MONASH University

MALAYSIA

SYNC

Say Yes N' Collaborate

COMPUTATIONAL MODELING AND SIMULATION IN ENGINEERING

$$F = G\frac{m_1 m_2}{r^2}$$

ISSUE 10, APRIL 2023

"Simulation is an essential tool for predicting the behavior of complex systems and for designing solutions to real-world problems."

- Richard M. Fujimoto

Contents

Letter from
the Editorial Team

Computational modeling and simulation involves using mathematical and computational techniques to simulate real-world phenomena. The use of computational models have allowed researchers to study the behavior of complex systems in great detail, often uncovering interesting insights that would be difficult or impossible to discover otherwise.

In this issue, we are proud to feature diverse computational works such as modeling turbulent flows via the lattice-Boltzmann method, heart arrhythmia control, supply chain management, heat exchangers, and environmental geotechnics from our distinguished academics. We also included an article on Pure (a research management platform) and Dr. Joseph's views on retaining territorial integrity as computational researchers.

As we also transitioned to normalcy from the COVID-19 era, we are glad that the PhD Global Mobility program is back, along with physical conferences, and MUPA events (yay!). If you are stuck with your coding and simulation work, see what our fellow GRSs have shared on troubleshooting errors. We hope you find some light at the end of the tunnel through their advice. Need a laugh? Check out the jokes in the breakzone section. We hope you have a good laugh just as we did.

The editorial team would like to sincerely thank all the contributors who made this issue possible. We welcome any feedback and/or suggestion through the Google form for our continuous improvement.

Lastly, I will be signing off as this will be my last editorial in SYNC. I have had the pleasure to be part of the team for the past four issues. I have learned and gained a lot through this journey, and I believe the team will continue to bring in innovative ways to make our newsletter even better!

Let us SYNC – Say Yes 'N' Collaborate.
Thank you.

Dora Lawrencia
Editor
mum.sync.soe@monash.edu

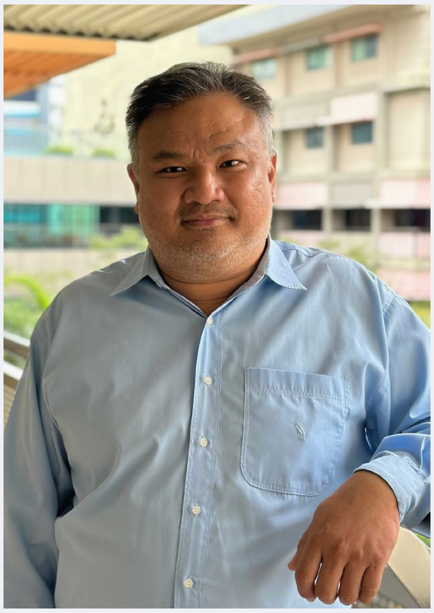
Join us or send us feedback!

Top row (from left to right):
Dr. Tan Wen Shan | **Dr. Mohammed Ayoub Juman**
Advisors

Bottow row (from left to right):
Janice Leong Suet Lin (GRS) | **Dora Lawrencia** (GRS) | **Yanru Wang** (GRS) | **Amelia** (GRS)
Journalist *Editor* *Reporter* *Designer*

Insights from

The Deputy Head of School - Education (Interim), School of Engineering



A/P Kenny Tan

A big thank you to the publishing team in SYNC for allowing me to share my insights on Computational Modelling and Simulation in Engineering. In today's engineering practice, computational modelling and simulation is a critical tool used to develop solutions that can meet contradictory demands of performance, cost and sustainability. Digital twins, which are also built using these tools, are also becoming a norm for condition monitoring in the realm of the Fourth Industrial Revolution (IR 4.0).

Computational resources, mathematical algorithms, and physical models are key elements in this area of study. Careful balance and consideration of all these factors is a must to ensure what is simulated matches the physical realities. In the early days when I started my research career in the area of computational fluid mechanics, computational power and resources severely limited the level of detail that could be simulated. Within the engineering community, emphasis was placed on developing efficient algorithms to maximise the capabilities at that time. The research focus has since shifted toward developing models that could accurately predict complex physics efficiently within a simulation. This would enable extremely complex phenomena such as biological systems, environmental, and nano-scale systems to be studied.

In this issue of SYNC, our community will share some of their work in this area. I hope the diversity of these ambitious projects will broaden your understanding of what is possible and give you inspiration for the next chapter in your journey.

A/P Kenny Tan
Deputy Head of School - Education (Interim)
School of Engineering

Spotlight

Computational Fluid Dynamics via Lattice-Boltzmann Methods

Dr. Yeoh Chin Vern

(Mechanical Engineering)

- Yanru Wang and Janice Leong

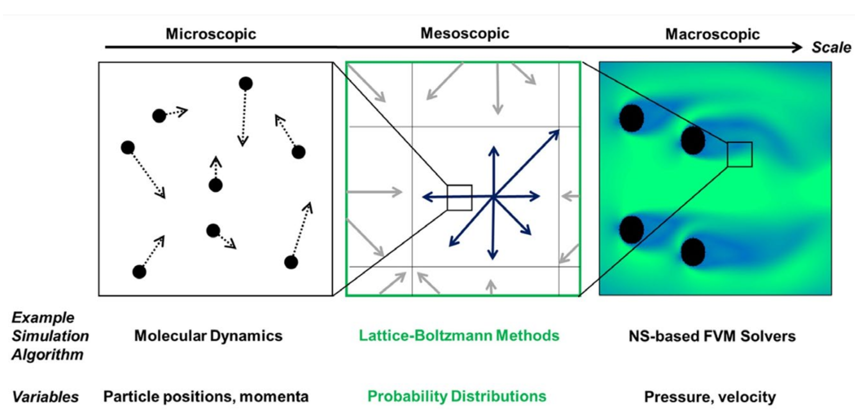
Dr. Yeoh Chin Vern

To contact Dr. Yeoh, visit

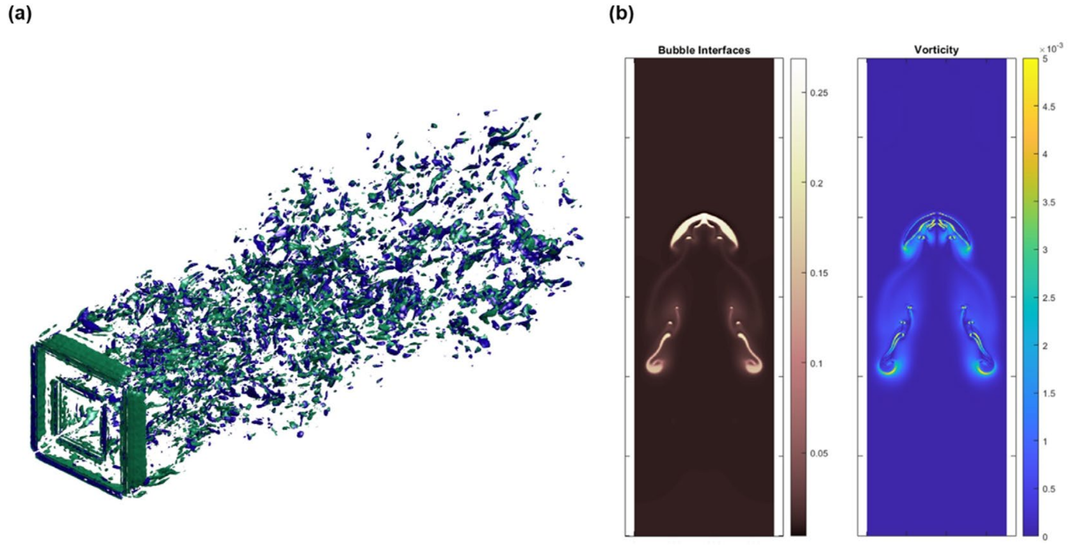
Fluid flows are omnipresent in the world around us, and can be observed in various systems ranging from our natural atmosphere to a wide range of engineering applications. Understanding the behavior of fluids is crucial for the design of many types of engineering equipment, including aircrafts, reactors, and heat exchangers. To mathematically describe fluid flows, the Navier-Stokes equations are at present our most complete classical description of fluid dynamics and is so widely established that it has been incorporated into almost all commercial computational fluid dynamics (CFD) software like ANSYS Fluent. CFD is a computer simulation technique that models the physical phenomenon of fluid flows, which allows one to understand the behavior of fluids quantitatively by obtaining complete pictures of the fluid's velocity, pressure, and (if energy is required) temperature fields. Modeling fluid flows via CFD is extremely useful, especially when dealing with complicated flow systems that cannot be investigated physically.

A common type of flow regime is turbulent flow, where fluids exhibit a chaotic behavior over a wide range of length and time scales. Yet, to date, there is still no one complete and universal 'theory of turbulence', and despite being almost two centuries old, turbulence is considered by some to be one of the greatest open problems of modern physics. Furthermore, modeling turbulent flows using the traditional Navier-Stokes equations requires enormous computational power, which could take up to days or months to simulate!

Dr. Yeoh Chin Vern from the Mechanical Engineering discipline, also a recent PhD graduate from the School of Engineering (SoE) in 2022, is studying an alternative simulation pathway, called the lattice-Boltzmann method (LBM), for simulating turbulent flows. While the Navier-Stokes models fluid using conservation principles at the macroscopic scale, LBM models the fluid through a molecular perspective, using a bottom-up physics approach.



Representation of the different scales of fluid flow, with the relative placement of the lattice-Boltzmann method highlighted in green. The unique 'bridging' location of the LBM at the mesoscopic scale allows for a potential best-of-both-worlds situation where the strengths of both microscopic and macroscopic representations may be combined for superior computational efficiency, with minimal artificial assumptions.



Example simulation applications of the LBM in Dr. Yeoh's research group and research collaborations; (a) direct numerical simulations of grid-generated turbulence (here, vorticity isosurfaces behind a single-square grid are shown), and (b) mesoscale simulation approaches to turbulent multiphase flows (here, density and vorticity fields in a rising 2D bubble for moderate Reynolds and Eötvös numbers are reported).

The LBM has thus emerged as a promising algorithm for simulating fluid flows, with an efficiency comparable to, if not exceeding, the Navier-Stokes solvers [1]. Moreover, the LBM is intrinsically transient and hence it can easily model unsteady flows. However, a drawback of the LBM is the inherent presence of numerical artifacts in the solver that can potentially cause instabilities in the simulation. When the LBM is executed, there will be generation of so-called artificial pressure waves for poorly-initialized solutions, which stem from the solver itself and do not occur in reality. This can jeopardize the simulation, especially for cases with high Reynolds numbers (turbulent flows).

As a recent PhD graduate, Dr. Yeoh recounts his PhD journey. His original plan for his research since his undergraduate days was to model transitional and turbulent flows using the LBM. However, he was unsettled about the numerical flaws in the LBM solver which are often neglected. As the saying goes: curiosity killed the cat, but satisfaction brought it back. Dr. Yeoh, curious about the sources of instabilities in the LBM solver, decided to invest some time in pondering over the numerical artifacts in the solver, which led to a detour in his PhD project. After playing around with the code for some time, by sheer luck, he had a Eureka moment. He realized that he could program a scheme that utilizes the artificial pressure waves as a source of information and apply some mathematical treatment, thus reducing the time for convergence (by more than 50%). He then developed his unique algorithm [2] for resolving the numerical flaws in the LBM solver by turning a disadvantage into an advantage. As his algorithm is still in its infancy, more work needs to be done for it to hit all the right notes.

When asked what motivates Dr. Yeoh to take up computational research, he stressed that engineering is not just applications, but physical understanding is important. For example, when using commercial CFD solvers, what is the rationale for selecting a particular turbulence or discretization model? It all boils down to physical understanding. "If the simulation algorithm is not mature enough, it is a physics problem, and that means there is a pathway to develop the code," said Dr. Yeoh. On some of the challenges met during his PhD, he broached that it can be difficult sometimes to define a fixed goal that is achievable in a certain time frame due to unexpected obstacles along the way. Although his research encountered a significant delay in having to deal with the unexpected fragility of the LBM for turbulent flows, an unforeseen problem was transformed into an alternative research opportunity which then became a major component of his PhD work – his own algorithm for improving the stability of the LBM solver.

Dr. Yeoh is searching for potential students to help him expand the current simulation capabilities of the LBM solver for modeling multiphase flows. He is also exploring the potential integration of machine learning to improve the efficiency and robustness of the LBM, as well as the application of multiphysics models to numerically simulate photobioreactors.

Sources:
[1] Yeoh, C.V., Ooi, E.H. and Foo, J.J. (2020) "Lattice-Boltzmann hydrodynamics of single-square-grid generated turbulence - a partial entropic stabilisation approach," Computers & Mathematics with Applications, 80(5), pp. 1301–1326. Available at: https://doi.org/10.1016/j.camwa.2020.06.013.
[2] Yeoh, C.V., Ooi, E.H. and Foo, J.J. (2021) "Utilization of pressure wave-dynamics in accelerating convergence of the lattice-boltzmann method for steady and unsteady flows," Applied Mathematics and Computation, 411, p. 126498. Available at: https://doi.org/10.1016/j.amc.2021.126498.

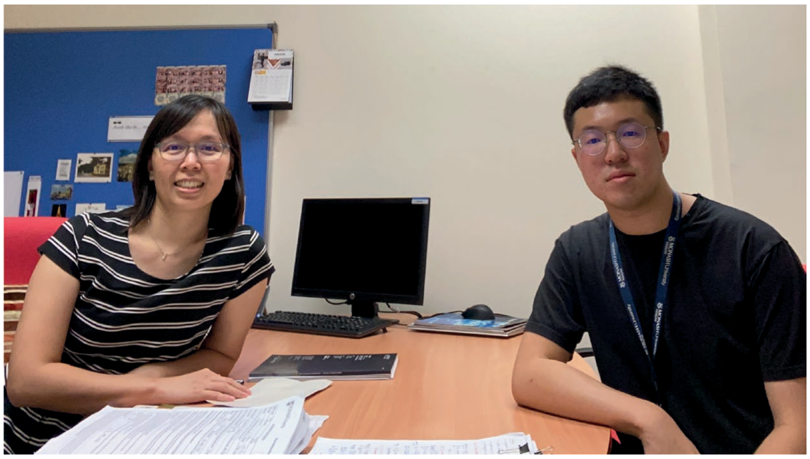
Spotlight

When the Heart Beats Abnormally

Dr. Liang Shiuan-Ni

(Electrical and Computer Systems Engineering)

- Janice Leong



Dr. Liang and her PhD student, Keong Jin.

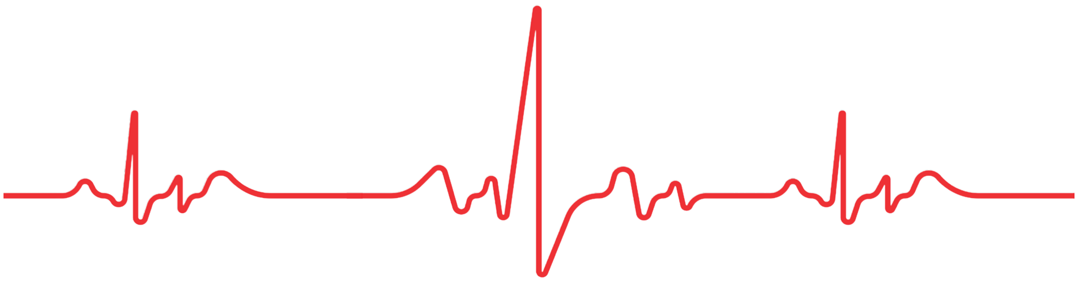
To contact Dr. Liang, visit

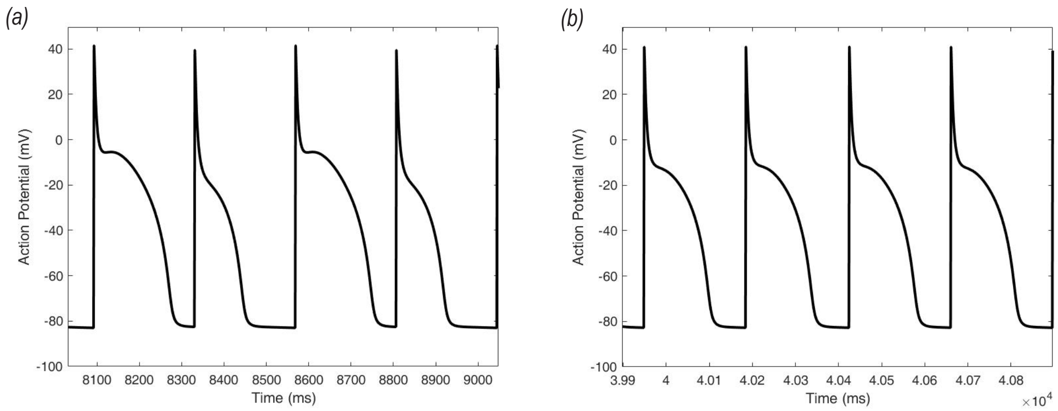
Heart or cardiac arrhythmia is a condition where heartbeats are abnormal—too fast, too slow, or irregular. Although a heart flutter or a racing heart (often referred to as palpitations) driven by feelings are largely harmless, an arrhythmia can range from discomfort to a potentially fatal problem [1]. Every year, millions of people experience arrhythmias, and some are successfully treated at early stages with proper treatment. However, some succumbed to the life-threatening condition by sudden cardiac death.

Cardiac arrhythmias come in various forms, one of which is cardiac alternans, where there is either an alternating strong and weak beat in the heart or an alternate-beat oscillation in the electrical activity (oscillates in a long-short-long-short pattern). This could be fatal and lead to sudden cardiac death if not treated. Among the various causes of arrhythmias include heart attack, blockage of the heart arteries, and scarring of the heart tissue based on past heart attacks. Thus far, the most common method for treating arrhythmias is via electrical cardioversion, which involves sending a strong electrical voltage to the heart to reset it to a normal rhythm. However, this approach may entail adverse side effects, including cardiac damage. Therefore, finding less damaging alternatives to treating cardiac arrhythmias is critical.

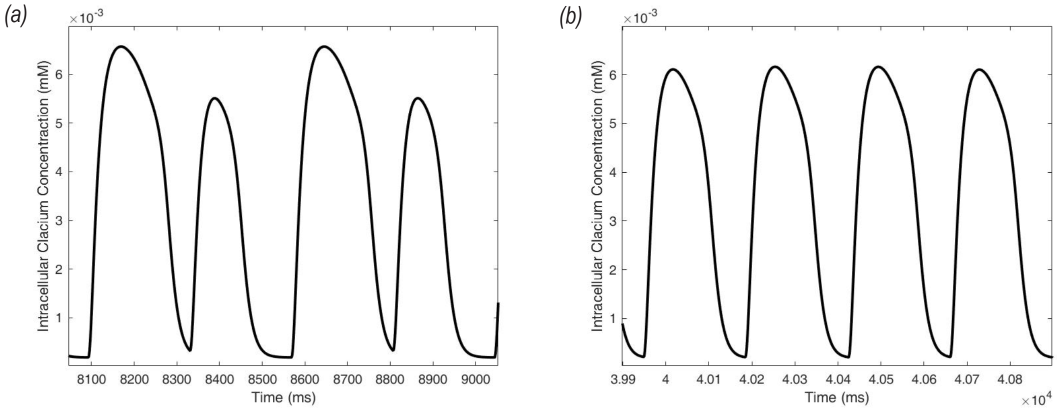
Here at the Electrical and Computer Systems Engineering discipline, Dr. Liang Shiuan-Ni and her research group are studying control methods for the suppression of cardiac arrhythmias via a low-voltage treatment that is less invasive than conventional electrical cardioversion. Proper control of cardiac arrhythmias using such an approach, however, is contingent on a fundamental understanding of the underlying dynamics, and to achieve this, computational modeling plays a significant role. Dr. Liang and her PhD student, Keong Jin, are currently working on a novel control method devised by a collaborator in controlling cardiac alternans. Specifically, they are examining the performance of this control method on a multi-dimensional scenario, which mimics the dynamics of the human heart more realistically. The work involves solving systems of partial differential equations to simulate the problem via programming tools such as MATLAB, C++ language, etc.

Dr. Liang highlighted that the main limitation of employing a lower voltage control approach is that it does not cover the entire human heart. In other words, it can only target a localized area. As a result, determining the position of the controls in the heart while maintaining a balanced compromise on the number of control points remains a challenge, and this is where computational modeling steps in to shed some insights.





Action potentials for alternans (a) before and (b) after control.



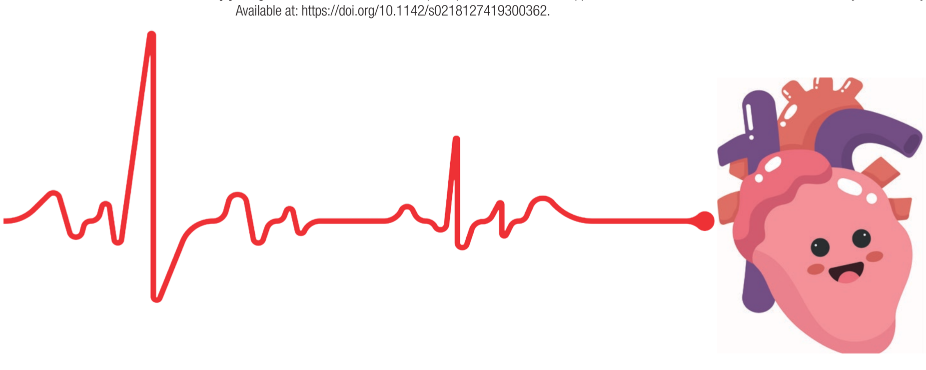
Intracellular calcium concentrations for alternans (a) before and (a) after control.

Further, as the human heart contains various kinds of chemicals, such as sodium and calcium ions, computational modeling can potentially reveal which chemicals had a drastic change in concentration before and after the control was applied [2]. Identifying the chemicals that had an influence on the occurrence of cardiac arrhythmias is a step forward in narrowing down the chemicals to target for the suppression of these fatal heart conditions. While Dr. Liang's research focuses primarily on pure electrical control, she divulged that computational modeling may also be used to explore the effectiveness of various combinations of control methods (e.g., electrical combined with mechanical and/or chemical means) in suppressing alternans.

When asked about some of the challenges faced in her research work, Dr. Liang mentioned that it was the low participation in computational work in general, noting that in this day and age, hot topics in the new industrial revolution take center stage. Although computational research is often avoided like the plague, Dr. Liang emphasized that it is highly crucial for extracting valuable insights for the treatment of cardiac arrhythmias that cannot be easily inferred from experimental works. She added that there are still many unchartered territories to explore in cardiac arrhythmia research, such as devising novel control mechanisms for other types of cardiac arrhythmias, as well as understanding the role of certain chemicals in preventing these heart diseases. Dr. Liang believes that when more come on board the computational field, the knowledge produced can significantly advance treatment, especially for a ticking time bomb health condition like cardiac arrhythmias, which have claimed many lives in the past.

Dr. Liang welcomes interested students to join her research team to investigate control methods for suppressing cardiac arrhythmias via computational studies.

Sources:
[1] Mageswari, M. (2021) Heart arrhythmia is cause for concern, The Star. Available at: https://www.thestar.com.my/starpicks/2021/08/22/heart-arrhythmia-is-cause-for-concern (Accessed: January 3, 2023).
[2] Liang, S.-N., Le, D.-M. and Lai, P.-Y. (2019) “Cardiac alternans suppression under T ± Feedback Control: Nonlinear Dynamics Analysis,” International Journal of Bifurcation and Chaos, 29(13), p. 1930036. Available at: https://doi.org/10.1142/s0218127419300362.



Opinion Article

Retaining Territorial Integrity as Computational Researchers

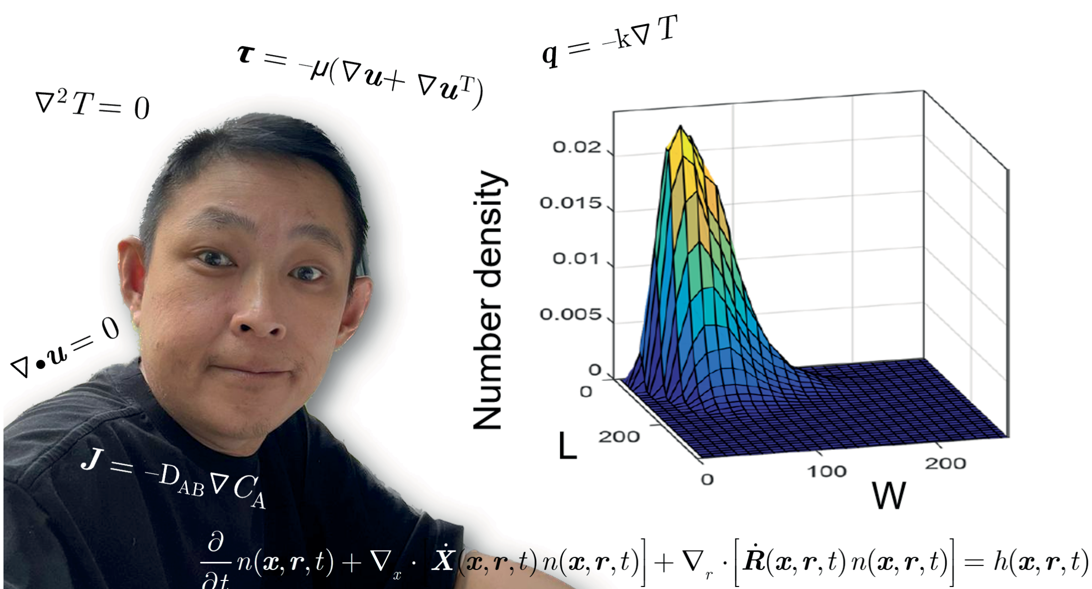
Dr. Joseph Ho Yong Kuen

(Chemical Engineering)

Since the beginning of time, mankind has aspired to uncover the mysteries of the universe by attempting to prescribe mathematical equations to predict observations of interest. From the study of phenomenon as simple as a fluid stream emanating from a faucet to the prediction of cosmological phenomena, time and time again, mathematics has been shown to govern the rhythm by which the natural world operates. The use of mathematics to explore the physical behaviour of the natural world accelerated in the late 20th century with the advent of modern computers. Multi-dimensional and spatio-temporal problems which previously were analytically intractable, finally saw the hope of being resolved numerically. Decades of intensive research labor thereafter bore fruit where it is now possible, with few clicks of the mouse, to model multi-physical phenomena through the use of various user-friendly commercial software. Undeniably, the abundance of such tools is invaluable for application-oriented engineering. For instance, one could inquire into the hydrodynamical features induced by various designs of heart pumps and their impact on patients. Such a feat would have been Herculean in nature without these computational suites.

To contact Dr. Joseph, visit

Many of these computing environments, while being extremely powerful, require minimal knowledge about the underlying mathematical framework to operate. From the perspective of cultivating talented human capital in STEM, the use of these software environments without core competency in mathematical understanding is a double-edged sword. A case in point, in the past one would need to master linear algebra, multivariable calculus, take up a course or two in basic programming and numerical methods, and attend a full course on transport phenomena, before one could begin to program the numerical solution to a simple two-dimensional steady state heat transfer problem given by the Laplace equation. This can now be done in under ten minutes with the help of commercial software by simply following the steps prescribed in a video tutorial on YouTube. While this has lowered the entry barrier for a novice researcher to perform "computational research", one could argue that it does nothing more than producing merely competent users of software packages.



> “The key here is not to replicate ancient materials, but to understand the underlying principles and thought processes involved, which will lead to the ability to generalize new knowledge.”

It is a worrying situation when young researchers in computational fluid dynamics (CFD) do not know how to perform a double dot product nor understand the physical implications of having a zero divergence and curl of a vector field. In other instances, users of the Galerkin’s finite element method are oblivious to the idea of basis functions, Lagrange interpolating polynomial, and the weak form of the governing equation. Worse, from the author’s own experience, the notion of ‘continuum physics’ is not very well known to average users of the Navier Stokes equation! Similar observations could be made about the average users of other computational fields (e.g., molecular dynamics and density functional theory simulations), but CFD is cited more frequently here as an example due to its broad familiarity within the engineering science fraternity. To this end, it is not the intention of this article to discourage usage of commercial software for research purposes, but rather to suggest a potential gap in our training of computational researchers.

While it is understandable that in this day and age of ‘microwave’ society, where stakeholders demand quick deliverables from principal investigators, there is immense pressure to accelerate progress in scientific research using computational tools. However, in the author’s opinion, this should not be done at the expense of a weakening core in the mathematical fundamentals. Citing again the field of CFD as an example, researchers ideally should strive to know the Navier-Stokes equation rather than to be perceived as someone who merely knows about the Navier-Stokes equation! Where possible, study of transport equations could be supplemented with knowledge of dimensional analysis or the classical asymptotic solutions pertaining to the Graetz problem. These, while not being of direct relevance to the more complicated scenarios pursued by modern day frontier research, are beneficial toward developing one’s mathematical intuition, without which there will be no basis for creativity. The key here is not to replicate ancient materials, but to understand the underlying principles and thought processes involved, which will lead to the ability to generalize new knowledge. The engineering fraternity has a lot to offer in that they bring to the table computational capacities which are typically lacking in the native field of frontier scientific research. While pursuing greener pastures, let us not neglect our core competencies in mathematical fundamentals, so that we continue to exert our territorial integrity as computational researchers.

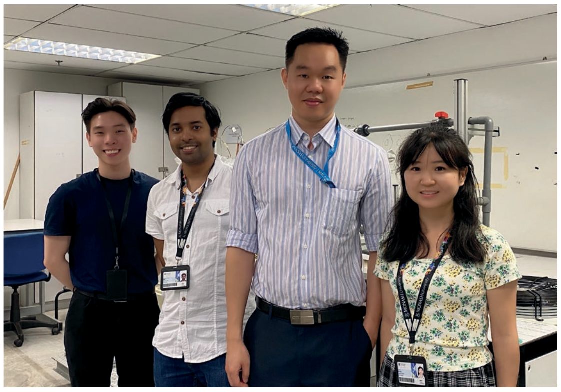
Dr. Joseph Ho is a Senior Lecturer in the Chemical Engineering discipline. He is known for his work to understand the continuum behaviour of distributed biomass particle states via an approach known as Population Balances. The views expressed here are the writer's own. For all things Population Balances, visit Dr. Joseph’s YouTube channel: https://www.youtube.com/@josephho6967.

Passive Heat Transfer Enhancement Techniques in Different Conduits Modeling

Dr. Oon Cheen Sean

(Mechanical Engineering)

- Yanru Wang



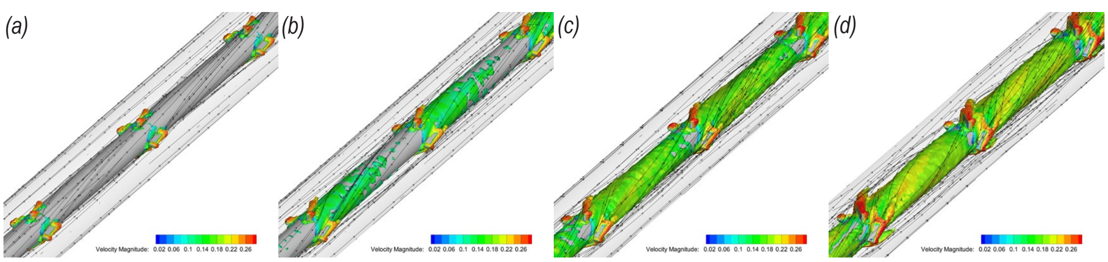
Dr. Oon and his research team

Heat exchangers can be used in many devices in the industry, such as car radiators, steam turbines, jet engines, nuclear power plants, and electric vehicles. Traditional heat exchanger designs which use smooth pipes and distilled water or chemicals can yield low heat transfer efficiency, increased energy consumption, and corrosion. Therefore, Dr. Oon and his research team focus on improving the heat transfer efficiency of heat exchangers by employing turbulators and nanofluids. Their research involves the fundamental study to understand the flow characteristics and thermo-hydraulic performance in the conduit using numerical and experimental methods. He mentioned that CFD is a helpful tool to understand ideas with less cost compared to running experiments. In addition, implementing simulation could help visualise the flow and particles which could not be easily observed in experiments.

To contact Dr. Oon, visit

Although previous work has demonstrated that the efficiency of heat exchangers could be improved by using turbulators and nanofluids instead of smooth pipes and base fluids, more research needs to be done to explore the heat transfer mechanism for the specific design. Dr. Oon and his research team are working on simple enhanced designs with low manufacturing and maintenance costs and easy installation methods to achieve high heat transfer enhancement. Their recent numerical work proposed angled fins, which caused swirling flow along the channel and improved the heat transfer with a low-pressure penalty [1]. He is also trying to collaborate with industries to solve their practical problems. In addition, they are working on applying functionalized graphene nanoplatelets nanofluids in the conduit. Although the drawbacks of nanofluids include high viscosity and sedimentation problems, they successfully produced the graphene nanoplatelets nanofluids using clove-treated functionalization techniques. Meanwhile, they proved it could obtain enhanced thermal performance by conducting numerical analysis.

The challenge for applying nanofluids commercially is their higher cost than other working fluids. In addition, there are some other problems that arise when nanofluids are employed, such as sedimentation issues and simple functionalization methods. Dr. Oon collaborates with researchers worldwide from Malaysia, Australia, Canada, the UK, and Japan to address these problems. Meanwhile, he also mentioned that running experiments is very important to verify the simulation results, even though the simulation results are accurate nowadays. The cause of heat transfer improvement must be well understood before implementing the findings for use in relevant industries.



Fins angled at (a) 10°, (b) 20°, (c) 30°, and (d) 40°. Streamlines indicate the path taken by distilled water at the mid-section of 4 angled fin cases for 12 L/min flow rate. The iso-surface Q-criterion plot displays the turbulence intensity at the wake of the fins.

Source:

[1] S. R. Nair, C. S. Oon, M. K. Tan, S. Mahalingam, A. Manap, and S. N. Kazi, "Investigation of heat transfer performance within annular geometries with swirl-inducing fins using clove-treated graphene nanoplatelet colloidal suspension," Journal of Thermal Analysis and Calorimetry, vol. 147, no. 24, pp. 14873–14890, 2022. Available at: https://link.springer.com/article/10.1007/s10973-022-11733-6.

Numerical Modeling in Environmental Geotechnics

Dr. Vivi Anggraini

(Civil Engineering)

- Dora Lawrencia

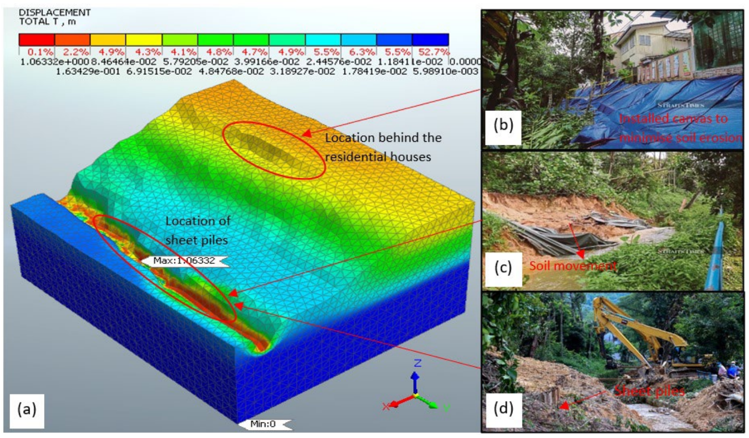
Dr. Vivi and her team visited the country's premier sanitary landfill at Bukit Tagar, Selangor, Malaysia

Environmental geotechnics is a discipline that focuses on the behavior of natural geological materials in engineered systems. Soil, as we know, is naturally inhomogeneous and is more sensitive to local environmental conditions than other prefabricated building materials like steel and concrete. Thus, it is important to comprehensively understand natural soil deposits, environmental interactions, and response to local conditions to better predict geomaterials engineering performance and behavior in projects through small scale laboratory work and validation using numerical modeling.

Many of Dr. Vivi's projects revolve around the geotechnical assessment of Malaysian soil to be utilized as clay liners in engineered landfills. According to geology, Malaysia is mostly covered with residual soils. This makes areas in Ampang or Bukit Antarabangsa prone to slope failure. Some areas are also covered with marine clay soil or peat soil which is even more problematic for construction due to the poor compaction. However, due to land constraint, developers and contractors often do not have a choice. Hence, soil needs to be pre-treated for ground improvement mechanically using machinery such as compactor, chemically, by mixing with cement, lime or fly ash, or through the insertion of geofabrics.

Some of her other projects investigate the rate of leachate transport through the residual soil liners and elevated temperature in the compacted clay liner due to the biodegradation of municipal solid waste organic fraction. This is where numerical modeling provides a great advantage as the service life of the liner can go up to 20 years or more, which is impractical to do at the laboratory.

Currently, she is moving towards incorporating IoT for monitoring and modeling water retention in urban vegetated soils and urban slope monitoring on rainfall-induced slope failure. She is also exploring more on using the Structure from Motion (SfM) photogrammetry technique of Unmanned Aerial Vehicle (UAV) to acquire an accurate three-dimensional slope surface and conduct 2D and 3D slope stability analysis. This also allows assessing slope failure in a more safe and practicable way.



(a) Displacement of 3D slope stability analysis; (b) Covered soil at the crest of slope; (c) Soil movement observed at the toe of slope, and (d) Sheet pile installation

Research Focus

To contact Dr. Vivi, visit

Research Focus

Ant Colony Optimization for Solving Problems in Supply Chain Management

Dr. Lily Wong
(Common Engineering)

- Dora Lawrencia

Dr. Lily Wong

Supply chain management (SCM) has become an integral part of a business' success. Poor SCM can result in quality issues and delays, which can become costly to the company and lead to customer dissatisfaction. Hence, in order to remain competitive, companies are looking for ways to optimize and integrate different parts of the supply chain such as production, inventory and distribution, to yield new benefits.

Dr. Lily Wong's work is mainly focused on solving the Inventory Routing Problem (IRP) by modifying the Ant Colony Optimization (ACO) algorithm. IRP integrates the inventory and transportation component of the SCM to minimize the total cost that consists of transportation and inventory cost.

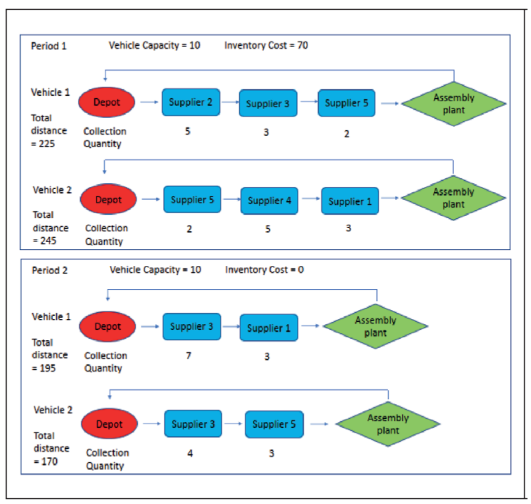
ACO was inspired by the natural behavior of ants to find the shortest and most efficient path between their colony and the source of food. Ants make use of chemical substances named pheromones to share the information regarding the distance of the path with other ants. When an ant passes by a location, it will deposit the pheromones on that trail in order to allow other ants to follow. The higher density of pheromones on an arc leads to attracting more ants to the arc.

To contact Dr. Lily, visit

Hence, the same concept was used to build the ACO algorithm which consisted of three main steps:

- Route construction: Building routes by selecting the next customer to be visited based on the formulation that consists of the information of pheromones deposited.
- Local pheromone updating: Simulate the natural evaporation of pheromone with the intention to avoid a very strong arc to be chosen by all the ants.
- Global pheromone updating: Resets the ant colony situation to a better starting point and encourages the use of shorter routes.

The biggest challenge she encountered throughout her research was the availability of data. Currently, she is using benchmark data sets available online and generating different datasets to be tested on different criteria. However, to solve more complicated problems, real data is needed.



Inventory Routing Problem

Dr. Lily proposed the algorithm of hybrid Population Based-ACO (P-ACO) which increases the exploration of finding different solutions and hence increases the chances of getting a better solution to solve the problem of IRP. In the future, Dr. Lily will extend the application of the proposed P-ACO to solve other variants of problems such as scheduling problems, network routing and machine learning. She also wants to work towards the green approach, taking into consideration the fuel consumption and emission of the transportation in IRP.

Managing Your Research: Why It Matters

- *Dora Lawrencia*

Academics

Research is key to creating new knowledge for the advancement of our society. Our academics at Monash University Malaysia (MUM) are ambitiously working to address pressing issues and major challenges facing the community today. While the research work itself is important, research management also plays an important role in supporting ongoing projects to obtain a bird's eye view of the research activities ongoing on campus. This will allow the campus to provide the required support in terms of funding and make strategic decisions based on the information at hand. The Research Excellence Unit (REU) takes on this role, and the first step is for academics to update the necessary information on the Pure platform.

"Pure is the Monash University research management system, which provides information about your grants, contracts, research outputs, and research

In Pure, you can:

- Lodge a research funding application for approval
- Access information about awarded grants and contracts
- Capture research outputs
- Record prizes and distinctions
- Create CVs
- Display research achievements

On 7 February 2022, the campus activated the Pure Profile, Awards Management, and Research Output modules. The Pure Profile is a central collection point for all your research related information and activities, and it is publicly available via the Monash University Research Portal.

Monash University Research Portal

Pure (Google site)

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Let's Ask Our GRSs!
How to Troubleshoot Coding and Simulation Errors?

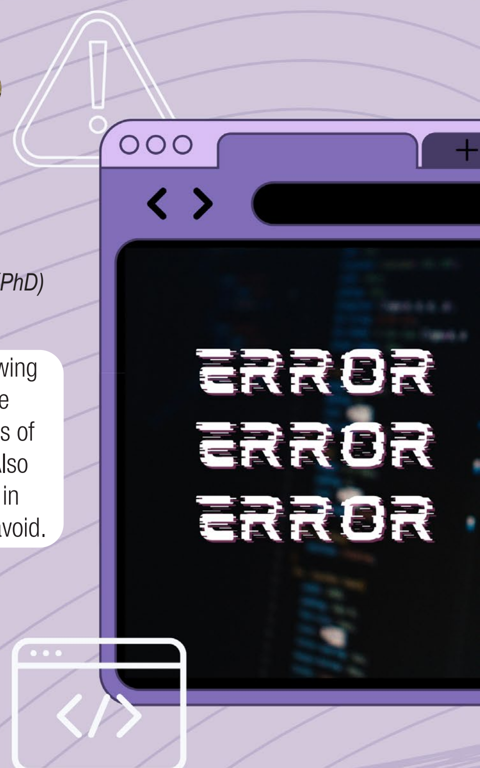
- Yanru Wang and Janice Leong

For troubleshooting code errors in Python programming, debugging is the most critical technique to be used, which allows you to trace the error to where it is caused. I always use Spyder for Python programming, and it is very friendly to the people who are not professional in programming. By using Spyder, you can debug the code step by step, line by line, and visualize all the relevant variables. Other than that, if you are using Jupyter Notebook, pdb.set_trace() will assist you debug the code as easy as in Spyder.

Zhihao Pan
4th Year, Mechanical Engineering (PhD)

To troubleshoot simulations, the mesh quality and the residual values are the fundamental aspects which need to be inspected. Most errors in simulation results can be traced to poor mesh quality or a simulation that has not fully converged. As for coding, it is basically bug tracing the code on a line by line basis after stripping the code down to its most basic function.

Sayshar Ram Nair
3rd Year, Mechanical Engineering (PhD)

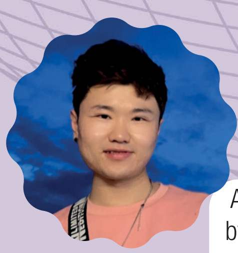


Depending on the error, I suppose I would often resort to reviewing the simulation or code, and comprehending what could have contributed to the error. After spending hours coding thousands of lines, it is easy to overlook or make mistakes along the way. Also reading official manuals and online forums can definitely aid in troubleshooting specific errors you have, and errors you could avoid.

Michael Luke Ho Gwanjie
2nd Year, Mechanical Engineering (PhD)

Before you start building your model, think about your problem first from the physics point of view and analytical philosophy, so you can have the ability to see your problem in higher dimensions. As they always say, think first, program after, and trust second. Avoid constructing a very complex FE model in the first place. Start simple to avoid the risk of errors while defining geometry, meshing, loading, or interactions. So start with a simple model and build on that to get what you want. Criticize the output data to ascertain how good the output results are and how accurate the output data are as they say garbage in, garbage out! Use visual inspection to determine model status and always perform manual calculation checks. Finally, always adopt the lawyer mindset to defend findings.

Mahmoud Moursy
2nd Year, Civil Engineering (Master's)



As a beginner in coding, when encountering errors that I am unable to solve, I always start by carefully reading the error message and searching online for a solution. Afterward, I take some time to reflect on what might have caused the error.

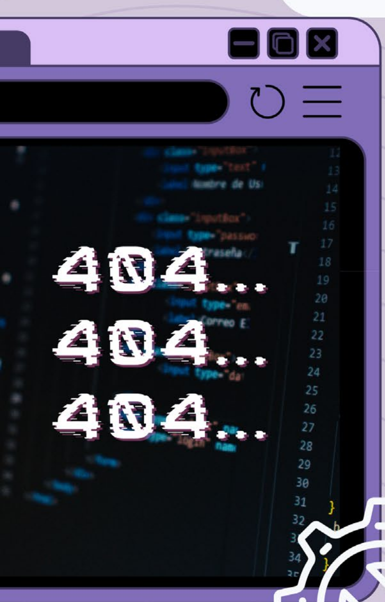
Chang Cheng
2nd Year, Mechanical Engineering (PhD)

I firstly review the error message as it can often provide valuable information about what went wrong. Next I usually put the error statement in the search engine and read various threads/posts relevant to this error message. The next source to get guidance is to ask my seniors and colleagues who use similar software. Lastly, I discuss it with my supervisor and in some cases if the project is not confidential I create a post on social media to get feedback from experts on the issue. I believe it is very important to approach the troubleshooting process systematically and methodically, as resolving a simulation error can often require a combination of various aforementioned steps.

Hafiz Zain Saeed
3rd Year, Civil Engineering (PhD)

Zeeshan Ali
4th Year, Mechanical Engineering (PhD)

As a researcher developing mathematical models for infectious diseases, I deal with complex nonlinear differential equations that require numerical methods to find the best solutions. While using MATLAB and Mathematica, errors can occur during the coding or simulation process. To troubleshoot these errors, I first analyze the error message and relevant code and then use debugging tools like breakpoints or print statements to identify the issue. I systematically work through the code to find the root cause of the problem. If I am unable to resolve the error on my own, I seek help from online forums to find the solution. These experiences have made me an expert in using mathematical software, enabling me to advance my research and contribute to our understanding of infectious diseases. I believe that making mistakes is not always a bad thing, as it provides an opportunity to learn and improve.



Troubleshooting errors in coding requires a systematic approach. Firstly, breakdown the error message and understand what it is trying to convey. Then, examine the code, look for any syntax errors or incorrect logic. If necessary, use print statements or log files to trace the values of variables and understand how the code is executing. Additionally, seeking help from online resources, forums, or other developers can also be effective in resolving the issue. The key is to be patient, persistent, and methodical in your approach to finding a solution.

Lim Jia You
2nd Year, Mechanical Engineering (PhD)

Zakia Hussain
2nd Year, Robotics and Mechatronics Engineering (PhD)

Read the error message received. Sometimes it can just be a simple syntax error. Next Google, that is what we all do. You will definitely find something related to your query if not exactly the same. Try connecting the dots between the error and the simulation/modeling you are doing to identify the type of error. It can be frustrating at times but it's all a learning process which will definitely improve your coding skills.

Coding is hard, but troubleshooting your own code can be more difficult! You almost never get your code to execute as intended at first. As a code geek, I would like to share some useful tips for debugging malfunctioning code. First, do not implement any fixes before you certainly understand the issue. Performing blind fixes is the last thing a programmer wants to do! You should first identify the problem, reproduce it in a simpler version, and then only troubleshoot it. Second, it is always a good idea to put in breakpoints while troubleshooting your code. It allows you to examine the value of variables at certain times, especially the ones in the function files. You will eventually discover something odd, then it would be easier to resolve from there. Last but not least, it might be bizarre to say that taking a break helps but it really does! Sometimes you will have to rest and let your brain enter diffused mode for it to work out the solutions subconsciously.

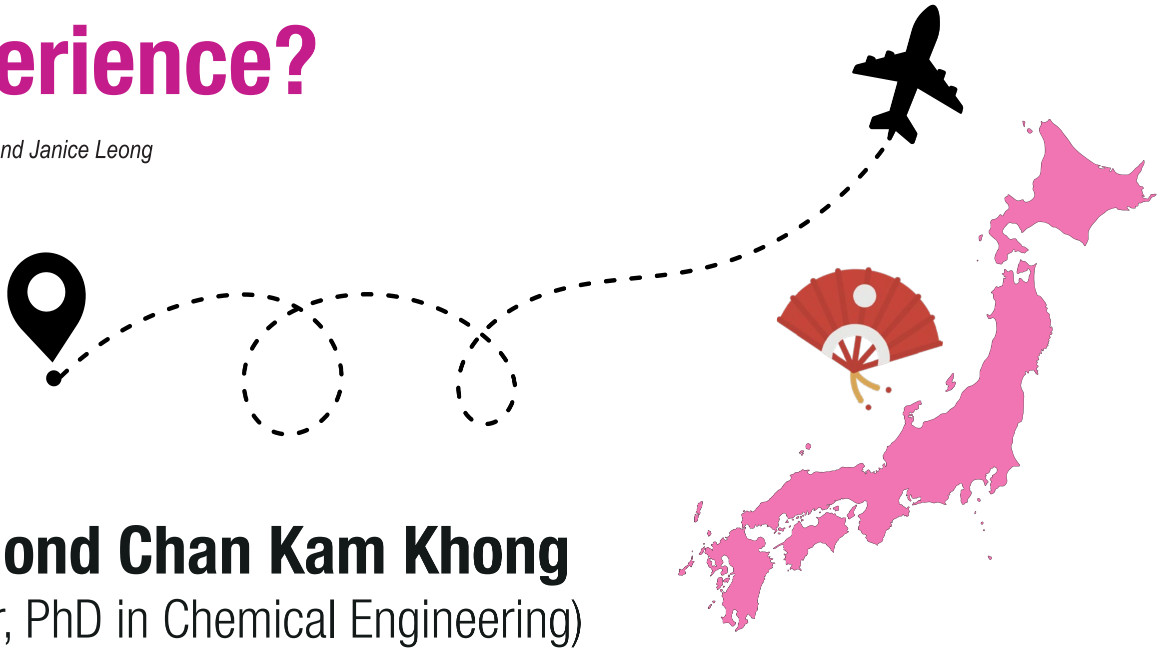
Simon Tiong Ing Xun
2nd Year, Chemical Engineering (PhD)

Feature

Let's Ask Our GRSs!

How was the Global Mobility Experience?

- Yanru Wang and Janice Leong



Raymond Chan Kam Khong

(3rd Year, PhD in Chemical Engineering)

Raymond and other students in Fukui, Japan

Raymond Chan Kam Khong is a final year PhD student in Chemical Engineering. His research focuses on how ionic liquids interact with enzymes. He participated in the Sakura Science Exchange Program (SSP) for a one-week exchange at Fukui University in January 2023. The SSP consists of student participation from various countries, including Malaysia, Taiwan, Indonesia, and Vietnam.

At Fukui University, Raymond engaged in fruitful discussions with the lecturers, visited the labs, and conducted laboratory experiments. An interesting observation Raymond noticed was that the local students were extremely meticulous when conducting their lab experiments and were excellent at troubleshooting problems swiftly. He also noticed that the students there are more laid back and less stressed when doing their research.

During his free time, Raymond travelled and explored the city by train, tried a variety of local cuisines, and visited the temples there. "Fukui is a traditional, clean, and peaceful city. I enjoyed experiencing the local culture there. The people are so polite and helpful," Raymond said. It was, however, difficult for him to communicate with the locals due to the language barrier. One amusing incident that occurred, Raymond shared, was when he returned back to the hotel and found a gigantic spider in his bag!

Although it was a short visit, Raymond's time there was truly an eye-opener. He learned to be independent when travelling alone and experienced new things abroad. Besides, he learned to come up with back-up plans in case things did not work out as expected. Lastly, Raymond is keen to return to Japan for a postdoctoral position.

University of Fukui, Japan

Fung Cheng May

(4th Year, PhD in Chemical Engineering)

Cheng May at Kobe University, Japan

Fung Cheng May is a final year PhD student in Chemical Engineering. Her research focuses on the conversion of carbon dioxide into valuable solar fuels. She applied for the PhD Global Mobility program and was given the opportunity to spend a month at Kobe University in Japan from mid-December 2022 to mid-January 2023.

When applications for the Mobility program were finally open after the pandemic restrictions were lifted, Cheng May was overjoyed. “I look forward to cultivating international knowledge and learning from other researchers. It allows me to understand better and be more accepting of diverse cultures. Being immersed in a different culture will allow me to see things from different perspectives and viewpoints as it will promote your wellness and adoption of multiple feasible approaches to learning and give you insights for problem-solving,” she said.

Cheng May is a sushi lover. That is one of the reasons why she selected Japan. She also mentioned that Japan is one of the safest countries in the world which is especially suitable for females to travel alone. In addition, Cheng May was fortunate to have a friend who graduated from Monash Malaysia and is currently a postdoc at Kobe University. With the assistance of her friend there, she was able to converse with the local students and order meals more easily as most locals do not speak English fluently.

At Kobe University, Cheng May conducted various laboratory activities such as using the transmission electron microscopy. She also attended group discussions and weekly meetings with her host supervisory team to exchange ideas. In terms of the skills gained, conquering the fear of working with people from other countries was one of them as well as developing a high self-awareness level in a totally unfamiliar environment. Furthermore, engaging and participating in a wide scientific network expanded her knowledge and skills, and building networks boosted her self-esteem, confidence, and career relationships.

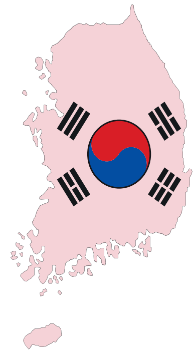
Cheng May (a) in kimono at Kiyomizu-dera Temple, (b) at Kinkaku-ji Temple, and (c) at Nara Park.

During the one-week holiday, Cheng May explored other parts of Japan including Tokyo, Kyoto, Osaka, and Nara. To her, the most memorable activity was wearing a kimono (Japanese traditional garment) at the magnificent Kiyomizu-dera temple. Interacting with the locals and immersing herself in the local culture was also a highlight of her time there. Besides, she learned to respect people by bowing, like the Japanese do. Cheng May recalled a peculiar incident that happened where she bowed to a deer in Nara, and to her surprise, the deer bowed back to her!

There are a few tips she would like to share with the current GRS. When emailing potential collaborators, a well-structured resume which includes a brief introduction of your research background, intention, and how the placement benefits you and your research are highly important. The most challenging part is finding a host supervisor who is willing to collaborate. Nevertheless, once you get the connection, you are one step ahead to securing the opportunity for the placement.

Jeremy Ong Chun Hooi

(3rd Year, PhD in Mechanical Engineering)



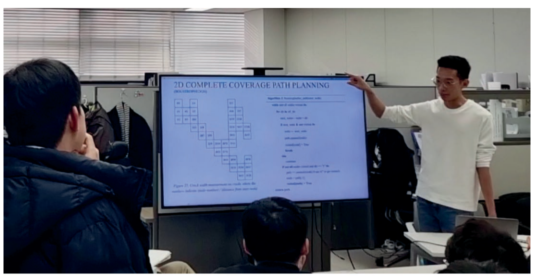
Jeremy at Seoul National University, Korea

Jeremy Ong Chun Hooi is a PhD student in Mechanical Engineering. His research focuses on identifying thin crack regions on typical road pavements and developing an automatic detection and repair system to seal cracks. He applied for the PhD Global Mobility program last year and was selected as one of the candidates to exchange at Seoul National University for three months, from December 2022 to February 2023.

Jeremy's motivation for applying to the program was to leave his comfort zone, experience living abroad, and learn from different perspectives. "Machine learning is a huge field," Jeremy stated, alluding to his research's use of machine learning tools. "There is no way that a researcher in the field can understand all papers published within the community. If someone else works in a similar field but uses different approaches, that could improve your understanding and provide insights to new ideas," he added.

At Seoul National University, Jeremy worked closely with the lab researchers and came up with new ideas. As machine learning is a vast and complex field, Jeremy mentioned that it is highly significant to select a suitable technique when approaching problems in the field. For example, in road pavement defect detection, it is costly and inefficient when the supervised learning method is used while other methods can provide better efficiency. Additionally, Jeremy learned their approach for solving research problems which can be applied similarly to his own research, such as learning how to combine statistical data into models in an effective and precise manner.

Jeremy and his fellow lab researchers



Jeremy presenting to other students

The skills gained during Jeremy's placement were not only relevant in the academic field but also in the business world. He learned how to commercialize his research there, which was very different from the PhD work itself. At the university, language barrier was fortunately not a problem for Jeremy as the students in the lab are fluent in English. Outside of the university, though, he struggled with the language barrier. Hence, Jeremy made an effort to adapt quickly by learning Korean, with which he was able to converse in simple Korean.

All in all, Jeremy's time in Korea was a fruitful one. It was a great pleasure for Jeremy to be working with such a dynamic team at Seoul National University. When asked what was the most extraordinary thing that happened during the placement, Jeremy shared that it was obtaining a long-term partnership with his host professor, for which he is extremely grateful and pleased.

On some tips for applying to the Global Mobility program, Jeremy mentioned that it is essential to find a host supervisor who has similar research interests to maximize learning. He got into contact with his host supervisor by emailing the author of the Modern Robotics textbook, whose research is similar to his. It is also advisable to prepare in advance since communications could take months.

Jeremy (a) in hanbok and (b) playing traditional games with Koreans

Monash Future Sensing Conference 2022

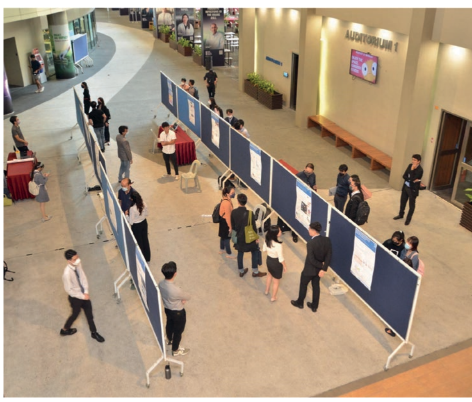
Monash Future Sensing Conference 2022, held on 21-22 November 2022, was organized by Monash Future Sensing Node (MFSN), a research cluster composed of academics and researchers from the Australia and Malaysia campuses of Monash University. The two-day conference had several academics and industry experts present on the recent developments in the field of sensors and related instrumentation.

At our Malaysia campus, a student poster competition was held on 22 November 2022 with student participation from various universities. All participants were awarded either a gold, silver, or bronze medal based on their scores. The top three (best poster and two runner-ups) were additionally awarded with vouchers. Congratulations to the GRSs from SOE who won the awards!

Gold
Andrea Liew (Best Poster)
Lim Hui Jean
Chamalka Perera
Widanalage Dakshina Thiwanka Fernando

Silver
Keenan Yap Zhihong

Bronze
Seah Ming-Yi
Jeshaiah Khor Zhen Syuen



YSN-ASM Chrysalis Award 2022

Congratulations to Dr. Ng Wen Cai (recent PhD graduate from SOE), for winning the Best Presenter Award at the Grand Final Pitch of the Young Scientists Network – Academy of Sciences Malaysia (YSN-ASM) Chrysalis Award 2022!

Chrysalis is a seven-month flagship leadership programme organized by YSN-ASM. The programme aims to identify, develop, recognize, and empower PhD students within our nation's science, technology and innovation ecosystem, and to inspire them to contribute to society. Throughout the programme, 15 finalists, including Dr. Ng Wen Cai, were evaluated individually on their demonstration of knowledge, enthusiasm, leadership, creativity, teamwork, presentation skills, among others.

Once again, congratulations to Dr. Ng Wen Cai on the remarkable feat!

COMMATCH 2022

MRC-MRANTI Commercialization Matching Day 2022 (COMMATCH 2022) is a joint collaboration between the Malaysian Rubber Council (MRC) and the Malaysian Research Accelerator for Technology & Innovation (MRANTI). The event aims to intensify research, development, commercialization, and innovation, as well as to promote the uptake of rubber-related technologies by industry players in the country.

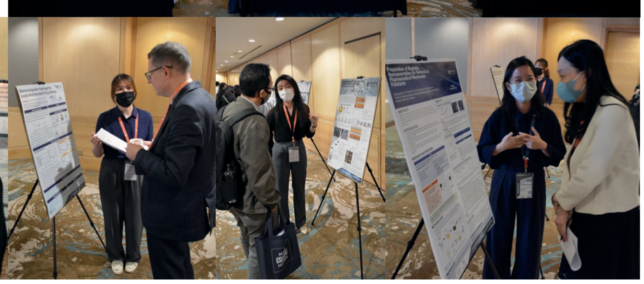
Dr. Patrick Tang and Darren Low (GRS) showcased their self-healing glove innovation at the event which was held on 8th December 2022 as below.

ISAFM2

The 2nd International Symposium on Advanced Functional Materials (ISAFM2), organized by the Advanced Engineering Platform, Monash University Malaysia, was successfully held on 16–17 February 2023 at Concorde Hotel, Kuala Lumpur.

The two-day hybrid event consists of Keynote Lectures, Invited Talks, Oral and Poster Presentations, with over 100 participants from more than 10 countries. Several GRSs from SOE participated and presented their research at the conference.

In summary, the ISAFM2 fostered insightful conversations and scientific discussions in a wide range of advanced materials fields, and provided delegates with an excellent platform for networking and establishing new connections and collaborations.



MUPA Events

The Monash University Postgraduate Association (MUPA) was founded in May 2007. MUPA serves as a representative body for all postgraduate (research and coursework) and honors students enrolled in Monash University Malaysia. MUPA organizes many exciting events throughout the year, including social events, retreats, competitions, annual dinner, and many more! These events are the perfect avenue for you to mingle around and make new friends.

Hoodie design competition (25 August–9 September 2022)

Team building event at Sunway Lagoon Park (9 October 2022)

Yoga session (28 October 2022)

MUPA Retreat at Desaru, Johor (12–13 November 2022)

Escape PJ (10 December 2022)

Annual dinner at Mandarin Oriental, KL (17 December 2022)

Follow MUPA to stay updated!

mupa.monash.edu.my

mupa.monash

BREAKZONE

JOKES OF THE DAY

% by Theshan Weerasinghe
Joke_1 = “Heartbreak is measured in Megahurts and Gigahurts.”

% by Smith 13
Joke_2 = “You can never have a good time with a Simon.”
(assignment)

% by Yohanathan Kumaran
Joke_3 = “An engineer, a doctor, and a lawyer decided to have a challenge who could spend the least amount of money traveling around Europe. After a week of traveling, they met and the lawyer proudly says, I only spent 1000 euros to visit 5 countries. I managed to convince everyone I was a local so I got discounted rates everywhere. The doctor then says I only spent 500 euros and visited 5 countries as well. I volunteered in the Red Cross and did not have to pay for lodging. The engineer then said, I did not have to spend any money. In fact, I made 1000 euros and visited 20 countries. I just worked half days at Eurorail for a week. Engineers rock.”

% by Smith 13
Joke_4 = “Which is faster, hot or cold? Hot, because you can catch a cold.”

% by Lim Jun Yi
Joke_5 = “When you think you've seen the worst presentation, wait till' you get a hold of my boy, Eason. The dude did a 20-minute presentation in 45 minutes. He's a funny guy by nature but that is if you get the joke. During his final review presentation, Eason was constantly throwing punchlines that the average PhD holder couldn't comprehend. "What issit you guys no get? Let me explain again.", and then proceeds to laugh at his own joke, while randomly giggling at times about an earlier joke. Imagine this happening on almost every slide, and there you go, the nastiest presentation one can ever witness.”

Thank you to the GRSs who shared their jokes.
We had a good laugh, and we hope you do!
Enjoy the rewards!

Stay tuned for the next SYNC issue for more exciting insights and fun :)