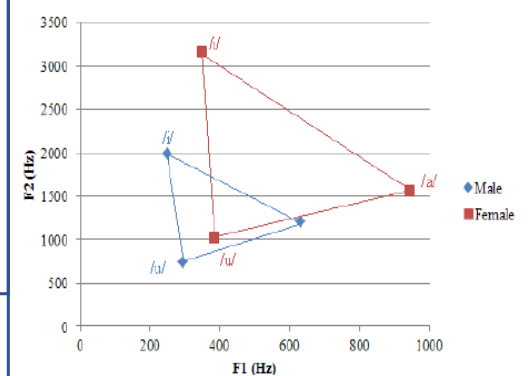




Characterization of Speech Intelligibility of Malay Words in Reverberant Environment

The cost to rectify the speech intelligibility problem in reverberant room such as large mosques, conference, and multipurpose rooms is always high. Sometimes, the solution to the problem is not practical and economic. Moreover, speech quality to be achieved in the room to be built was put objectively in the term of reference (TOR) even though the listening judgement from the listeners who use the room are always final. The challenge here is that, the listening judgement of listeners is subjective. In addition, researches have found out that the output of listening judgement varies from one language to another. Therefore it is needed to develop Malay words speech intelligibility prediction model that includes both objective and subjective parameters (listening judgement from listeners).

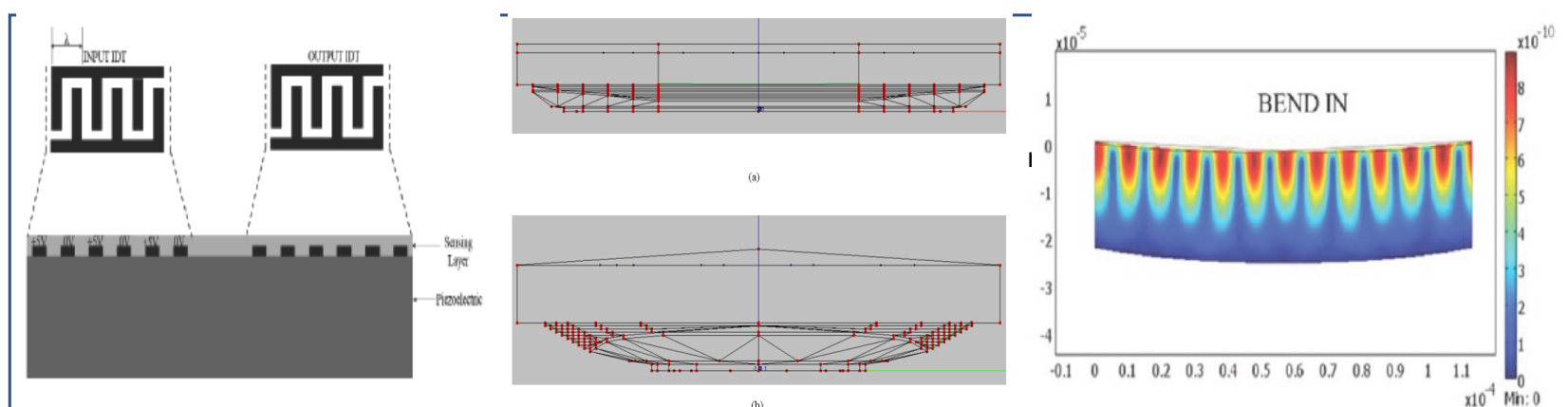
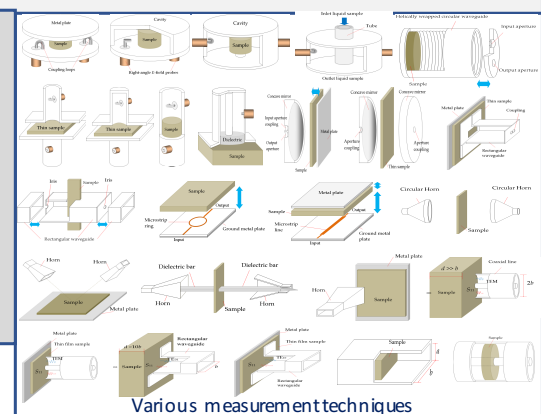
The algorithms from this research will be useful for predicting correct speech intelligibility as early as room design stage. This will eliminate wastage due to room treatment to treat poor speech clarity. Not only to Malay language users, indeed, the nation can empower the algorithms to other polysyllables language users such as Indonesia, Brunei and Philippines.



Materials Characterization Using Microwave Waveguide Techniques

For macroscopic characterization, three properties of the material are often tested: Complex permittivity, complex permeability and conductivity. Based on the experimental set-up and sub-principle of measurements, measurement techniques can be categorized into either resonant technique or non-resonant technique. A free-space and transmission/reflection measurement techniques are grouped in the category of non-resonant methods. Although various measurement techniques are available to be used, choosing the appropriate technique requires some other factors to be considered in the selection of technique, such as accuracy, cost, samples shape and operating frequency.

Recently, there has been an increased interest in the determination of dielectric properties of materials at microwave frequencies range. The important roles of these properties in the construction of high-frequency electronic components, the superconducting material properties, the quality of printed circuit board (PCB) substrate, the efficiency of microwave absorption materials, metamaterial characterizations, food-chemical processing and the performance of dielectric antenna design appeared to be the main reason that lead to increasing interest.





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Perbadanan Harta Intelek Malaysia
Intellectual Property Corporation of Malaysia

TRADE MARKS ACT 1976
TRADE MARKS REGULATIONS 1997
CERTIFICATE OF REGISTRATION
(Regulation 56)

TelG Mote

Trade mark no : 2014001383

To : Universiti Teknologi Malaysia

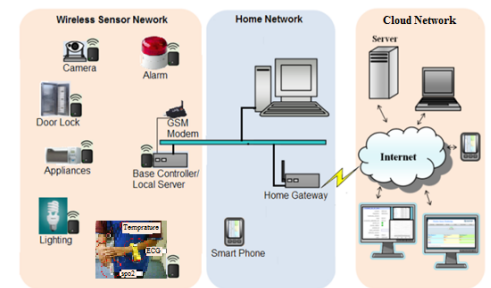
I HEREBY CERTIFY THAT under the provisions of the Trade Marks Act 1976 and the Trade Marks Regulations 1997, the above-numbered trade mark has been registered in the Register for a period of ten (10) years from 04/02/2014 to 04/02/2024 in Class 9 in respect of the following goods:



TelG Mote

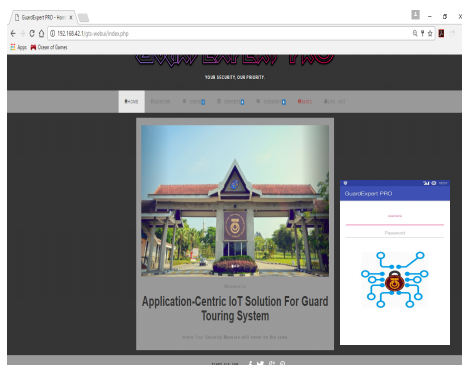
TelG mote, which is a proprietary to ATT RG, is designed to enable cutting edge research and development in wireless sensor network (WSN). It has low power consumption and low data rate. It has been designed using XBee RF modules and is ideal for application requiring low latency and predictable communication timing. TelG mote enables robust multi-point, multi-hop connectivity as well as facilitates mesh network topology for maximized wireless performance and ease of development.

TelG motes form the WSN in the development of a Smart Home and Ambient Assisted Living (SHAAL) system which is a residential setting equipped with sensors and automated devices specifically designed for care delivery, remote monitoring, early detection of problems or emergency cases and promotion of residential safety and automated living. The cloud network in SHAAL system holds the server where the sensed data is stored and updated for remote access on the Internet.



SHAAL system

Signature Project/Research #1



Internet of Things (IoT) Applications

Internet of Things (IoT) allows for remote data control across wireless network infrastructure and is a catalyst for increasing application areas for Internet connected automaton. It is a system composed of smart objects or sensors which are identifiable, able to communicate and interact, either among themselves, or with end-users or other entities in the network, for ubiquitous real-time information services.

ATT RG is involved in the developments of several IoT application initiatives such as Smart Living, Environmental Monitoring, Smart Transportation, Sports Monitoring, Healthcare Monitoring, Smart Energy Management, Smart Poultry Farming as well as Smart Security and Access Solutions. The developed IoT applications can be monitored and accessed via any types of end user devices such as smartphone, laptop, tablet and PC from three different platforms; Windows, Web-based and Android.

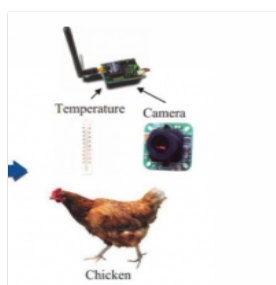


Wireless Water Quality Monitoring Module Using IoT

Signature Project/Research #2



IoT in Healthcare
(Spine Monitoring Module)



IoT in Farming
(Poultry Farm Wireless Monitoring System)



IoT-based Sport Monitoring System



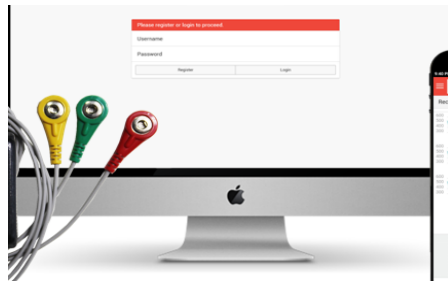
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Mini Heartcatcher
Web-based arrhythmia detection

MINI HEARTCATCHER

Conventional medical grade Holter is too expensive and returns the assessment results after days. Due to the price, patients will rent it from hospital and most of the time, patients are unable to record any abnormal signal during the rental period and thus, cardiologists are unable to make any diagnosis. We developed a heart recorder that transmits the data wirelessly to a mobile phone and the internet. Heart rhythm can be analysed immediately and users will be alerted if an abnormal signal is detected.

Cardiovascular disease is causing 17.5 million deaths per year with a global economic burden of nearly USD850 billion in healthcare and lost productivity costs. More than 75% of cases occur in low and middle income countries. While early treatment can prevent premature deaths, most people in lower income countries do not get early screening due to the high costs of healthcare devices. The Mini Heartcatcher is aimed to provide an affordable option to monitor and screen for possible heart problems, so that patients can receive early treatment, prevent stroke and reduce healthcare delivery costs.



1st Place in Telemedicine Innovation Challenge
1st Place in Microsoft Imagine Cup
TM Innovation Award 2014

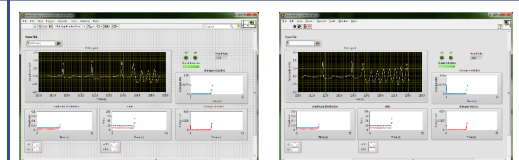


Best of the best award and gold medal at INATEX

ASIC DESIGN OF SUDDEN CARDIAC ARREST MONITORING

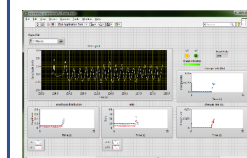
The product is based on project that developed a system which could classify cardiac arrhythmias segments accurately. The complete prototype can track the behaviour of ECG signals that is useful for cardiac monitoring either in real-time or off-line. The developed system allows for more efficient monitoring of patients in which it can determine the onset of occurrence of ventricular arrhythmia by studying the alteration behaviour patterns of ECG signals. Product features include hardware design of which the extracted features are to be monitored.

This product can be a catalyst for developing an early warning system for cardiac sudden death. Currently, effort has been made by various researchers to have this kind of technology. We believe second order dynamics algorithm may break the barrier as it directly deals with oscillatory behavior of human heart. Additionally, patients can maintain their regular activities with increased mobility and their stress is reduced because their data can be wirelessly transmitted to the medical system, thus allowing immediate analysis, lower cost, and easier monitoring.

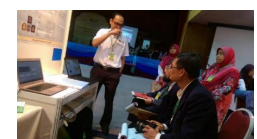


VT/VF onset indicator

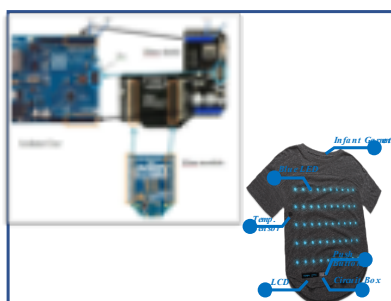
VT/VF onset indicator



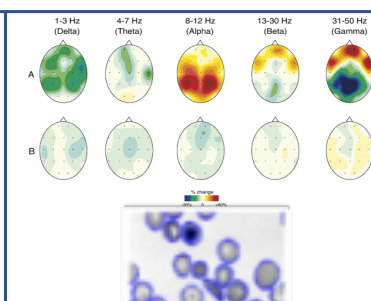
VT onset detected



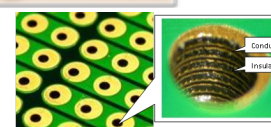
Industrial presentation



Electronics and Biomedical Instrumentation



Biomedical Signal and Image Processing



Bio-sensors



Rehabilitation

Computational Nanoelectronics (CoNE)



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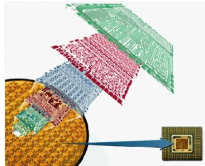
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Research Area

Advanced simulations and analysis, Design, modelling and simulations of strained silicon based devices, Development of silicon and carbon based materials, Circuit level modelling, Analog CMOS circuit design, biomolecular sensing, DNA chip, Single Photon Avalanche Diode (SPAD) as an imaging sensor, Graphene based sensors, Zinc Oxide nanowire and thin film fabrication for sensor devices, Nanocrystalline graphite device for sensor applications.



Gordon E. Moore

Scaling Transistor by Gordon E. Moore

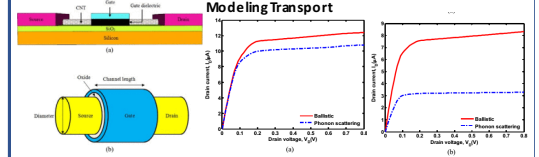
THE SCALING OF TRANSISTOR

Moore's Law stated that the number of transistor on a chip of constant area will be doubled approximately every two years. Moore's Law is used as a reference in scaling down the transistor and become the guideline for new concept of semiconductor device. The scaling of transistors allow the circuit to run at a faster speed and the increased of Metal-Oxide-Semiconductor Field-Effect-Transistor (MOSFET) density enable more complex applications in a chip. The conventional MOSFET has reached its limitation for further scaling down. The transformation of transistor have to play a role to obey Moore's Law. Hence, a alternative structure of transistor or new material are needed to extend Moore's Law. The new idea in revolution of transistor can be appropriated to overcome scaling problem of a transistor.

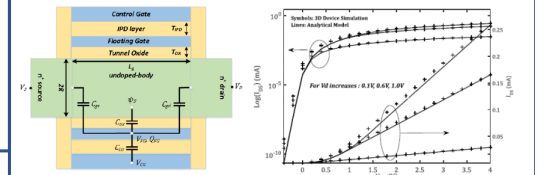
The miniaturization of nano-scale electronic devices of MOSFETs, has given rise to a pressing demand in the new theoretical understanding and practical tactic for dealing with quantum mechanical effects in integrated circuits. This project includes mathematical models and computational algorithms for the simulation of nano-scale MOSFETs. TCAD device simulations and compact physic-based modelling such such as ballistic transport, nanowire, carbon nanotube, graphene, nanoscroll, nanobelt, superlattice strained etc on emerging device structures and materials are done in understanding the physics and its electrical behavior/characteristics for MOSFET, bio-sensor and flash memory cell applications.

Modeling and Simulation of Nano-Electronics Device

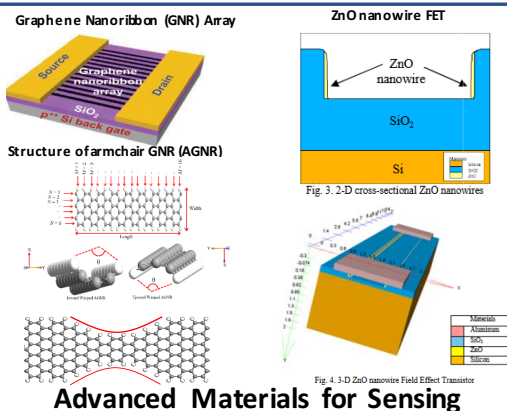
Structure and IV characteristics of CNTFET and SiNW-FET Non-ballistic



Compact Modelling of s-FGMOSFET



Simulation and Compact Model



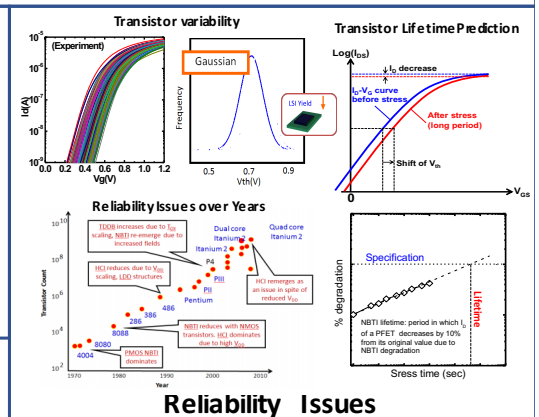
Advanced Materials for Sensing

Advanced Materials For Nano-Electronics Device (TCAD Simulation, fabrication and characterization for various sensing applications)

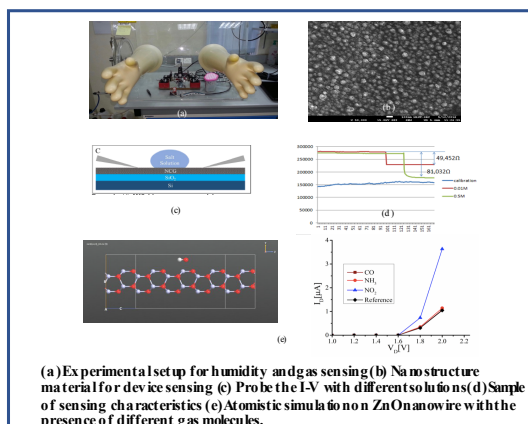
Several device technologies known as "Technology Boosters" such as introducing new materials which is non-Silicon such as CNT, Graphene, Phosphorene, Graphene Nanoribbon, ZnO nanowire are developed. The introduction of new materials is needed to augment and ameliorate the classical CMOS process/devices that can provide reliable device performance. The focus is on the nanoscale energy transport and its applications in nano-electronic devices, as a combination of theoretical and experimental/fabrication studies. The novel sensing behaviour (as well as DNA sensing) of these devices will create new opportunities in solid state sensing development.

Nano-reliability is extremely important due to the fact that the scale of electronic devices continues to decrease. The ability to predict lifetime require a deep understanding of the reliability physics. Understanding the failure mechanisms will ensure that there are no surprises lurking to cause premature failure. The focus is on the reliability concerns in material, interface and specific devices. This involves with Time dependent dielectric breakdown (TDDDB), Negative Bias Temperature Instability (NBTI), and Hot carrier degradation (HCI).

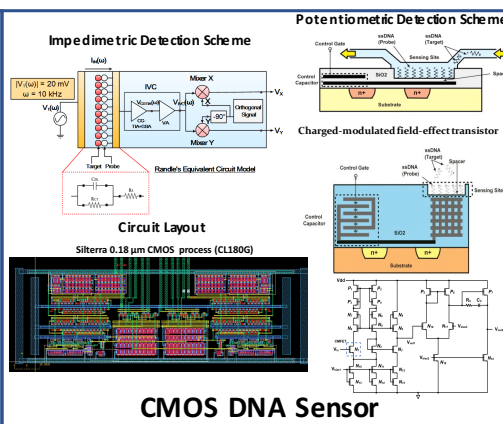
Reliability Physics of Nano-Electronics Device



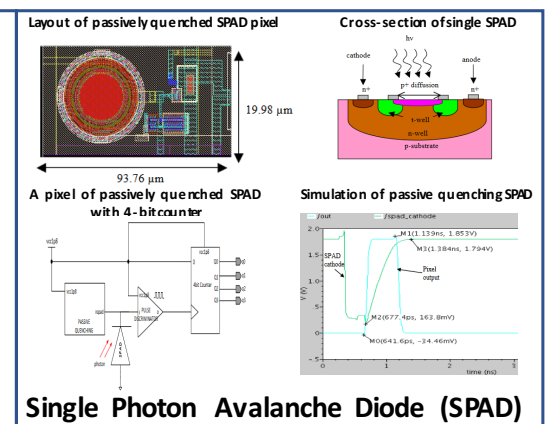
Reliability Issues



(a) Experimental setup for humidity and gas sensing (b) Nanostructure material for device sensing (c) Probe the I-V with different solutions (d) Sample of sensing characteristics (e) Atomistic simulation on ZnO nanowire with the presence of different gas molecules.



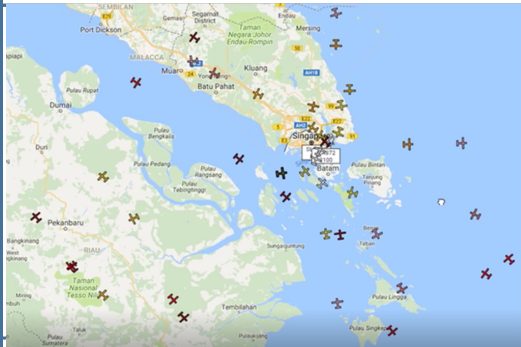
CMOS DNA Sensor



Single Photon Avalanche Diode (SPAD)



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Air traffic situation over Johor, Singapore and Indonesia.

Wireless Positioning for Asset Tracking and Intrusion Detection

Applications can be found in civil aviation, maritime, defense and homeland security well as in other variety of applications and services such as enhanced-911, improved fraud detection, intelligent transport systems and improved traffic management. From the emitted electromagnetic signals, position of assets can be estimated by intercepting and performing analysis on these signals and perform identification from the signal parameters. By employing multiple receivers, the spatial difference between the intercepted signals can be exploited by estimating the difference between the received signal strength (RSS), angle of arrival (AOA) and time delay of arrival (TDOA) to determine the position of the tracked object.

Significance of Work:

Active implementation such as radar due with its relatively high transmit power is not suitable for applications such for indoor use and has a potential for causing interference or health hazards to potential users. Other passive technology such as global navigation surveillance system (GNSS) has some limitations such as high power consumption, blocking of the RF signal by foliage and buildings. The technology investigated is therefore environmental friendly with low power consumption, low installation and maintenance cost, and no RF interference.



Keynote address at the Keysight Measurement Forum 2017.

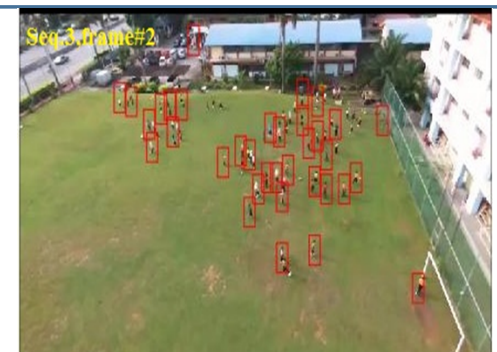


Video Analytics for Object Detection, Identification and Classification

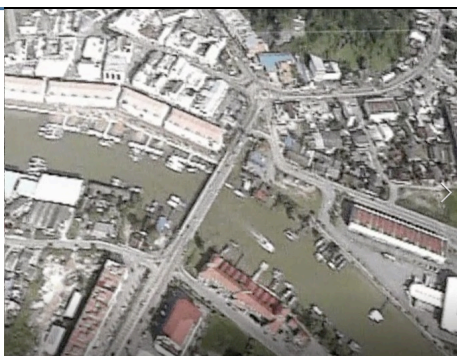
Video surveillance is widely for traffic monitoring, facility protection, public safety, border patrol, and homeland security. The quality of manned continuous video surveillance will downgrade due to fatigue and lack of concentration which could result in missing of critical events. Current practice of surveillance based on recorded video only allows action to be taken after critical events have taken place and not as when they occur. With daylight vision and thermal imaging technology, a smart vision system with video analytics allows round the clock detection, positioning and classification of critical events which allows the authorities to take immediate action.

Significance of Work:

Automatic video surveillance requires video analytics to make real-time decisions. Current approaches are limited in terms of the ability to perform video content analysis with high accuracy and in timely manner. The developed technology has improved algorithms for various domains of content analysis including video enhancement for object detection, shape recognition, tracking, action recognition and content-based retrieval for higher accuracy and faster response time to triggered events. Such advancement is beneficial to many surveillance applications thus providing enhanced situation awareness.



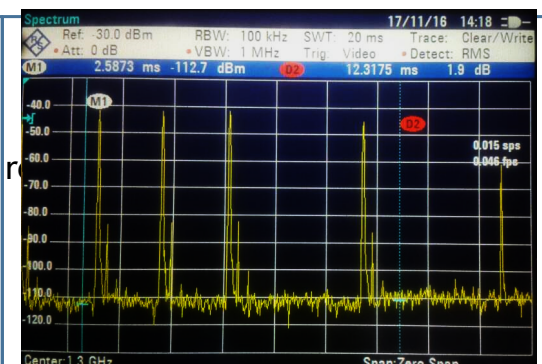
Crowd detection



Aerial video enhancement



Networking with collaborators



Analysis of captured radar signal

Lightwave Communication Research Group
Faculty of Electrical Engineering
Universiti Teknologi Malaysia
Skudai, Johor
<http://www.fke.utm.my/research-groups/lcrg/>



Harnessing The Power Of Light

ACTIVITIES AND SERVICES

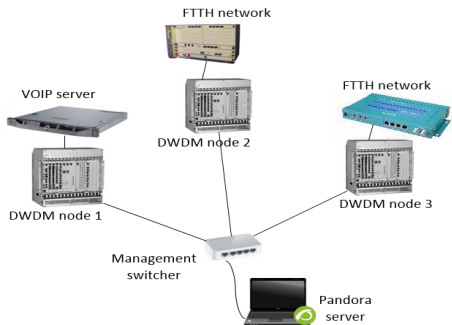
R&D and consultation services related to optical devices and system
Collaboration with research institute, industries and communities
Hands-on training in optical fiber cabling and networking

NICHE RESEARCH AREAS

Polymer and sol-gel based optical devices technology
Radio over fiber and free space optical communication
Optical network routing and transport system
Optical sensor and applications in industries

GROUP MEMBERS

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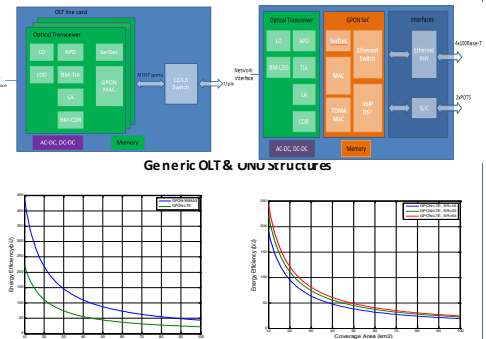
Optical Core-Access Network Testbed

Optical Communication and Networking

Optical communication revolutionizes the way we communicate by allowing high speed and reliable long distance data transmission at a considerable cost. Optical communication has now emerged to support networking functionalities instead of merely a high capacity transmission medium. Early deployments involved applications in the core network to increase transport capacity over longer distance. However, as optical elements are getting mature and economic, the applications of optical communication and networking are brought closer to the user (FTTH). Issues such as upgradability, reliability and energy efficiency are among major concerns to be addressed in both core and access optical networks.

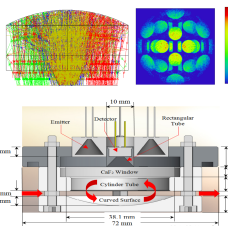
Passive Optical Networks (PON) is a promising and cost effective solution to provide fiber to the home (FTTH).based services. In order to facilitate for the increasing traffic growth, next generation PON is introduced that aims to support for longer fiber distance and higher splitting ratio. increasing attention is given on the dynamic bandwidth allocation algorithms to ensure fairness in the upstream bandwidth. Apart from that, energy efficiency is also a major concern in PON considering the high no. of its network elements, ONU in the network. Meanwhile, integration PON with wireless networks allow the high mobility feature to be incorporated in PON.

Research in the Next Generation Gigabit Passive Optical Networks (GPON)



Energy Efficiency Study in GPON-Access

Design and simulation



Prototype



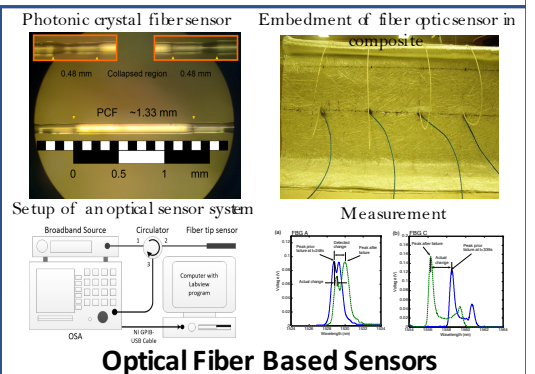
Optical Spectroscopic Based Carbon Dioxide Sensor

Optical Sensor and Applications

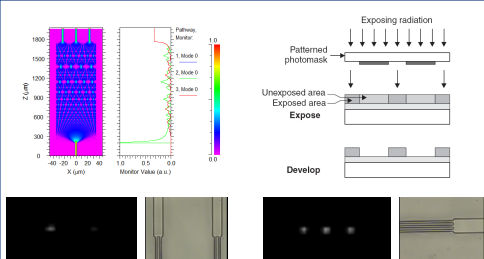
Optical sensor is a promising technology which uses light to detect physical/chemical element such as temperature, strain, pressure, vibration, pH, gasses and humidity. Optical sensor plays a critical role in meeting the needs of our evolving technology. Number of sensing techniques have been successfully developed by LCRG including spectroscopic, interferometric, intensity and wavelength based techniques. The developed sensors potentially can be applied in various engineering and biomedical applications. Research in of optical sensor is aimed for low cost, practicality and superior sensing performance compared with the electronics counterpart.

Optical sensors overcome limitation of existing electronic sensors due to its advantages such as small size, free from electromagnetic interference and able to perform in harsh environment. For example a thin fiber optic strain sensor with thickness of 125 μm can be easily embedded into composite structure without affecting integrity of host structure while survive during vacuum infusion process. The embedded optical fiber sensors give accurate measurement of internal strain of composite layers when undergo mechanical test which is not possible with conventional piezo or electronic sensors.

Optical Fiber Sensors and Application in Structural Health Monitoring



Optical Fiber Based Sensors



Hybrid Sol-Gel Based Optical Devices



Commercialized Products in News



Hands-On Certified Training



**MICRO-NANO SYSTEMS ENGINEERING
RESEARCH GROUP**

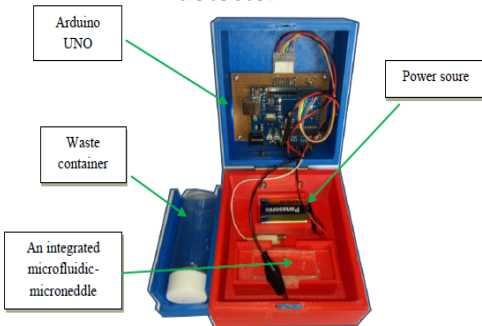
RG leader: Assoc. Prof. Ir. Dr. Mohd Ridzuan Bin Ahmad

List of members: Dr. Shaharin Fadzli Bin Abd Rahman , Dr. Mastura Shafinaz Bt Zainal Abidin , Dr. Amirjan Bin Nawabjan and Dr Mohd Amri bin Md. Yunus

RG Vision: To be recognised as an advanced of micro-nano mechatronics group in academic, research and technology innovation.

Contact Num: 07-5536333 | ridzuan@fke.utm.my | mnserg.fke.utm.my

Portable device of liquid capacitance detector



LIQUID CAPACITANCE DETECTOR USING AN INTEGRATED MICROFLUIDIC-MICRONEEDLE SYSTEM

Contamination of water supply has been a major problem nowadays. We come out with a new idea and innovation of portable product, device that is able to detect water quality of open rivers before supply to agricultural, domestic and industrial needs.

- ❑ The system that consist of microfluidic and microneedle able measure the capacitance value of liquid and monitor through the LCD.

- ❖ The device is capable to detect the difference capacitance measurement between various types of liquid
- ❖ Real time monitoring detection & contamination notification to control room
 - ❖ Efficiently sending water quality data to control room
 - ❖ Provide traceability and online management data
- ❖ The technology revolution to water companies in Malaysia.



Laku Management Sdn Bhd



Syarikat Air Terengganu Sdn Bhd (SATU)



Pengurusan Air Pahang Berhad (PAIP)



SARAWAK BERKALAN AIR TIDUR BUNYAN



SYABAS



SYARIKAT AIR MELAKA BERHAD



Air Kelantan Sdn Bhd



SADA

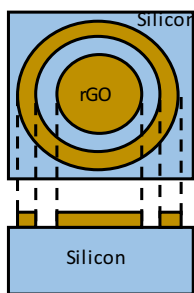


PBA

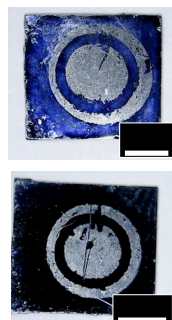
Perbadanan Bekalan Air Pulau Pinang Sdn Bhd (PBA)



Industrial collaboration with SAJ



Schematic structure and camera image of the diod

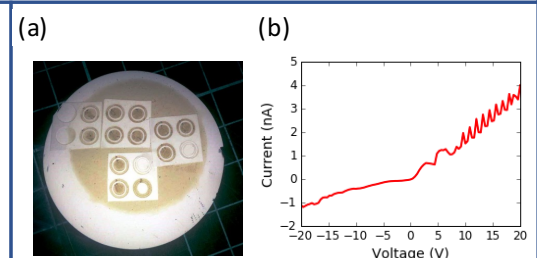


SIMPLE DIODE CONFIGURATION USING REDUCED GRAPHENE OXIDE FOR CHEMICAL SENSING APPLICATION

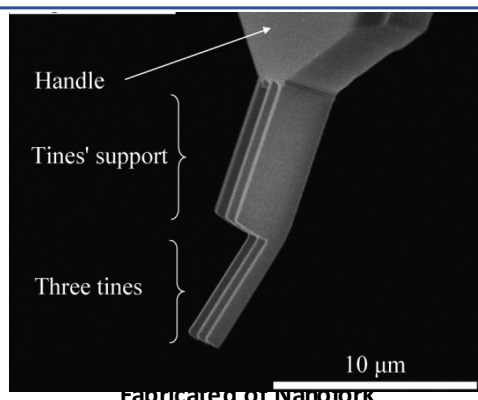
Low cost and high sensitivity are two of desired features for a chemical sensors. In order to achieve such specification, we are looking to several aspects and approaches;

- **Reduced graphene oxide (rGO) as sensing material:** highly sensitive and possible chemical modification for improvement, low cost
- **Back-to-back diode structure:** relatively high sensitivity, easy to be fabricated
- **Low-cost fabrication technique:** simple deposition, patterning technique

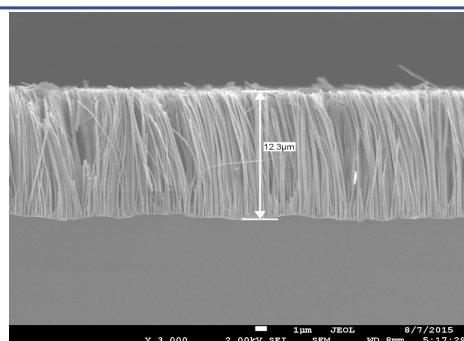
- ❖ Development and assessment of the low-cost device fabrication procedure without usage of sophisticated instruments. The technique can also be applied for other type of electronic device.
- ❖ Feasibility study on potential of using the back-to-back diode structure for chemical sensing.
- ❖ Investigation of device operation and sensing mechanism. This enable the enhancement the sensor performance (i.e. sensitivity)



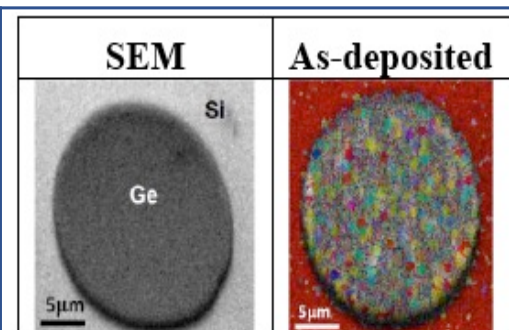
(a) Patterned rGO obtained from filtration.
(b) (b) Device characteristics



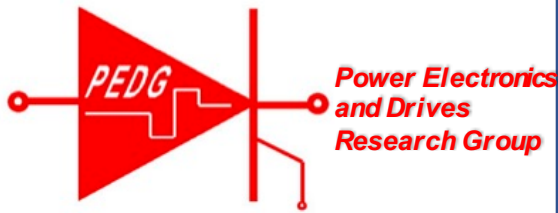
Fabricated of Nanotek



Silicon Nanowires formed from chemical etching process



Fabricated of Ge on Si by EC deposition



Research Group Members:

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 Assoc. Prof. Dr. Awang Jusoh,
 Assoc. Prof. Dr. Naziha Ahmad Azli,
 Mr. Nik Din Mohamad, Dr. Shahrin Md Ayob,
 Mr. Mohd Zaki Daud, Dr. Mohd Junaidi Abd Aziz
 Dr. Mohd Rodhi Sahid, Dr. NorJulia Mohd Nordin
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Research interest:

- Power electronics converters: topology and control
- Control of electrical drives: AC motor drives
- Power electronics application in renewable energy system
- Power electronics modeling and simulation

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All-electric Buggy



All-electric buggy in construction

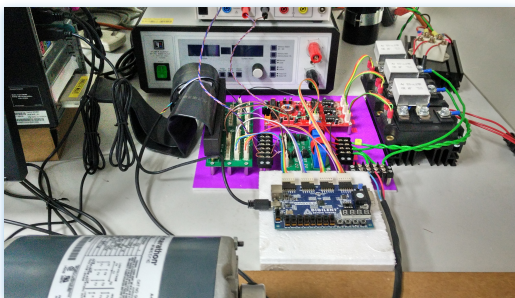
Most of the buggies available in market nowadays (including Malaysia), are based on internal combustion engine (ICE) that run on fossil fuel such as petrol. Apparently, conventional buggies suffer from drawbacks that are inherited from ICE based vehicle, namely their contribution to the air-pollution, noisy and poor efficiency. Other than this, it is also noted that in a typical driving cycle of a buggy, energy is wasted during idle states, for instance in fieldwork where regular short stoppings are required. The obvious solution to the problems of fossil fuel based vehicles, including buggies, is to use battery as the energy source. The project takes the challenge of building a high efficient buggy that runs on electric – i.e. all-electric buggy. The electric buggy is built by converting the conventional ICE-based buggy; replacing its conventional engine with an electric motor and its petrol tank with a high energy-density Li-ion battery pack.

This work is funded by the Research Group Flagship Program, consisting of three main projects: (1) Propulsion system, (2) Battery management system, and (3) Battery charger system. It is hoped that the application of this electric buggy and its charger infrastructure in UTM can be used as a model to promote a wider and larger usage of EV in Malaysia. A broad benefit that is directly gained from this research program is the enhancement of knowledge of UTM expertise in EV technology. Indirectly, the outcomes of the research contribute to the global efforts in reducing air-pollution and CO₂ emissions. Universiti Teknologi Malaysia has moved a step forward to becoming the model and hub of an advanced EV technology in the region.



Students working on the all-electric buggy construction

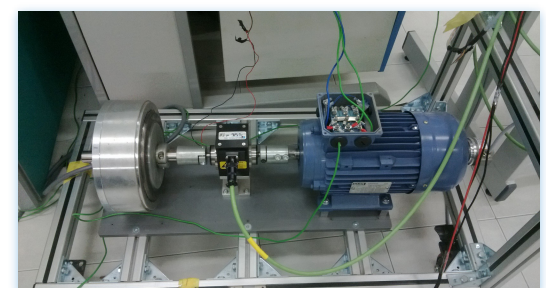
Speed Sensorless Drive for EV Applications



Experimental set-up of speed sensorless drive:
Digital signal controller and FPGA

Undoubtedly electric vehicles (EVs) will become the dominant transportation in the near future. A sharp rise in the interests of EV can be seen from the increase in the demand for EVs and increase in the conducted researches related to the EV. The common concerns of these conducted researches is on the efficiency improvement, safety and reliability. Among these vast research areas, this project deals with the improvement on the motor control system, more specifically, on the improvement of its reliability and safety. This is accomplished by employing a direct torque control (DTC) drive system and replacing the mechanical speed sensor with a speed estimator.

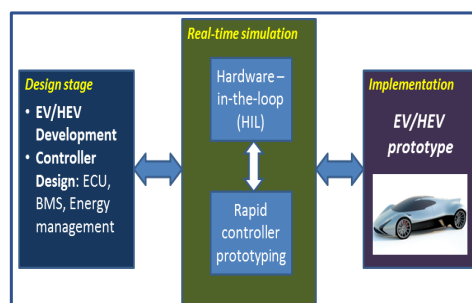
In EV, or even ICE-based vehicle, speed control is normally used when cruise control feature is active. Otherwise, the accelerator pedal is just used to control the torque. To completely remove the mechanical speed sensor, a speed estimator using only motor terminal variables is implemented. The application of a speed estimator means a more robust, cheaper and more reliable operations compared to the conventional mechanical sensor. In this work, the speed estimation, which is based on *Extended Kalman Filter* (EKF), is further enhanced by improving the stator flux estimation using a *constant switching frequency controller* (CSFC) -based DTC.



Experimental set-up of speed sensorless drive: Induction motor and hysteresis brake



Previous electric vehicle conversion project:
Successful collaboration work with PROTON Holdings



Design process in EV/HEV: HiL and Rapid Controller Prototyping



Group discussion: Engagement with local and international researchers

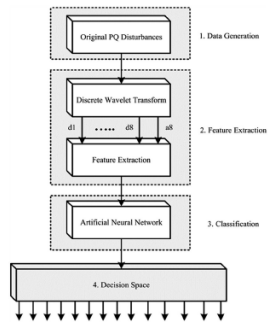


Research Area:

Power System Protection Power System
Deregulation Power System Distribution
Power System Analysis Power System Operation
Power Generation Dispatch
Smart Grid Distributed Generation
Sustainable Energy Regulated
Renewable Energy Renewable Energy Planning
Transmission usage Allocation
Expert system application in power system
ATC, FACTS Optimization in Power System

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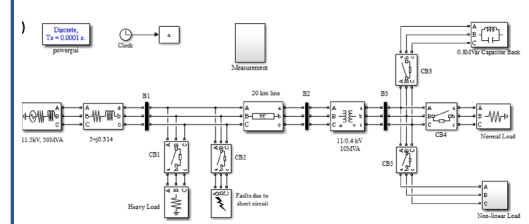
PQ Disturbance Automatic Classification System

Power Quality and Disturbances

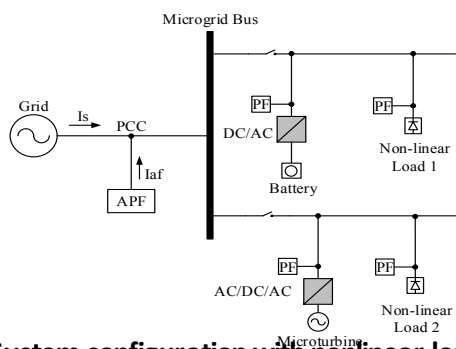
In the last decade, commercial electric consumers have become interested in the quality of the power they consumed. Any power disturbance can cause harmful effects to the customers equipment and utilities, mostly damage and disrupt sensitive electronics, computers and microprocessors. As businesses rely more heavily on modern high-tech processes, power quality will become even more important. Hence, it is important to efficiently detect and analyse power disturbance to assure the life and reliability of sensitive equipment. However, current monitoring systems which is by manual requires high cost, time consumption and manpower to analyse such a huge data. Hence, automatic and systematic monitoring method is required to solve this issues.

An automatic classification algorithm for PQ disturbances based on wavelet norm entropy (WNE) features and probabilistic neural network (PNN) is introduced as highly effective disturbance pattern classifier. The proposed method using multi resolution analysis (MRA) technique to extract the most important and constructive features of PQ disturbances at various resolution levels. PQ signals are then transformed into a reduced form of WNE features before feed to PNN to recognize the disturbance pattern. Proposed methods also successfully covered stationary and non-stationary PQ disturbances for more accurate analysis. This findings has provide a fast, cost effective and reliable solution to detect PQ problems and help consumers to planning ahead to minimize PQ effects.

Automatic Pattern Recognition of Single and Multiple Power Quality Disturbances



Simulink Model of Power Distribution System



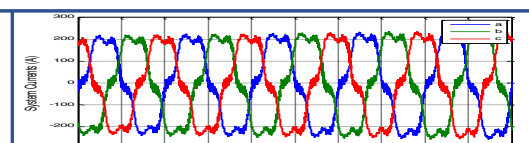
System configuration with nonlinear loads and dispersed generation sources

Distributed Generator and Harmonic Current Compensation

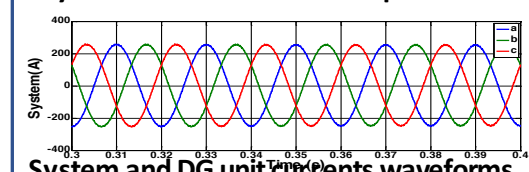
A large number of power electronics interfaced DG units have been installed in the low voltage power distribution systems showing the growing importance of Distributed Generation Sources(DGS). With new and improved technologies at hand, industrial, commercial and residential consumers requirement for power quality of power has increased. The DG sources and nonlinear loads make the system current nonlinear and unbalanced causing the harmonic distortion. The control of DG's need to be improved to effectively compensate for the unbalanced harmonic currents distortion.

Active Power Filters (APFs) is a dedicated compensation devices which is proposed to control the interface inverter of DGs in a micro grid (MG) to effectively compensate for the power injection and harmonic currents at the point of common coupling (PCC) and the microgrid (MG). APFs is a combination of Adjustable Synchronous Reference Frame (ASRF) and Synchronous Reference Frame (SRF) which effectively stands out of common passive filters which suffer from some drawback such as strong dependence on system impedance, susceptible to source and load resonance and characteristic variation due to aging. It provide a simple but effective solution by injecting a harmonic distortion which is equivalent to a distortion but with a different polarity, into the system which lead to correction of the waveform into a sine wave.

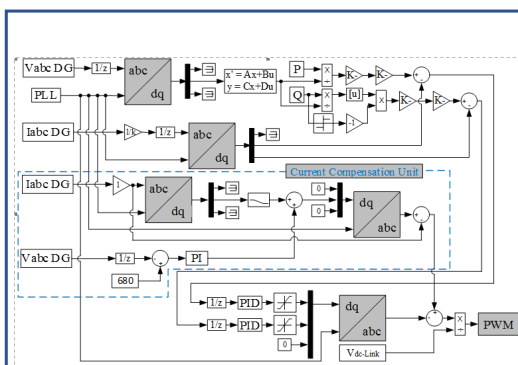
A Control Scheme to Improve the Power Quality with the Absence of Dedicated Compensation Devices in Microgrid



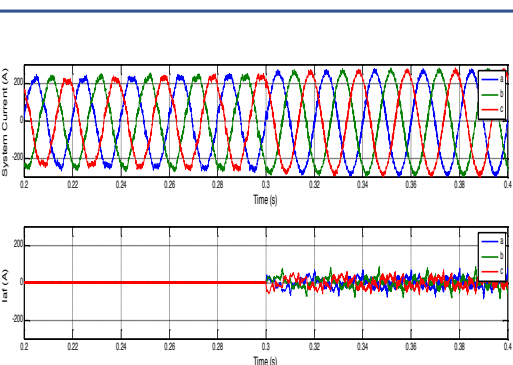
System current without compensation



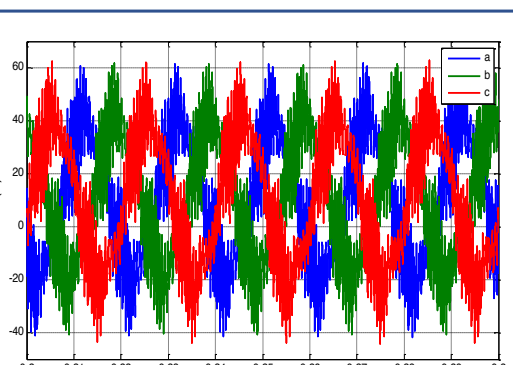
System and DG unit currents waveforms with the Absence of compensation



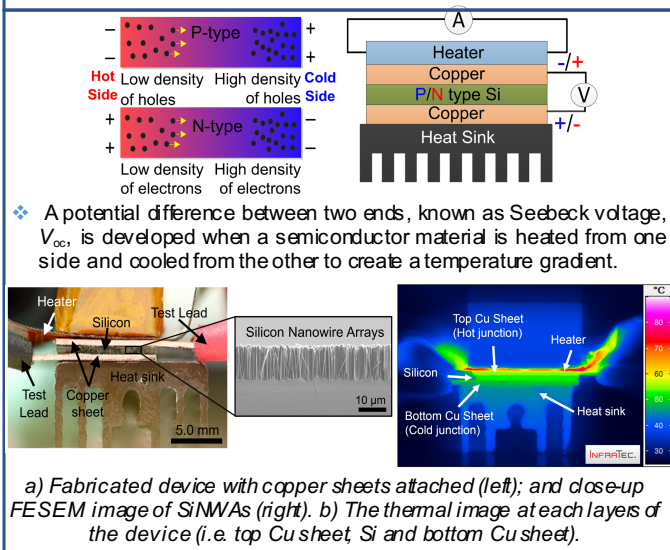
APF Block Diagram



System and Active Power Filter Current



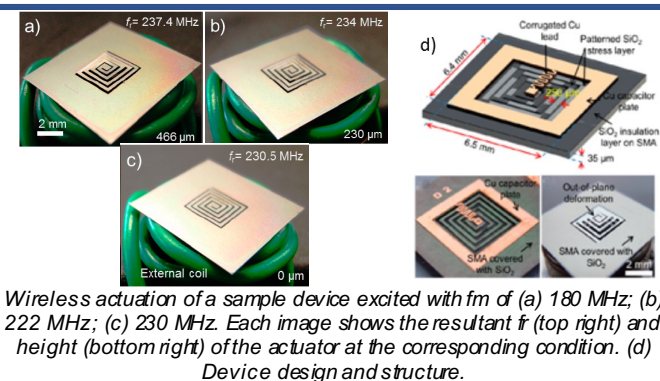
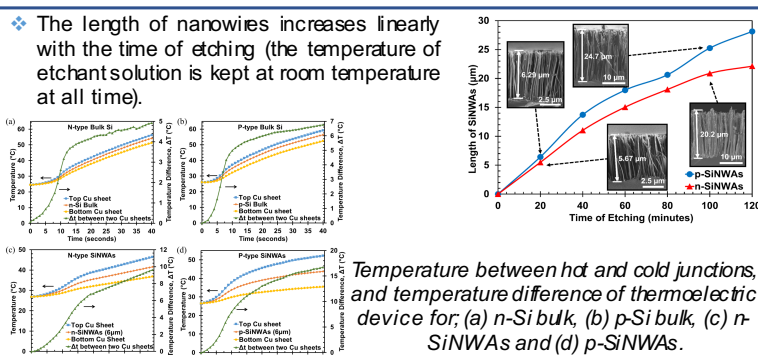
MT current



SILICON NANOWIRE ARRAYS FOR THERMOELECTRIC POWER HARVESTING

Thermoelectric devices are commonly composed of a bismuth-tellurium compound which is expensive and have limited resource. Alternatively, silicon, a semiconductor may be a prominent material in thermoelectric devices. However, high thermal conductivity in bulk Si affects the thermoelectric efficiency. On contrary, the nanostructured Si i.e. nanowires can be used in enhancing thermoelectric properties. Therefore, the performance of Silicon Nanowire Arrays (SiNWAs) and bulk Si material as thermoelectric power harvesters are investigated. The heat flow across the material that affects temperature difference, ΔT across hot and cold junctions of the samples is examined while the Seebeck voltage, V_{oc} and Seebeck coefficient, S are measured. A two-step metal-assisted chemical etching is used to develop SiNWAs because of its simplicity and low-cost technique.

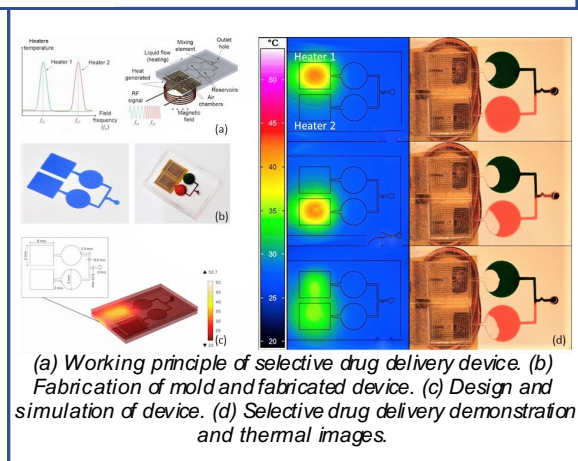
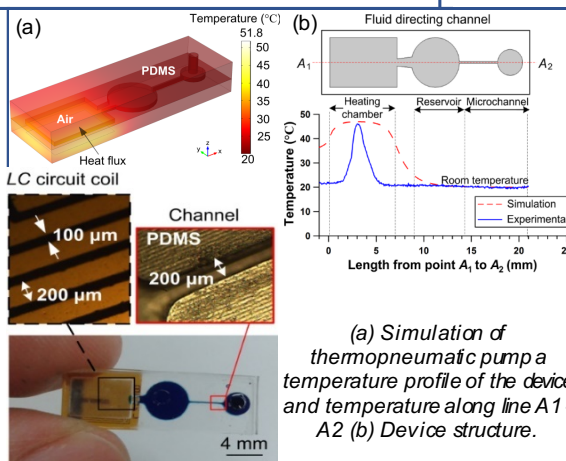
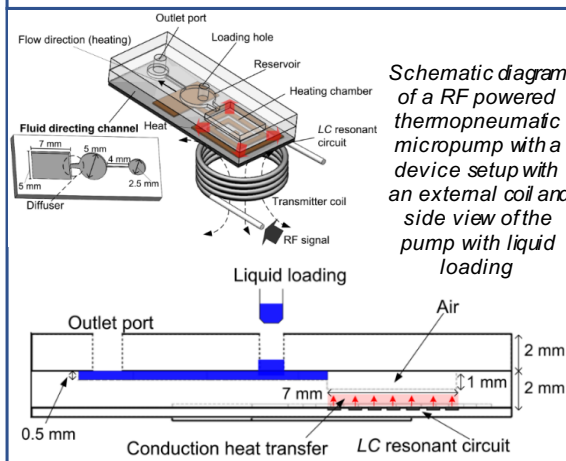
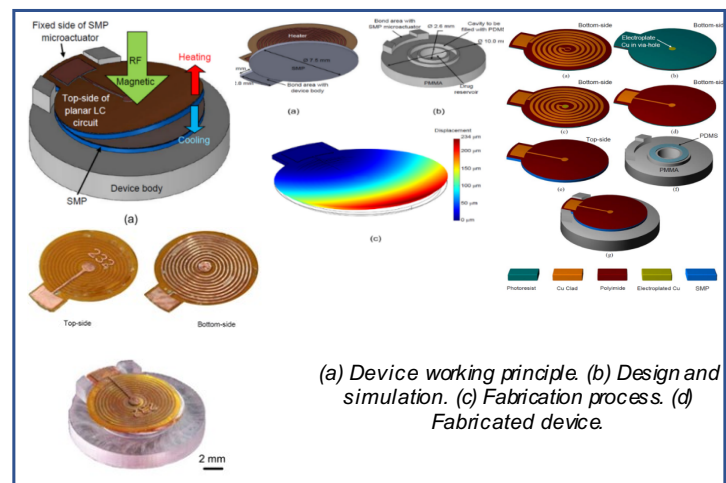
The application of SiNWAs as an element in power harvester utilizes green technology in which, it has solid-state parts that able to increase the longevity of a power harvesting device, while its non-toxic, emissions-free and noiseless characteristics encourage a healthier environment. Inexpensive and commonly found silicon material, and a simple fabrication technique without any requirement of expensive tools to build SiNWAs power harvesting device promote economic advantages to the manufacturers and end-consumers.



Development of Radio-Controlled MEMS implantable Drug-Delivery Device with Selective and Controlled-Release Capability using Shape-Memory-Alloy Microactuators

This report describes the development of an out-of-plane shape-memory-alloy microactuator, a shape-memory-polymer drug delivery device, a thermopneumatic micropump, and a selective drug delivery device. These devices are powered and controlled by frequency manipulation of an external magnetic field.

Over the past decade, the technology and applications of drug-delivery devices have gained tremendous interest. However, the ability to implement these devices in portable and implantable applications is still limited. To date, such devices are restricted to the use of bulky magnetic cores or on-board power supplies. These approaches require consideration of several practical issues, such as the device size and complexity as well as feasibility for biomedical applications and multiple-actuator control. Passively actuated actuators offer the opportunity to minimize the size and cost of such systems while maintaining a higher robustness and longevity as compared to actively actuated actuators.





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Research Area:
Radar and Communication Based System



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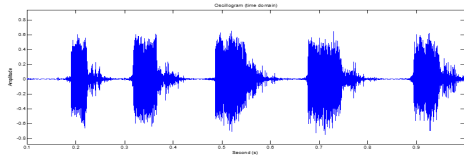


Fig. 1 A five consecutive shouts sound wave pattern produced by swiftlets

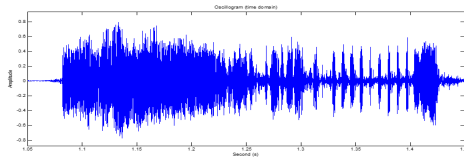


Fig. 2 The aggregating sound pattern just after the shouts sound

External and Puller Sound System for Swiftlet Farming in Malaysia

A desire for good health had prompted a positive development in traditional and modern medicine. This has increased demand for health supplement such as bird's nest. Consequently, many entrepreneurs are building swiftlet birdhouses to produce edible bird's nests. However, building a swiftlet house is not easy. It requires expertise in terms of special techniques to attract swiftlets entering the birdhouse. One of the technique uses sound to attract swiftlets to enter and reside into a birdhouse. Sound is said to be the largest contributor to draw and make swiftlets comfortable to inhabit. Basically, there are two types of sound used to attract swiftlets to reach out and build nests in a birdhouse. The first type of sound is known as external voice to call and attract swiftlets. The second voice is known as internal voice to make swiftlets comfortable and build nests inside the birdhouse. Nevertheless, not all sound are suitable to call and attract swiftlets.

Sound system is critical towards the growth and sustainability of swiftlets farming. Different songs have different sound wave patterns which reflect the uniqueness and diversity of the natural shelter of the swiftlets. It will determined and increase the rate of success of the swiftlet farming.



Man-made birdhouse for swiftlet.

External and Puller Sound System for Swiftlet Farming

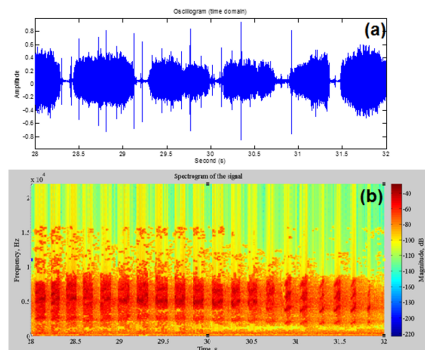


Fig 1. (a) Oscillogram and (b) spectrogram of swiftlet internal sound

Sound Analysis as a Basis for Successful Swiftlets Farming

Several factors need to be considered to ensure swiftlets stay inside the birdhouse and continuously produce bird's nests. Sound system is one of the main factor that leads toward successful birdhouse. The swiftlets sound needs to be analysed to ensure that it is capable to lure swiftlets into a birdhouse regardless of the location of the birdhouse. The frequency, amplitude, and magnitude of puller and external sound system are investigated. Signal processing techniques such as Fast Fourier Transform (FFT) have been used to analyse sound using the Matlab software. Based on the findings, the best average peak frequency for birdhouse sound for internal and external ranges from 4 – 5.5 kHz and 4.5 – 6 respectively. This finding is really significant as swiftlets are really sensitive to sounds.

Suitable swiftlet's sound will increase the total population of the swiftlet inside the farming house. Therefore, the sound analysis on swiftlets sound are crucial to increase the rate of success of the swiftlet farming. Based on survey, only 20 % of the swiftlet industries able to draw and make the swiftlets nesting. Another 80 % of the industries failed due to several factors. One of the main factor is the sound to call and attract the swiftlets. Currently, the swiftlet's farming industries only used the trial and error concept to attract the swiftlet to enter the house. Usually, this technique will consume about 6 to 8 months duration to choose a suitable sound to be place in a house. Hence, this research aims to deliver a suitable swiftlet's song to be implemented at the swiftlet farming with less consuming time and cost effective.



Sound system in swiftlet's birdhouse.

Sound Analysis for Swiftlets Farming

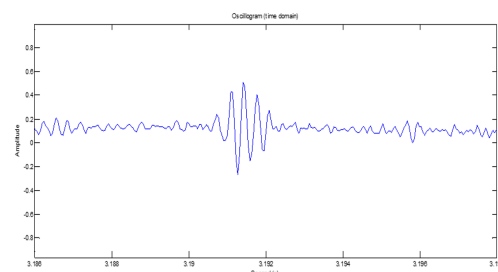


Fig. 1 A sharp on and offset of the sound wave produced by swiftlets

Table 1: Swiftlet's external and internal sounds characteristics based on sound analysis

Sound Name		Frequency Range (kHz)	Frequency (kHz)			Peak	Peak
			1 st Peak Reading	2 nd Peak Reading	Average	Magnitude Spectrum (dB)	Amplitude (cm)
External	ExtSound1	1 - 9	3.6	5.8	4.7	2400	0.6
	ExtSound2	1 - 10	5.0	5.6	5.3	2700	0.8
	ExtSound3	1 - 16	5.6	6.0	5.8	3300	0.5
Internal	IntSound1	1 - 10	3.0	5.8	4.4	2100	0.9
	IntSound2	1 - 12	5.4	5.6	5.5	2300	0.6
	IntSound3	1 - 9	3.0	4.6	3.8	3400	0.9

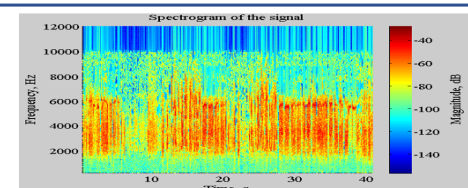


Fig 2. The spectrogram of Swiftlet sound

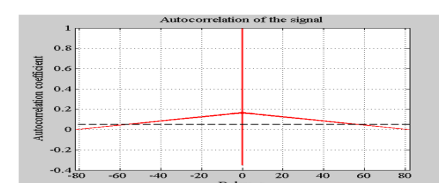


Fig 3. The autocorrelation of Swiftlet sound

VeCAD

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Research Area

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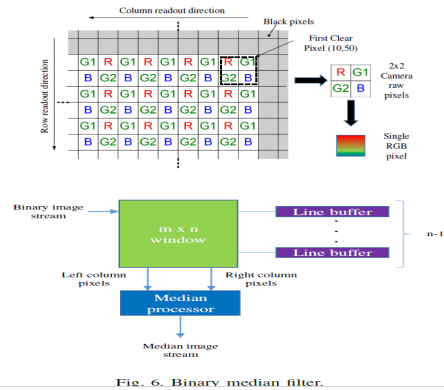


Fig. 6. Binary median filter.

FPGA System-on-Chip

Processors and FPGAs (field-programmable gate arrays) are the hardworking cores of most embedded systems. Integrating the high-level management functionality of processors and the stringent, real-time operating, extreme data processing or interface functions of an FPGA into a single device forms with powerful embedded computing platform. SoC FPGA devices integrate both processor and FPGA architectures into a single device. Consequently, they provide higher integration, lower power, smaller board size, and higher bandwidth communication between the processor and FPGA. They also include a rich set of peripherals, on-chip memory, an FPGA-style logic array, and high speed transceivers.

Hardware accelerated face detection system using skin color segmentation method on FPGA is proposed. The image pre-processing, skin segmentation, filtering and connected component labeling processes were designed using stream-oriented hardware architecture. To gauge the performance of the system in terms of execution speed, the algorithm is also implemented in full software executed by the NIOS II embedded soft-core processor of the Cyclone IV FPGA. The hardware design achieved a speed-up of 250 times compared to software implementation when processing a RGB video frame of 800×600 pixel size.

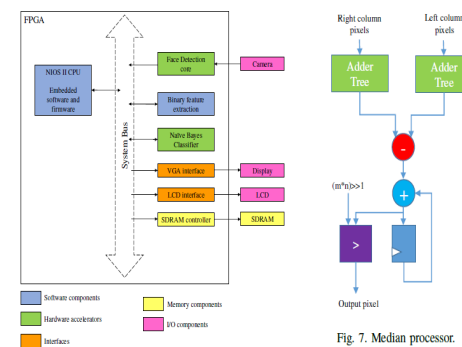


Fig. 7. Median processor.

Research in the Naïve Bayes classifier hardware core

Heterogeneous Multiprocessor System-on-Chip Prototyping

Heterogeneous computing refers to systems that uses more than one kind of processor or cores. Current heterogeneous applications such as multimedia, digital signal processing, network processing, and wireless communication require ever-growing amount of resources and speed for data processing and storage, which can no longer be satisfied by uniprocessor systems. This trend has led to the need for concurrent task processing on embedded multiprocessor systems. Multiprocessor SoC (MPSoC) systems have emerged as a viable alternative solution. However, achieving high performance computing on MPSoC is limited by the efficiency of parallel programming.

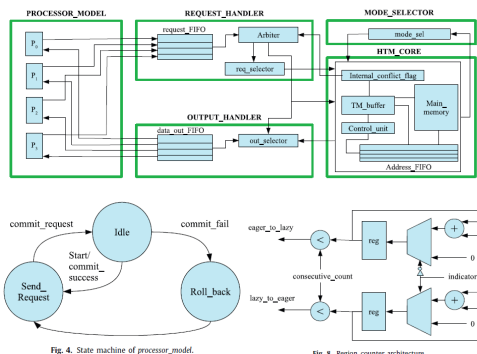
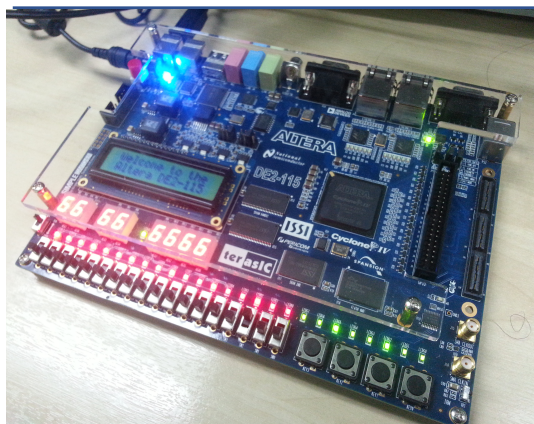
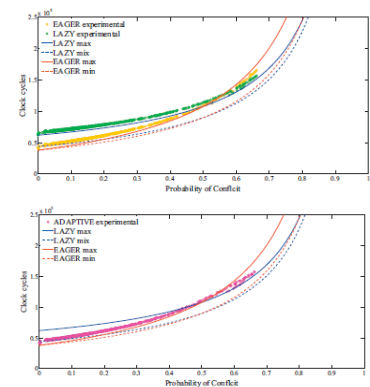


Fig. 4. State machine of processor model.

Fig. 8. Region counter architecture.

Hardware Transactional Memory (HTM) targeted for embedded applications is proposed which is able to adapt its version management based on application behaviour at runtime. It is prototyped and analysed on Altera Cyclone IV platform. Random requests at different contention levels and different transaction sizes are used to verify the performance of the proposed HTM. Lazy version management is able to obtain up to 12.82% speed-up compared to eager version management at high contention level. Meanwhile, eager version management obtains up to 37.84% speed-up compared to lazy version management at low contention. The adaptive mechanism is able to switch configuration at runtime based on applications behaviour for maximum performance.

Hardware Transactional Memory on a Real Applications





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