

## HIGHLIGHTS

WIE Forum 2019	1
CARe Members at European Research Day Malaysia, Asia-Europe Institute	2
KIK 2019	3
A Trip to UNS	4
Research Visit to ICOE-RAIL	5
Instructional Videos	6
Be a Professional Brother & Sister	7
Intelligent Mobility (i-Mobility)	8
Fishing Bait Launcher	9
Nurturing STEM skills	10
Roundabout Sensor Detection System	11
Effects of Process Parameters On Strength of Polymer	12
External Flow Modeling by CFD	13

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## WOMEN IN ENGINEERING FORUM 2019 (WIE2019)

10<sup>th</sup> July 2019 have marked a big day for female academics particularly those involved in engineering to participate in the first Women in Engineering Forum 2019 (WIE2019) which was organised by the Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka and Centre for Advanced Research on Energy (CARe), Women Chapter, Institution of Engineers Malaysia (IEM), Centre of Academic Excellence and Scholarship (CAES), Persatuan Suri dan Anggota Wanita Perkhidmatan Awam (PUSPANITA) and Persatuan Staf Akademik UTeM (UTeMASA) on 10<sup>th</sup> July 2019 in Dewan UTeM1, Technology Campus UTeM. With over twenty organising committees from all the organisers involved, the event can be regarded as a day to remember for many.

With the notion of “Empowering Women in Engineering, Education and Research: How”, it is also the first ever-held forum organized among the Malaysian Technical University Network (MTUN), that brings together academics, researchers and industrial practitioners in Malaysia, particularly from the southern region, to discuss issues on empowering women in engineering from various perspectives. The forum moderator is Dr. Rafidah Hasan, CEng, from the Faculty of Mechanical Engineering, UTeM while the four prominent leading professional engineers’ panellists are Professor Ir. Dr Haslenda Hashim from Universiti Teknologi Malaysia (UTM), Assoc. Professor Dr. Jariah Mohamad Juoi (CAES, UTeM), Ir. Dr. Jeyanthi Ramasamy (APAC Oceanering International) and Ir. Mah Siew Kien (Women Engineers Section, IEM). The event was officiated by the Y.B. Datuk Ginie Lim Siew Lin, Melaka State Government Exco of Women, Welfare and Rural Development following the closing session of the forum by IEM representative on the Route to Professional Engineers.



WIE 2019 Program Director, Dr. Siti Hajar Sheikh Md.Fadzullah highlighted that through such an event, UTeM aims to provide a platform to continue aspiring women engineers to succeed in their career as an engineer and more importantly, to contribute to the nation’s development. As pointed out in the YB. Datuk Ginie Lim closing remark, such action is parallel to the National Women Policy which intends to ensure the development and empowerment of women by mainstreaming women’s interests in achieving their full potential in the planning and country development to achieve gender equality.

The Dean of FKM, UTeM, Dr. Ruztamreen Jenal, as the Advisor of WIE2019 expressed his gratitude to the hardworking committees for the great teamwork and proud to witness that the forum received an overwhelming response from especially female academics in the university, as well as from other agencies and institutions with over 117 participants and have shown great teamwork among the committee organizers. With financial support and sponsors received, it is hoped it will become an annual event for the university in the years to come as UTeM continue to aspire the educators in producing human capital for the IR4.0 evolution in Malaysia,



Report by: Siti Hajar Sheikh Md Fadzullah



## CARe Research Group

Advanced Materials  
(A-MAT)

Green And Efficient Energy  
Technology  
(GrEET)

Green Tribology And  
Engine Performance  
(G-TriboE)

Innovation and  
Sustainability In Machine  
Technologies  
(i-SMAT)

Intelligent Mobility  
(i-Mobility)

## INFO CARe Lab Facilities

Advanced Materials Lab

Air Conditioning Lab

CAD Studio

Condition Based  
Maintenance Lab

Control and Electronic  
Systems Vehicle Lab

Engine Performance Lab

High Performance  
Structure Lab

Innovation Laboratory

NDT Laboratory

Rapid Prototyping Lab

Structural Health  
Monitoring Lab

Tribology Lab

Turbo Machinery Lab

Vibration and Acoustics  
Laboratory

## ABOUT EURAXESS

*Researchers in Motion is a unique pan-European initiative delivering information and support services to professional researchers. Backed by the European Union, member states and associated countries, it supports researcher mobility and career development, while enhancing scientific collaboration between Europe and the world.*

Source: EURAXESS website

## FROM THE EDITOR

Welcome to the fifth issue of CARe Newsletter. This publication provides information on recent news, developments, and announcements about CARe. This year CARe has been consolidated from seven research group to five. We welcome Intelligent Mobility (i-Mobility) research group to CARe family. Another year has passed, another has come. It has been a good year for CARe in 2019 and we hope CARe will achieve more success and further progress in 2020.

Happy New Year 2020 from the newsletter team.

**Dr. Siva Kumar Dhar Malingam**



## CARE MEMBERS AT EUROPEAN RESEARCH DAY MALAYSIA, ASIA-EUROPE INSTITUTE, UNIVERSITY OF MALAYA

CARe, UTeM has encouraged the members to seek research career opportunities in Europe by joining European Research Day on 27th August 2019 at Asia-Europe Institute, University of Malaya (UM), Kuala Lumpur. 15 CARe members have attended the event which also involved over 200 researchers from 26 institutions across Malaysia. The European Research Day is a EURAXESS ASEAN initiative with the support of Asia-Europe Institute, University of Malaya; Prof. Dr. Azirah Hashim (Executive Director), Prof. Dr. Low Wah Yun (Deputy Executive Director) and their team.

In the event, well-experienced speakers from different backgrounds and EU countries shared the information on European researcher mobility programs and research collaboration opportunities. As a Regional Representative Euraxess Asean, Dr. Susanne Rentzow-Vasu in her talk explained that the EURAXESS, *Researchers in Motion* is an initiative by EU and 40 countries in Europe to offer information and support for researchers wishing to pursue their research careers in Europe or with European partners. Thousands of research jobs, fellowships, funding offers and research partners from Europe can be found from their website. She also gave details on the opportunities for postdoctoral research with Marie Skłodowska-Curie Action – Individual Fellowships (MSCA-IF), one of the fully-funded fellowships in Europe.



The event was also attended by Dato Prof. Dr. Fauzi Mohd Zain, Director, Research Excellence Division, Ministry of Education Malaysia who addressed the participants on the importance of researcher mobility to the nation and individuals. While the experience of joining DIES ProGRANTS was shared by Dr. Tong Woei Yenn, who is a senior lecturer at UniKL. The program supports researchers

during their proposal writing process by transferring knowledge on general proposal writing skills and engaging in a peer-review process. It is a good program that guides young researchers to write an outstanding research proposal for national or international research funding. This kind of event surely helps CARe members in planning their career advancement and provide networking opportunities with participants from other institutions.



Report by: Fadhilah Shikh Anuar



## KUMPULAN INOVATIF DAN KREATIF (KIK) 2019

Innovative and Creative Convention, which is also known as Konvensyen Kumpulan Inovatif dan Kreatif (KIK) 2019 was held from August 19 until 21, 2019 at Dewan 1, Kampus Teknologi, Universiti Teknikal Malaysia Melaka (UTeM). A total of 35 groups from all public universities (UA) in Malaysia participated in the convention. The program was officiated by Y. Bhg. Mr Masdzarif Mahat, Chief Operating Officer of UTeM.

Fakulti Kejuruteraan Mekanikal (FKM) is represented by ACHIEVE group. Dr. Mohd Basri Ali leads it as a facilitator with 9 members; Mr. Mahader Muhamad (Group Leader), Dr. Nurfaizey Abdul Hamid, Mr. Wan Mohd Zailimi W. Abdullah, Mr. Mohd Hanif Harun, Mr. Adzni Md Saad, Mr Febrian Idral, Mr. Junaidi Salam, Mr. Mohd Hairi Md Rahim and Mr. Mazlan Tumin. This group has created an online laboratory booking system, which is known as e-Laboratory Booking System (e-SLAB). It enables students and staffs of UTeM to book FKM laboratories and get approval in a short period by eliminating the current time consuming manual application process.

Professional juries awarded the ACHIEVE group the GOLD rating. These successes have indirectly shown the capabilities of FKM staffs to invent an efficient and useful system, which has been recognised by qualified experts. It encourages other UTeM staffs to come out with more new invention and participate in KIK in the future. This achievement can never be accomplished without the support of FKM management team and all staffs, who have been very helpful in assisting the effort of completing this project.





## A TRIP TO UNIVERSITAS SEBELAS MARET (UNS)



From 20th to 22nd August of 2019, Ir. Dr. Fudhail Bin Abdul Munir had visited the Faculty of Education and Teacher Training in Universitas Sebelas Maret (UNS) Surakarta Indonesia. The following days were an experience for both representatives as connecting network with foreign universities proved to be a fruitful venture. The invitation is to share the knowledge on micro combustion and micropower generation.

Ir. Dr. Fudhail conducted several sharing session on the Application of a Plasma Actuator to a Small Tube Combustor. The controlling of flow velocity inside the combustor using a plasma actuator while expanding the domain of micro combustor was briefly introduced and discussed. Flame stability in small tube micro combustor was outlined and was concluded with possibilities for future research.

Exchanging knowledge has always been a practice advocated by all researchers as it is a part of the core values in research. The visit ended, but not without a rewarding networking session between researches from both universities. By exchanging insights on the research topic, it is a hope to all that this visit will mark for a more successful future collaboration and new research ventures.



Postgraduate students from UNS attended the lecture by Ir Dr Fudhail lecture on micro power generation

Sharing session between undergraduate and postgraduate students on research findings



### ABOUT UNS

*Sebelas Maret Surakarta Public University was legally established on March 11, 1976. On 1982, the name and abbreviation Sebelas Maret Surakarta Public University (UNS Sebelas Maret), was set to Sebelas Maret University (UNS). Source: UNS website*



Meeting session with the Dean, Vice Deans and International Office representative



## RESEARCH VISIT TO ICOE-RAIL, UTHM PAGOH

The Malaysian government is expected to continue with the plans to build high-speed rail that connecting the Malaysian capital with Singapore. The development of the transportation system is still in its early stages and the involvement of researchers at the Local University is welcomed to compete with other industry players in the local and international markets. To meet the government's expectations, on July 17, 2019, a group of researchers and research assistants from UTeM held a visit to UTHM Pagoh intended for a research collaboration on the rail industry with the Industrial-Centre of Excellent (ICOE-RAIL) of UTHM. This visit was led by Prof. Dr. Zahriladha Zakaria (Head of COE) and assisted by the Assoc. Prof. Dr. Tee Boon (Manager of COE-CARe). Also present were several researchers from COE-CARe, Assoc. Prof. Dr. Mohd Azman Abdullah, Mr. Mohd Hanif Harun and Mr. Qamar Fairuz Zahmani. The visit was also attended by the researchers from other COE, including Ir. Dr. Anas Abdul Latiff (Coordinator of COE-CETRI), Ts. Dr. Zikri Abadi and Dr Imran Ibrahim. The results of the visit have also been agreed to involve the researchers from UTeM in rail skills training at UTHM.





## INSTRUCTIONAL VIDEOS KEEPING UP WITH THE MILLENNIALS

As part of initiatives to promote active learning among the students, Dr Zakiah Abd Halim, Dr Mizah Ramli and Assoc Prof Dr Mohd Azman Abdullah have developed six instructional videos for BMC1011 Mechanical Engineering Laboratory 1. The subject is a compulsory subject for first-year students of Fakulti Kejuruteraan Mekanikal, Universiti Teknikal Malaysia Melaka.

### PLAN

Describe the objectives, basic theory and apparatus to carry out the experiment



### BUILT

Detailed of experimental procedures and safety precautions



### EXECUTE

Replicate the procedural steps and record the findings



The instructional videos are prepared for the following experiments:

- |                                   |                            |
|-----------------------------------|----------------------------|
| L1 Axial loaded members           | L4 Young's Modulus         |
| L2 Coefficient of static friction | L5 Free fall               |
| L3 Gravitational Acceleration     | L6 Rotational acceleration |

The instructional videos consist of the objectives of the experiment, basic theory to put the experiment into context, the apparatus and materials needed to conduct the experiment, the steps-by-steps procedure, details of data to be measured and safety precautions. The videos are uploaded in YouTube and can be watched anytime, anywhere based on student availability and readiness.

The instructional videos have proven to enhance their digital learning as well as transformed their learning style. Students are more prepared when they enter the laboratory. The instructional videos have won the Silver award in e-Learning Conference, and Competition (eLCC2019) organised by Pusat Sumber dan Teknologi Pembelajaran (PSTP).

1

#### EFFICIENT

Students watch the videos **BEFORE** the laboratory sessions

2

#### EFFECTIVE

Students know how to conduct the experiment **DURING** the laboratory session

3

#### ENGAGING

Students can always revisit the videos **AFTER** the laboratory sessions

## BE A PROFESSIONAL BROTHER & SISTER

An academic Forum, "Be a Professional Brother & Sister" under Faculty of Mechanical Engineering was held on the 28th of August 2019. The main objective for the event is to encourage academic staffs in achieving the Professional Engineer (Ir.) status. It is a fact that gaining the title of Ir. is a difficult task and many academic staffs are unaware about the route or path in applying for Professional Engineer status. Hence, the forum was open to all academic members of UTeM for sharing session about the journey in achieving the title.

The forum panel members consist of Assoc. Prof. Ir. Dr. Abdul Talib Din, Assoc. Prof. Ir. Dr. Mohd Rizal Alkahari, Ir. Dr. Mohd Shukri Yob, Ir. Dr. Fudhail Abdul Munir and Dr Siti Nurhaida Khalil with Dr Suhaimi Misha as the moderator. The forum started with Assoc. Prof. Ir. Dr. Abdul Talib and Ir. Dr. Fudhail briefly explaining the routes and method of applying for Professional Engineer in Malaysia. Then, each of the forum members shared their experience in attaining their Ir. The open session allowed the academic members to share their difficulties in applying to be professional engineers such as the precautions that needed to be taken before going for the exam and what field is suitable or related to when aiming for Ir. The forum ended in a great success with a good turnout rate where the academic members that attended were able to understand in greater detail of how to be a professional engineer.







## INTELLIGENT MOBILITY RESEARCH GROUP



*Amrik Singh Phuman  
Singh  
(Leader)*



*Juffrizal Karjanto  
(Deputy Leader)*



*Nidzamuddin Md. Yusof  
(Secretary)*

The Intelligent Mobility (i-Mobility) research group was established in 2019 and is located at the Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka (UTeM). This research group is one of the five research groups under the Centre for Advanced Research on Energy (CARE) which focuses on the research on sustainable energy and automotive. The research focus of this group is vehicle systems for autonomous driving.

### Research Areas

The research areas of the i-Mobility research group are as follows:

*Autonomous vehicle systems.* This research area includes vehicle autonomous functions such as trajectory planning, trajectory tracking, and collision avoidance.

*Electric vehicles.* This research area focuses on the electrification of vehicles for driving and energy efficiency.

*Human-vehicle interaction.* This research area focuses on the optimal design and interaction between humans and vehicles for mechanical and electronic systems in vehicles.

*Vehicle dynamics and control.* This field of research emphasises on the dynamics and control of vehicles under steering inputs, drives, and brakes. In addition, the focus is also given on the dynamics and control of other vehicles such as railway vehicles and heavy vehicles, and on-vehicle aerodynamics.

### Members

The members of the i-Mobility research group are as follows:

Dr. Ahmad Kamal Mat Yamin  
Dr. Cheng See Yuan  
Dr. Faizul Akmar Abdul Kadir  
Dr. Fauzi Ahmad  
Ir. Dr. Fudhail Abdul Munir  
Ir. Ts. Mohamad Hafiz Harun

Assoc. Prof. Ir. Dr. Mohd Azman Abdullah  
Assoc. Prof. Ts. Dr. Muhammad Zahir Hassan  
Dr. Nur Hazwani Mokhtar  
Ts. Nur Rashid Mat Nuri @ Md Din  
Mr. W. Mohd Zailimi W. Abdullah @ Zakaria  
Mr. Mohd Hanif Harun

### Selected publications

Ahmad, F., Hudha, K., Mazlan, S. A., Jamaluddin, H., Aparow, V. R., & Yunos, M. M. (2018). Simulation and experimental investigation of vehicle braking system employing a fixed caliper based electronic wedge brake. *Simulation*, 94(4), 327-340.

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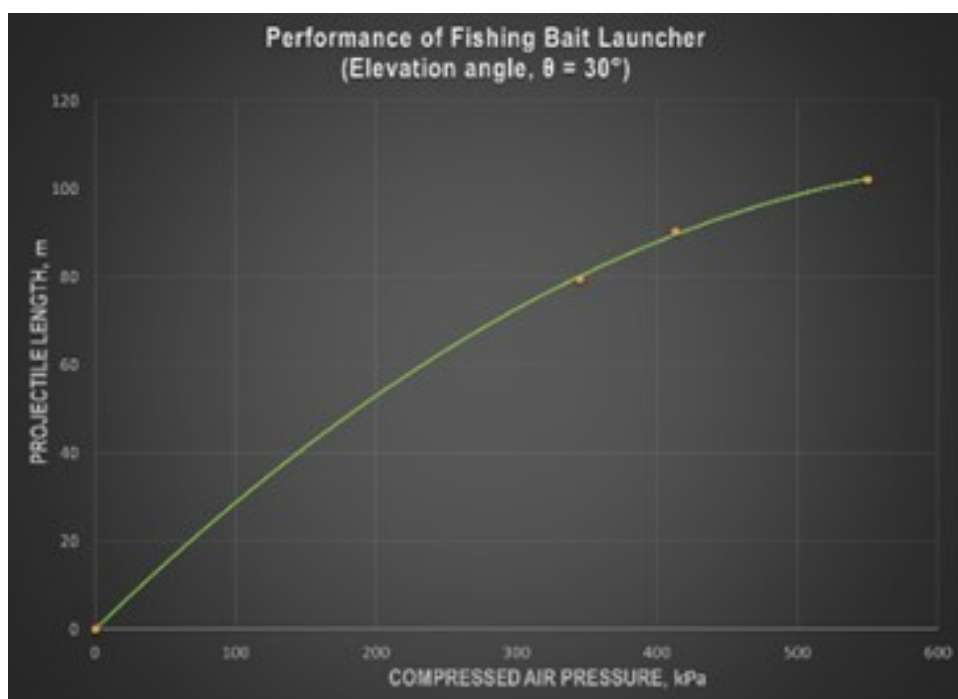
Singh, A. S. P., & Nishihara, O. (2018). Nondimensionalized univariate equation characterizing optimal state feedback control for collision avoidance. *IEEE Transactions on Intelligent Transportation Systems*, 19(10), 3344-3359.



# FISHING BAIT LAUNCHER: THE FUTURE OF MALAYSIA RECREATIONAL AND COMMERCIAL FISHING

Surf fishing is popular among Malaysian as Peninsular Malaysia, Sabah and Sarawak are surrounded with long coastlines. Either it is recreational or commercial fishing, complete fishing gears are a must to the anglers, especially the fishing rods. Longer rods give an advantage of longer casting distance with a better chance to catch a larger fish. However, their catches are also limited to the casting spot. To cast the rods, there should be no trees or obstructions nearby. Ultimately, the surf fishing required good casting skills and it will be quite tricky for a beginner.

A solution to the above-mentioned problems is the Fishing Bait Launcher; an air-powered launcher that can blast a fishing bait. The launcher used a simple projectile motion concept, where once projected, the bait continued in motion by its inertia (frozen bait) and influenced by the downward force of gravity. The material is 100% PVC; thus, it is light-weight and affordable for fishing hobbyists. It is also energy efficient as it could be manually powered using a simple pump, such as a bike pump or a low cost (mini) air compressor. This is the first bait launcher in Malaysia, specifically designed to combine a chamber and barrel. From the preliminary tests, results show that the Fishing Bait Launcher is capable of getting the frozen bait to move 100 m forward, with its current material. It is expected that the distance could be longer, considering the PVC maximum operating pressure is up to 240 psi (~1600 kPa). However, it is also limited to the sealant and other part connections, which will require more failure tests.



Since its development, Fishing Bait Launcher has won several innovation awards; a bronze in Universiti Teknikal Malaysia Melaka Research & Innovation Expo 2019 (UTeMEX 2019) and another bronze in The International Research and Symposium and Exposition 2019 (RiSE 2019) organised by UTHM. The researchers that involved in this project are Noor Muhammad Izni bin Husin, Dr. Mohd Hafidzal Bin Mohd Hanafi, Dr. Fadhilah Binti Shikh Anuar, Dr. Nurul Hilwa Binti Mohd Zini and Mohd Noor Asril B. Saadun.





# NURTURING STEM SKILLS VIA EXPERIENTIAL LEARNING PLATFORM

A group of researchers from Fakulti Kejuruteraan Mekanikal has shared their expertise to design, fabricate and install a rainwater harvesting system (RWHS) for Sekolah Menengah Kebangsaan Iskandar Syah (SMKIS), Jasin, Melaka. The project is lead by Assoc. Prof. Ir. Ts. Dr. Abd Talib Din, and assisted by Dr. Rafidah Hasan, Dr Zakiah Abd Halim, Dr Mohd Afzanizam Mohd Rosli, Dr Ernie Mat Tokit, Dr Asriana Ibrahim, Dr Mohd Asri Mohd Yusoff, Mrs Norasra A Rahman and Mr Mohd Hafiz Md Isa.

The project was initiated to address heavy rainwater stream which eroded soil and outpoured the school building. The installed RWHS has successfully reduced the rainwater stream by 50% and solved the flood problem faced by the school.

At the same time, the RWHS has become the experiential learning platform for the high school students, especially in STEM subjects like science and physics subjects. The water retention dam and turbine have attracted students interest and curiosity to learn about energy conversion from potential energy to kinetic energy, kinetic energy to electrical energy as well generation of renewable energy for powering a scrolling board. The RWHS also supplies water to freshwater habitat in their fish pond. The active participation of the teachers and students to exploit the developed RWHS has helped SMKIS to secure second place in Eco-School Competition organised by Green Growth Foundation.

Meanwhile, the research team has successfully secured a Knowledge Transfer Program (KTP) grant worth RM45,000 to expand the RWHS capabilities. The second phase is currently ongoing and is expected to be completed by July 2020.



The research team also won consolation prize of Anugerah Khas Kumpulan in Anugerah Akademik Universiti 2018.





## ROUNDABOUT SENSOR DETECTION SYSTEM – ROUNDABOUT MANEUVERING MADE EASY

A roundabout is an alternative to conventional stop signs and signal signal-controlled junctions to create an intersection for drivers. Roundabout manoeuvring is based on the traffic density and the behaviour of the drivers. However, the unpredictable behaviour of the drivers is the main reason for the confusion among the roundabout users, especially at the roundabout entrance. This confusion leads to the high number of accidents at the junctions or in the roundabouts.

The idea of this technology called Roundabout Sensor Detection System is to detect vehicles in a roundabout and alerts the road users that are about to enter the roundabout. The system consists of warning lights with ultrasonic sensors, which are positioned at every junction of the roundabout to help the users decide, depending on the traffic density either to stop at the junction and yield to oncoming vehicles from inside the roundabout or to enter the roundabout.

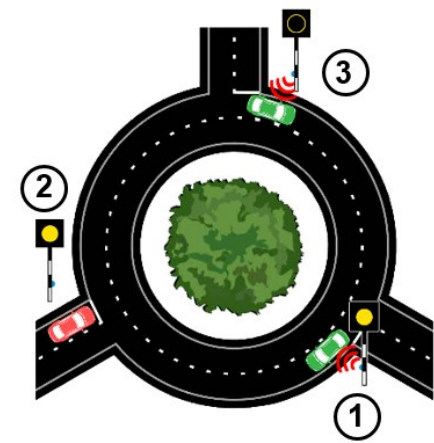
Roundabout Sensor Detection System was selected as one of the 20 finalists out of 70 participations in the Shell Selamat Sampai Varsity Challenge 2019 (SSSVC2019) and was awarded a start-up fund of RM 1,000.

The fund was used to build three prototypes of the warning light, and a pilot study was successfully conducted at UTeM Canselor Roundabout on August 2019.



### How the system works?

1. When a vehicle inside the roundabout passes the nearest light pole, an ultrasonic sensor (on the pole) will detect the vehicle.
2. Signal will then be transmitted to the receiver of the next pole, and its warning light will blink to alert vehicles that are about to enter the roundabout.
3. The warning light will stop blinking when there is no incoming vehicle inside the roundabout.



Roundabout Sensor Detection System was awarded silver in the recent Universiti Teknikal Malaysia Melaka Research & Innovation Expo 2019 (UTeMEX 2019). The researchers involved in this project are: Dr. Nurul Hilwa Binti Mohd Zini, Muhammad Hafiz Bin Mohd Fadzil, Muhammad Shukri Azizi Bin Razak, Muhamad Fakhru Akmar Bin Fazli, Syed Hafiz Hakimi Bin Syed Najmuddin, Zam Firdaus Bin Che Zamri, Dr. Fadhilah Binti Shikh Anuar and Dr. Nurhidayah Binti Ismail.





# EFFECTS OF PROCESS PARAMETERS ON STRENGTH OF POLYMER LATTICE STRUCTURE MANUFACTURED BY USING 3D PRINTER

This research focuses on the compressive stress of 3D printed polymer lattice structure using different combinations of process parameters which are layer resolution, print strength, print pattern and strut diameter. Acrylonitrile Butadiene Styrene (ABS) polymer is used as the 3D printing material in this research. The 3D printed lattice structure specimens are tested using Instron compression test machine with ASTM D695 standard.



The objectives of this research are to study the effects of process parameters on the strength of lattice structure manufactured using the 3D printer and to study the behaviour of lattice structure under compression test.

The polymer lattice structure is 3D printed by using different combinations of process parameters to get the best combination of process parameters that can produce the optimum strength product.

Figure 1 shows the methodology of this research, while Figure 2 shows some data and results from this research.

From this research, it can be concluded that 3D printed polymer lattice structure fabricated by using 70  $\mu\text{m}$  layer resolution, almost solid print strength, cross and honeycomb print pattern and 1.2 mm strut diameter has the optimum compressive strength. For future works, it is recommended that the failure of the lattice structure is identified by using finite element analysis (FEA) method as well as microscopic analysis.



Rafidah Hasan

HiPS Research Group / i-SMAT 3D Printing Research Group



Ng Wai Hoe

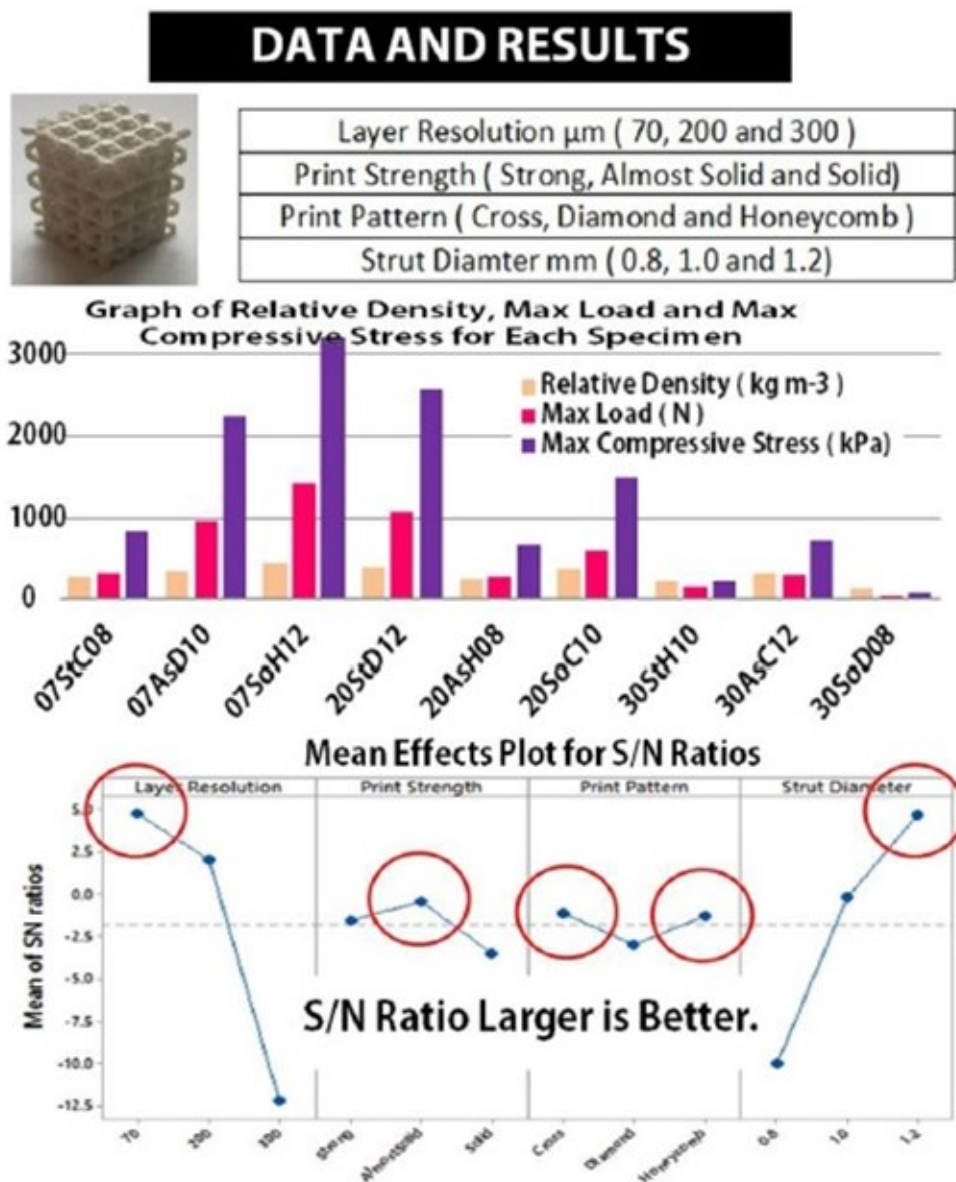


Figure 1 Research Methodology

Figure 2 Data and Results



By:



**Cheng See Yuan**  
i-Mobility Research  
Group

## EXTERNAL FLOW MODELING BY CFD – PART 1: INTRODUCTION

Computational Fluid Dynamic (CFD) is a modern tool for analysing fluid flow problems. Although it is mainly used for fluid flow simulation, it can also model complex phenomena such as combustion, heat transfer, and multiphase flow, including interface tracking.

In general, most fluid flow problems mainly concern about the pressure and velocity of the flow. These problems can be categorized as external and internal flow problems depending on the location of the flow with respect to the solid boundaries. In the former, the fluid flow is surrounding the solid boundaries such as the case of an aeroplane in which the airflow is surrounding the aeroplane surfaces. In the latter, the fluid flow is surrounded by solid boundaries. An obvious example is a flow inside a pipeline.

Figure 1 shows the five typical steps involved in a CFD modelling process. The further descriptions of these steps are as follows:

### STEP 1 – FLOW DOMAIN CREATION

A flow domain is a region in which the governing equations are applied and solved in CFD. This region is bounded by the domain boundaries. Some of the domain boundaries are with the surfaces of solid bodies, while others are located at where the flow enters or leaves the domain. Typically, a flow domain is created with a CAD software package.

### STEP 2 – GRID GENERATION

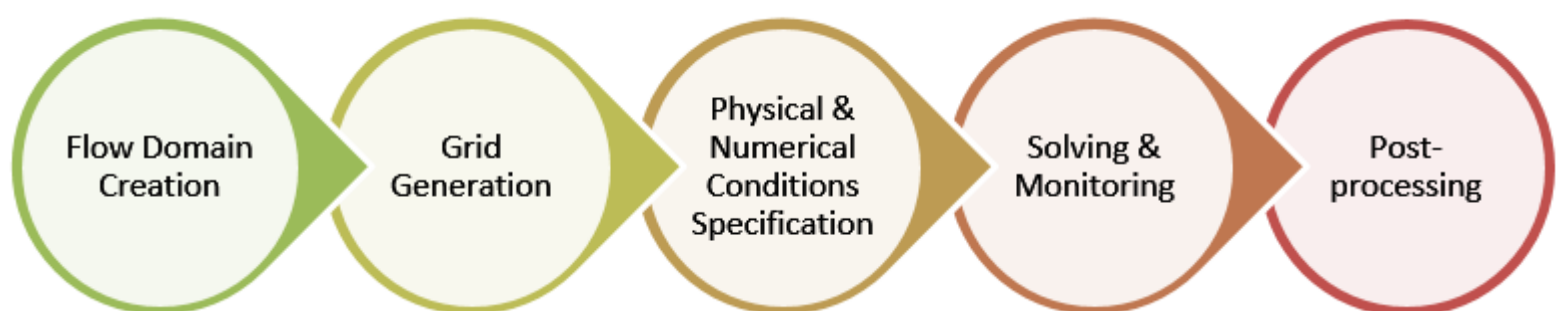
The flow domain is divided into many small cells through a grid generation process. Each of the cells is treated as a control volume where the discrete governing equations are applied and solved numerically. To ensure reliable CFD solutions, the grid has to be of acceptable quality. Indicators for grid quality include orthogonality, relative grid spacing, cell skewness, cell aspect ratio, etc.

### STEP 3 – PHYSICAL & NUMERICAL CONDITIONS SPECIFICATION

Prior to the solution process, the relevant fluid properties and physical conditions of the domain boundaries need to be specified. Then, CFD uses the assigned boundary values to determine the values of the flow field variables throughout the domain. In addition, the discretisation schemes and an initial solution need to be assigned. Then, CFD uses an algorithm to reach a final solution iteratively.

### STEP 4 – SOLVING AND MONITORING

This is when the computer takes over the task. However, it is important for the user to monitor the convergence progress. Should there be any convergence issue, the user should terminate the calculation and return to the preceding steps to perform the necessary adjustment on the settings.



**Figure 1** Typical steps of CFD modelling process

These steps need to be customised when applied to a particular flow category. In this article series, the focus is on techniques and considerations required to customise the CFD steps for modelling external flow problems. So please stay tuned to find out more about the modelling considerations in the next instalment.



**Visit our website:**  
<http://www.utm.edu.my/care>

**Contact us**

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