Uplink.

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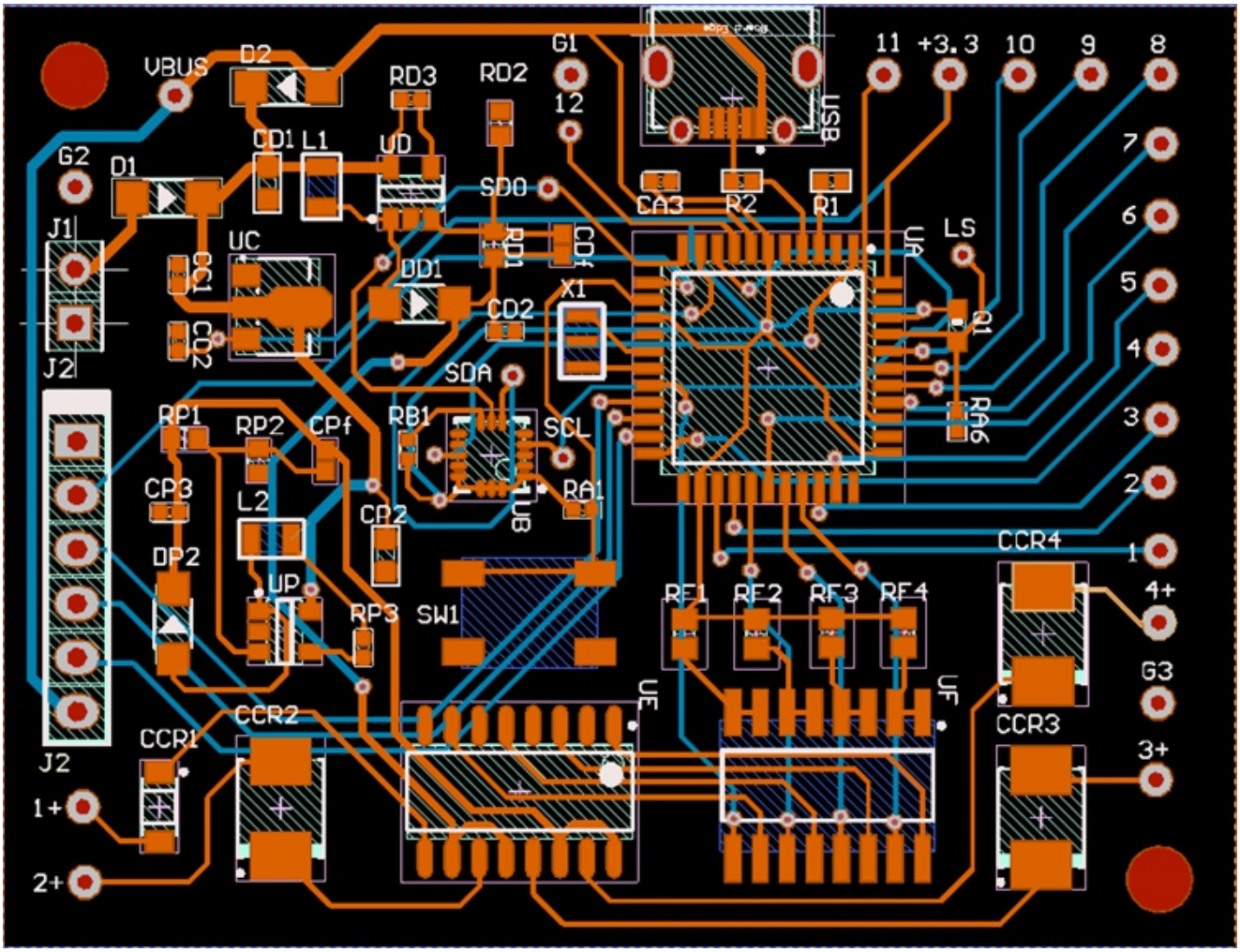

IEEE

Address to IEEE Victorian Section members

Dear Members and Friends of IEEE Victorian Section,

Uplink is *your* Journal. This publication exists, not only to inform and enlighten you and other Readers, but also provide a channel of communication for you. If you have any technical topic or matter of interest on which you would like to write an article about, then please do so!

Also, letters to the Editor will be very much appreciated. For example, suggestions on new things you think the Section could do or comments on how we are going would be appreciated. Letters about *Uplink* itself, will be particularly welcome! Priority will be given to letters of 200 words or less. For further details about letter requirements, please refer to the Section website.

We hope to hear from you soon!

The Editor, *Uplink*.

Our Cover:

Printed Circuits are now a well-established technology, but they continue to evolve rapidly in numerous aspects of design, manufacture, quality assurance, materials selection, and scope of application.

Photo on cover page: GNS Associates Pty Ltd.
Photo on page 2: http://www.iemoji.com/view/emoji/368/objects/postbox

August 2021

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From the Flight Deck

As I write this note for our next Uplink edition, we are again in lockdown in Victoria. However, overall, it appears we are now better equipped to fight this pandemic. On May 17 this year, we held our first IEEE Victorian Section face-to-face meeting since early 2020. It was a gathering of our student branch committee members, albeit with restrictions on numbers, and we were thrilled to see them all in person. Many of our student members have been impacted by the pandemic with experiments on hold, travel to other labs or conferences not possible and social events at universities much restricted. It is, therefore, important to keep engagement with our students ongoing through events (virtual or in person), Uplink sections dedicated to students and our student paper competitions.

For all members, our technical chapters and affinity groups continue to hold online events and where possible, we have been publishing these through our YouTube channel, in case you missed attending any of these events. We encourage you to have a look at the great talks and workshops that you can access online.

We again hope all our readers are safe and well and that we are in a less restricted stage by the next edition of Uplink.

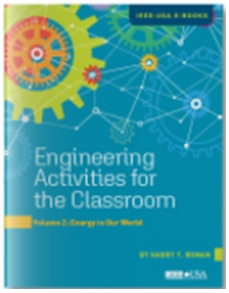
Mehrnaz Shoushtarian, PhD
Chair, IEEE Victorian Section
mehrnaz@ieee.org

IEEE News

IEEE online events on YouTube channels

Found an IEEE online event interesting? Wanted to attend but had another important commitment during that time? We totally understand! We are publishing the events of the technical Chapters and Affinity Groups on the Section's YouTube channel. We also have exclusive YouTube channels for AP-MTT Joint Chapter and University of Melbourne Student Branch. So next time you find an interesting event to attend, but can't make it, watch it on YouTube at your own convenient time!

IEEE USA eBooks



IEEE has many hidden resources for its members, and one of these is IEEE USA eBooks. It has several interesting eBooks and Audio Books for free for all IEEE members in different genres that you may find interesting, such as STEM education, employment, career guidance, fun, and Women in Engineering, to name a few.

2021 IEEE R10 Special Recognition of Student Branch Award

It's a proud moment for Victorian Section that the University of Melbourne Student Branch has been awarded with 2021 IEEE R10 Special Recognition of Student Branch Award. This award is in recognition of activities organised by the 2020 Student Branch Committee with a commendable number of 50 events throughout the year! Congratulations to Noor Karishma Shaikh (2020 The University of Melbourne Student Branch Chair) and her team.

IEEE Day 2021 is coming soon!

IEEE Day is an annual event that takes place on the first Tuesday of October every year to celebrate IEEE members! One of its objectives is to show the ways in which thousands of IEEE members join together and collaborate to work on ideas that leverage technology for a better tomorrow.

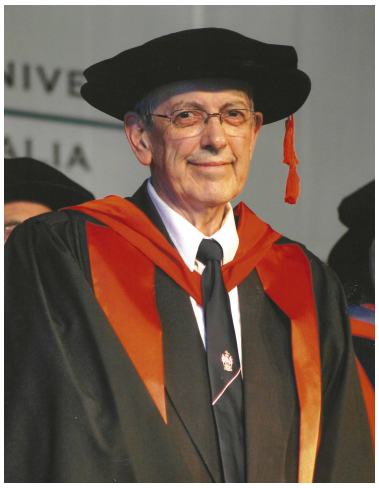
This year, IEEE Day will be a hybrid celebration, with events taking place both physically and virtually, around the world. It will take place on 5 October 2021. If you would like to encourage IEEE Victorian members to share their technical ideas and be inspired to achieve their technical goals, please contact us and submit your events on IEEE Day Events website.

Remembering Laurie Cahill (1939-2020)

by Enn Vinnal

Laurie was a colleague and long time friend of us on the IEEE Victorian Section Executive Committee. He passed away on the 22nd of November 2020. As background, he was born in Korrumburra, Gippsland, on the 17th of July, 1939. He was schooled locally up to Year 11 and then moved to Melbourne to complete his education. He completed his Year 12 while employed full-time as a technician-in-training in the Postmaster General's Department (PMG), the fore-runner of Telstra and Australia Post. The PMG offered Laurie a cadetship to attend the University of Melbourne to study Engineering. Laurie completing his Bachelor of Engineering there and followed that up with a Master of Engineering in 1967, and a PhD in 1971.

He came back to the PMG to work at the Research Laboratories specialising in optical engineering and communication systems. He told some of us many a tale about the wonderful cast of eclectic characters there. His ultimate calling, however, was academia and Laurie joined the newly formed Department of Communication Engineering in 1977 as one of its first lecturers. There, he developed his research interests in the area of optical and photonics. His focus was on semiconductor laser dynamics, high speed circuits for optical sources and receivers, mid infrared detectors, photonic switching, fibre sensors, computer aided design, image processing, and signal processing. He had a nuanced approach to problem solving using analytical methods in combination with his much liked Wolfram Mathematica. He took over as Head of Department when the founding professor left in 1980 and was fundamental to the establishment of the undergraduate Bachelor of Electronic Engineering in 1990. In 1999, Laurie was appointed Head of the School of Engineering and Mathematical Sciences, a post he held for three years. In 2009, Laurie retired and was awarded the title of Emeritus Professor, which he was very proud of.



Laurie joined IEEE in the mid-1960s, in the very early days of the IEEE in Australia. He was a Senior Member of the IEEE, and was a member of the IEEE Asia-Pacific (now Region 10) Tencon Organising Committee for the conferences which were held in Melbourne in 1992 and 2005. He was a member of the Section Committee for 28 years, firstly as Section accreditation officer, which involved reporting to the IEEE on the accreditation status of Victorian engineering schools, and then as a member-at-large, acting as a wise counselor in the issues that needed resolving. His contributions in the Section Budget Advisory Committee was another example of such contributions. His genuine kindness to others, wit and wonderful sense of irony, along with sharpness of mind, will be fondly remembered. Laurie is survived by his wife Jan, daughters Melissa, Sara, Joanna and son Mike.

This article uses extracts of Emeritus Professor John Devlin's La Trobe tribute, Jim Whittington's eulogy and Tony Gascoigne's historical recollections prepared for the 2020 IEEE Victorian Annual General Meeting.

Interview with Professor Kamran Ghorbani

by Enn Vinnal

Professor Kamran Ghorbani is a continuing academic and the Director of the Communication Technologies Research Centre at RMIT University. He is responsible for strategic planning and managing the research center. His research interests include dielectric measurements, composite material structures, frequency selective surfaces, metamaterials, RF energy harvesting, radar systems, ferroelectric devices and phased array antennas.

Prof. Ghorbani was the Chair of Asia Pacific Microwave Conference APMC2011, held in Melbourne, Australia. He was the Co-Chair of Technical Program Committee for IEEE International Microwave and RF Conference, IMaRC2014, held in India. He was the Chair of first Australian Microwave Symposium, AMS2014, held in Melbourne, Australia. He was also the Chair of Technical Program Committee of the Asia Pacific Microwave Conference APMC2016, held in India. He is an elected AdCom member of IEEE MTT-S.

[Uplink]: Kamran, congratulations! we hear that you have been elected to the IEEE Microwave Theory and Techniques Society (MTT-S) Administrative Committee (AdCom) Board as a Member at Large. Can you tell us a bit about MTT-S, AdCom, your previous work for MTT-S and about being a member at large?

[Kamran]: Thank you. MTT-S AdCom is the administrative committee that manages and runs the MTT Society. There are 21 elected members, seven of which are re-elected each year. AdCom members will make a decision on every policy that the MTT Society would like to make. MTT-S tries to select AdCom members from different regions who are familiar with the needs of those particular regions.

[Uplink]: I've heard people say that MTT-S considers itself a family. Is that true?

[Kamran]: They do. This term is used quite often in some of the Society's activities that I have been involved in. Being on AdCom, one develops one's own leadership skills. This has helped me in my own work. It helps not just for volunteer work but your work for a company or university.

[Uplink]: What are the challenges coming up for MTT-S and what areas will MTT-S AdCom like to focus on in 2021?

[Kamran]: The short-term challenge is COVID-19 because face-to-face conferences are not running, so there will be some financial impact on the Society. The whole purpose of having financial stability is to provide services to members. One new recent initiative was to fund conferences to provide scholarships/travel grants to students at the conferences - it is all about giving back. Also, MTT-S will increase the number of webinars and the number of Distinguished Lecturers. There will also be "guest-speakers" who will be possibly supported financially to provide presentations for local chapters. There are a lot of activities to support MTT-S members.

[Uplink]: So these "guest speakers" are not people from the Society but local MTT speakers?

[Kamran]: Yes, the scheme will support travel for local presenters who are MTT members.

[Uplink]: What is your professional history and current work-focus? A calibration question, perhaps.

[Kamran]: I did my under-graduate studies here at RMIT and after that went to work for AWA Defence Industries in Salisbury in South Australia for a couple of years, on pure radio frequency (RF) transceiver design. Then I did my PhD in a similar area and added some antenna topics - so I learned about the optical domain, the RF domain and antenna theory.

[Uplink]: That sounds like the definition of “wireless”?

[Kamran]: Yes. After that I worked for another company designing RF transceivers, such as designing diplexers and different heterodyne receivers. My background up to then was RF and antennas and that work was a continuation of that. After leaving the company and joining at RMIT, I have developed expertise in multi-functional microwave structures - that is, RF structures which also function as a platform: it could be an aircraft, UAV, ship, bicycle or a car.

[Uplink]: Does that mean optical and RF integration?

[Kamran]: No, not optical, but “RF” and “structure” - we analyse the structure with RF - things are being integrated where integration wasn’t thought before. For example, in the past, people integrated antennas into cars but we are now talking about putting an entire transceiver on a surface – we can call it a “smart-skin”. As an example of this, your mobile phone skin could be a transceiver and you don’t need an internal cavity to put a printed circuit board (PCB) and other material into- that is what we are working on. The proper way to refer to this is by the term “microwave multi-functional structures”- these have application in radar.

[Uplink]: We are seeing a lot of the communications technology, in the cellular area perhaps, moving into the radar area, for example, Multiple-Input-Multiple-Output (MIMO).

[Kamran]: Yes indeed, MIMO is used in synthetic aperture radar to increase the resolution - it is a distributed system, and radar combined with MIMO would be a beautiful area to work on.

[Uplink]: It must be hard to do this in a structure where you need multiple antennas for MIMO but there is limited surface area or awkward surface topology - does that make for an extra degree of complication?

[Kamran]: Yes, real-estate is a problem. Another problem is cooling - as soon as you start putting power amplifiers on the surface, and there are a large number of radiating elements, then you have to cool down that nice “oven” - so the complexity lies in the cooling and the real-estate.

[Uplink]: You won a best paper award 2-3 years ago too. That sounded exciting! Can you tell us a bit about that?

[Kamran]: We received a couple of best paper awards at different conferences but the one which received a lot of discussion was the embroidery technique for multi-functional structures. This technique integrated microwave devices into carbon-fibre composites - that was the paper that stood out and there were a lot of industries who liked the idea. Surprisingly, we moved away from that!

[Uplink]: Why?

[Kamran]: Well, we had a better idea - we moved to veil structures - a mesh structure with much better conductivity compared to the embroidery technique. It is also mechanically more robust.

[Uplink]: I’d have to look into that to understand it, because a veil sounds very flimsy?

[Kamran]: You put a veil in between the layers and epoxy it and it becomes very rigid and strong.

It has been an interesting progression in the research - we started with a topic ten years ago and published papers on that, but we thought let’s move onto something new, with more potential. In the multi-functional field, we have moved the focus areas 3 times now- that is technology progress.

[Uplink]: You have been instrumental in supporting a number of local, and perhaps international microwave conferences - what has made these successful & how will these cope going forward, if COVID-19 is around?

[Kamran]: In 2005, I met Professor Ito, who is well known in the microwaves community, and he observed that MTT-S didn’t have anyone from Australia working on any MTT-S committees at the international level. He introduced me to the APMC steering committee in 2006, and I learned the ropes and eventually ran Asia-Pacific Microwave Conference (APMC) 2011. That led me to work with other conferences and so my professional network expanded. I found that if you are successful in your work then people will approach you to do other volunteer work and that expands your network even more. If anyone would like to work on a conference in the next ten years, then I would be happy to pass on my experience.

[Uplink]: It seems that conferences still have a real place in our professional lives.

[Kamran]: I haven’t been to a conference in the last year or more and I realise now what I’ve missed. There would be things at conferences that would attract my attention, and I often thought about why something was done in a particular way. I would come back to my group and say “what about this new way?

what do you think about it?". This would allow us to come up with new ideas. The problem now is that the online experience is not the same. You can't go along to a session room and ask questions easily and have a chat with the presenter when they are finished and find out more detail - it is that discussion which is what is missing now.

[Uplink]: Are PhD students also severely disadvantaged by COVID-19 because they can't go to conferences and find out what others are thinking?

[Kamran]: Yes, and just as importantly it affects their ability to find jobs! At the European Microwave Conference (EuMC) and IEEE International Microwave Conference (IMS), there were sessions where companies and universities who wanted to hire people, would meet students - a career opportunity session - we had one in APMC in 2019 - that is missing now. Also, when students present at conferences, companies and universities, people who are looking to hire someone, can approach students, listen to what the students have done, ask questions and see how confident and good the students are, and maybe, invite them to apply for a job.

[Uplink]: What are the trends or innovations in universities in how they teach microwaves and microwave theory? Has it changed?

[Kamran]: The fundamentals don't change - we still teach students the basics of physics, Maxwell's equations, transmission line theory, microwave circuits, antennas and the like. But the applications have changed, for example, when we taught microwave circuits in the past, the students learned about s-parameters and z-parameters, and now they also learn about how to analyse metamaterials or metasurfaces. There are also new techniques in how to do network matching (multiple port matching, matching in MIMO scenario, etc.), power amplifier (PA) design, low noise amplifier (LNA) design or filter design, where there are new techniques coming up. In the past, it was about using lumped elements in filters, but now we are talking about low temperature co-fired ceramic (LTCC) techniques. These allow you to achieve performances that you couldn't achieve previously. You have more technology at your fingertips, but the fundamentals are the same. So, there is no point in talking about applications if you haven't learned the fundamentals.

Another example is software-defined radio technology. There are a lot of radar chips that require programming to make them work. You can buy a chip from Texas Instruments (TI) and "all you have to do is program it to make it work" - is that a microwave engineering or an embedded system job? At first glance, it seems to be more of an embedded system one - but if a microwave person expands their knowledge and learns about the embedded system, then the opportunity for them becomes huge. So, to answer your question, "yes" you need to learn about s-, y-, z-parameters and transmission-line theory, but you also need to be able to sit down and write the C-code to talk to the transceiver, designed by a company, to use it as a radar or a communication system.

[Uplink]: So the technology has wonderfully expanded the capabilities of the person who are working in the area?

[Kamran]: That is right.

[Uplink]: Is there any advice you'd give to young people looking for a career in Microwaves?

[Kamran]: In terms of advancing a career, if you don't understand something, go and read and read it again and ask questions until you understand it - don't learn on the surface. If you only know the surface and encounter a problem, then you will not know how to solve it. The lack of understanding will come back to bite you.

Even in my PhD or undergraduate days, if I didn't understand something, I would read about it 5 times until I found out exactly what I needed to know. It is not good enough to look at something on the surface and use it because if something changes in the problem, you will not know how to overcome that new problem.

If you learn deeply from the start and then you hit a problem, you will solve that problem fast and efficiently. If you strike something you need to know but don't understand, then read again and again and ask questions - that is my advice to the new generation.

[Uplink]: Kamran, thank you very much - it has been a pleasure to talk and to hear your viewpoints, which I can see, encompasses lots of experience. A thank you from the IEEE Victorian Section.

[Kamran]: My pleasure, always.

-oOo-

Key aspects of a solar farm: From design perspective

by Harshal Patel and Matthew Priestley

As the cost of solar PV panels continues to fall globally, the development of solar farms is becoming increasingly sensitive to financial pressures as Engineer, Procure, Construct (EPC) contractors race to the bottom in a highly competitive market. These market pressures can lead to increased risks throughout the project lifecycle impacting key project objectives such as performance, economics, etc. This article intends to cover some of the key aspects of a solar farm from a design perspective that are commonly overlooked and highlights how the importance of these aspects can lead to a successful project. One key aspect that is commonly overlooked is the actual layout of a solar farm (figures 1 and 2).

Figure 1. A close view of the solar panels on the farm

Figure 2. A distant view of the layout of solar panels on the farm

It can be tempting during the early stages of design to maximise the number of panels to be installed within the nominated area to achieve the highest possible yield. This approach can lead to compromising other areas of a solar farm such as reducing access to road width, impacting key operational and maintenance activities such as firefighting access. Hence it is recommended during the early stages of the design that the local fire authority is engaged as a key stakeholder to provide input to the fire requirements. These include number and size of water tanks for firefighting purposes and size of firebreak perimeter. These requirements will ultimately drive the layout requirements for the solar farm and final arrangement. Another key aspect that may be overlooked during the design phase is the ratings and compliance of primary plant equipment when working under compressed timeframes. Careful consideration should be given to the selection of primary plant equipment to ensure it complies with local standards and specifications under all modes of continuous uninterrupted operation (CUO).

The following key factors can be measured at the point of connection to determine the different modes of CUO are: minimum, nominal, and maximum system strength configuration; voltages at the lower and upper ends of the CUO voltage band; minimum, nominal, and maximum active power output of the solar farm; and minimum, nominal, and maximum reactive power output of the solar farm.

The primary plant equipment should be analysed in all modes of CUO to ensure certain limitations of the primary plant equipment are not exceeded, such as: voltage withstand limits of the primary equipment, the current carrying capacity / thermal withstand capability of the primary equipment, the voltage-drop limits of the system as stated in the specification, and the fault-withstand capability of the primary equipment.

It is recommended that there is early engagement with the local Network Service Provider to understand generator performance requirements that need to be achieved so that appropriate allowances can be made

during design and procurement to minimise risk of design rework, additional cost of major primary plant and delays with the connections approvals process that could lead to revenue impacts. Lastly, inter-row shading is another area that needs to be carefully considered at the early stages of the design as it will have a direct impact on the yield of the solar farm. Depending on whether the system will be fixed tilt or single axis tracking, adequate modelling should be undertaken to determine the minimum spacing required between rows to mitigate the impacts of inter-row shading whilst providing enough clearance to undertake operational and maintenance activities. In summary, some of the key aspects discussed in this article have the potential to introduce considerable risk to a solar PV project which can lead to economic and performance issues. Layout, equipment ratings, and inter-row shading should be considered early in the design phase with appropriate input from Network Service Providers, local fire authority and other key stakeholders to minimise project risk associated with time, cost and performance issues to maximise project outcomes.

Harshal Patel is a power and energy leader at Beca and currently leads the Future Energy Solutions business across Australia and New Zealand. He has been involved in a number of projects where renewable energy plays an important part towards meeting energy sustainability goals through decarbonisation. His experience includes technologies such as solar PV, battery energy storage systems, hydrogen and wind generation.

Matthew Priestley is a part of the Future Energy Team at Beca and has been involved in undertaking generator performance system studies. His recent experiences include generator performance studies for solar PV systems, battery energy storage systems and synchronous machines. Outside of generator performance studies, Matt is also involved in projects designing new protection & control systems that protects critical high voltage infrastructure, improves operational health & safety and provides reliable supply of electricity for Melbourne and wider Victoria.

Molecular Communications: Connecting Nano/Micro-Things

by Yuting Fang and Trang Cao

Molecular communications (MC) is an interdisciplinary research topic which lies across wireless communications, signal processing, mass diffusion, and biology. It uses conventional communication theory and techniques to study and design systems that use chemical molecules to transmit information. It helps to understand biological systems and gain inspiration for the design of synthetic biological networks.

The process of MC includes the following steps: 1) Information emission: the transmitter generates molecules and releases molecules. 2) Information transmission: the released molecules propagate in a fluid medium until they reach the receiver. 3) Information decode: the receiver observes the molecules and recovers the information encoded in these molecules.

MC has two unique potential benefits: bio-compatibility and low energy consumption. Hence, it has been acknowledged as one of the most promising communication methods in nanoscale. It is used by many organisms and no external energy is required because of the free diffusion of molecules. The resulting network is a nanonetwork which will advance a diverse number of potential applications in i) medical and healthcare areas, such as targeted drug delivery, health monitoring, disease detection, and nanomedicine, and ii) environmental areas, such as biosensor and actuator networks, environmental monitoring, and pollution control.

Cooperative MC with hard decision rules [1] by Yuting: In the first work, the cooperative detection among multiple distributed receivers (Rxs) in a diffusion-based MC system was studied. Unlike most existing studies that consider one-phase noisy transmission or one-symbol transmission for simplicity, multiple-symbol transmission and two-phase noisy transmission from a transmitter (Tx) to a fusion centre (FC) via multiple Rxs were considered. The FC used hard fusion rules to

arrive at a final decision. The system error probability was derived and the suboptimal convex optimization problems were formulated to determine the optimal decision thresholds. The results demonstrated that the system error performance was greatly improved by combining the detection information of distributed Rxs.

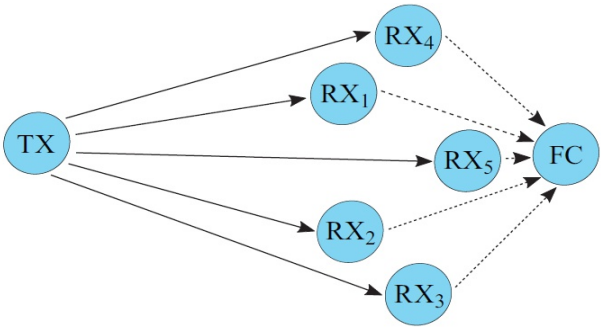


Figure 1. Cooperative MC system

Maximum likelihood for cooperative MC [2] by Yuting: The following work was on symbol-by-symbol maximum likelihood (ML) detection for a cooperative diffusion-based MC system. Different from the above work, the FC used the likelihood of its observations from all RXs to make a decision on the transmitted symbol in each interval. Three ML detection variants were proposed, according to different Rx behaviours and different knowledge at the FC. The system error probabilities were derived for two ML detector variants and the molecule allocation among RXs for one variant was optimized. Results showed that simpler and non-ML cooperative variants studied in the first work have error performance comparable to ML detectors.

Quorum Sensing Modeling [3] by Yuting: An analytically tractable model for predicting the statistics of the number of cooperative microorganisms was developed as the third part of the project. Unlike prior studies that considered abstract signal propagation channels among microorganisms, this work used diffusion-reaction equations to accurately characterize the signal received at each microorganism due to independent diffusion and degradation of molecules. Microorganisms are randomly distributed in a two-dimensional (2D) environment where each one continuously releases molecules at random times. She derived the 2D channel response due to one bacterium or randomly-distributed bacteria, the expected probability of cooperation at the bacterium, the moment generating function, and different statistics for the number of cooperators. The developed model can be used to predict the impact of noisy signalling, e.g., diffusion coefficient and reaction rate, on the statistics of the number of responsive cooperators in QS.

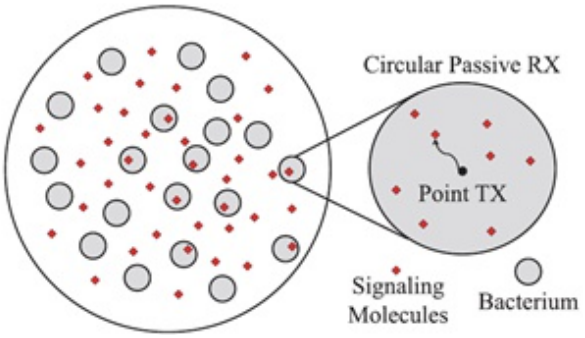


Figure 2. Quorum sensing system model

Porous Channel Modeling [4] by Yuting: Last but not the least, the communication through realistic porous channels was investigated for the first time via statistical breakthrough curves. We assume that the number of arrived molecules can be approximated as a Gaussian random variable and use fully resolved computational fluid dynamics results for the breakthrough curves. We obtained the numerical results for the throughput, mutual information, error probability, and information diversity gain, which were used to reveal the unique characteristics of the porous medium channel.These advancements serve as an unprecedented way to enable 1) high-accuracy disease detection and health monitoring and 2) bacterial infection prevention and new environmental remediation. They also provide useful insights for designing the optimal MC systems through porous media and the optimal cooperative MC systems.

Mobile MC systems [1] by Trang: Many promising applications of MC involve mobile transceivers, for example, drug delivery, mobile ad hoc nanonetworks, and detection of mobile targets. The movement of the transceivers results in a time-variant channel, whose model is required for the design of a mobile MC system but it is challenging to obtain it. Hence a stochastic analysis of the time-variant channel impulse response of a mobile MC system was provided. The results were employed for the design of MC systems with imperfect channel state

information to ensure reliability, efficiency, and optimal performance. Especially, the time-variant MC channel model was applied for the optimization of the release profile of drug delivery systems with mobile drug carriers (see Figure 3).

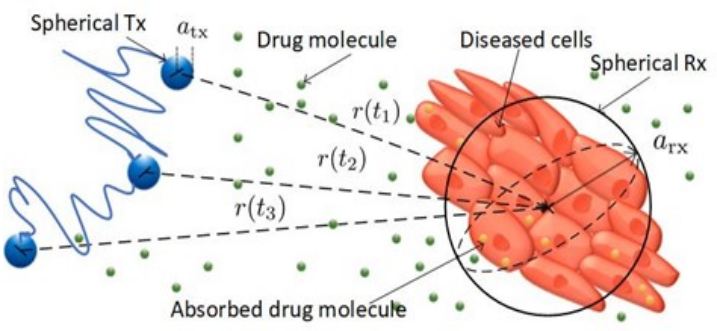
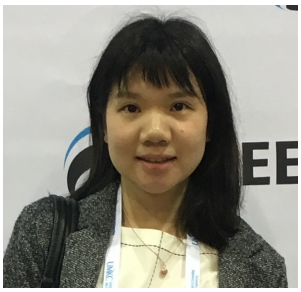


Figure 3. System model for drug delivery. The drug carrier and the diseased cells of a tumour are modelled as a diffusive spherical transmitter (Tx) and spherical absorbing receiver (Rx), respectively.

Indirect Detection Mechanism [2] by Trang: In some MC systems, the direct detection of signalling molecules may not be possible due to the lack of suitable sensors and interference from co-existing substances in the environment. Therefore, a novel indirect detection mechanism was proposed in this work, to process the received signal for MC systems by using chemical reactions between the signalling molecules and a molecular probe, to produce an easy-to-measure product at the receiver. For the system design and analysis, an efficient iterative algorithm to analyse the concentrations of the reactant and product molecules was developed.

Development of a practical channel model [3] by Trang: While Brownian Motion is widely adopted to model the movement of molecules in MC systems, it fails to result in an accurate system design in non-ideal environments such as porous media or turbulent flow. Hence anomalous diffusion as a practical channel model was proposed in this work and this model was used to design MC systems. For the analysis, Fox-function, a general function that can represent many functions, was used.

Interference Mitigations [4, 5] by Trang: MC system performance is significantly affected by inter-symbol interference, which is caused by the molecules arriving in unintended symbol intervals. This is more challenging to deal with as the system is also interfered by external noise and signal-dependent diffusive noise. The unique characteristics of a diffusive MC channel were carefully considered to design equalisation and detection schemes in order to mitigate the impact of inter-symbol interference for MC systems. For systems interfered by another transmission link, an easy-to-apply optimal detection interval technique was designed, which led to a significant improvement in system performance.



Yuting Fang and Trang Cao are pioneering PhD graduates in molecular communications in Australia. Please contact them for any potential collaborative interests in the field of molecular communications. Yuting Fang received her Ph.D. degree from The Australian National University in 2020. She is currently a Doreen Thomas Post-Doctoral Fellow at The University of Melbourne. Her research interests include cooperative and large-scale molecular communications and behavioural dynamics in microscopic population.

Trang Ngoc Cao received her Ph.D. degree from the University of Melbourne in 2020 and is currently a research fellow at Turner Institute for Brain and Mental Health, School of Psychological Sciences, Monash University. In 2018, she received the Diane Lemaire Scholarship from the Melbourne School of Engineering for a six-month research visit at the Friedrich-Alexander University of Erlangen-Nuremberg (FAU), Germany. Her research interests are in communications theory, information theory, and statistical signal processing with a focus on molecular communications.

An agile approach to digitisation of patient-care-AMII Field Hospital

by Jacquie Hennessy and Derek Welsh

Aim of the project

As COVID-19 surged in Papua New Guinea (PNG), the demands on St John Ambulance PNG (SJA) skyrocketed. In addition to the usual ambulance service, we were asked by the local health authority to set up care centres. In order to increase our capacity to respond and enhance patient outcomes at the centres, an information technology solution was sought to:

1. Simplify patient flow management;
2. Digitise patient admission and care records; and
3. Provide real time situational awareness.

By reducing and simplifying record keeping, clinical staff will have more time to care for patients. More accurate and timely awareness of current demand and expected demand changes will reduce wasted resources and speed up response times. Electronic records combined with in-application analytics will enable retrospective learnings. Ten days before the first centre was due to open, we understood that standard IT solutions would not work and that we needed something customised to our situation. Working with our technology partner Pointing North, AMII Field Hospital was ready to be rolled out in a week.

Background

In March 2021, as a surge in COVID-19 cases threatened to overwhelm the capacity of the local health system, SJA was asked to establish the first of the 3 field hospitals - a 120 bed COVID-19 care centre at the Taurama Aquatic Indoor Stadium. Resources were diverted from normal operations, the roll out of a new electronic Patient Care Reporting (ePCR) and digital assistant system (AMII Field Hospital) was put on hold, and a large team of health professionals (registered nurses, community health workers and environmental health officers) were recruited.

The Nightingale Covid Care Centre is a collaborative effort to increase isolation beds. It is an annex of the Port Moresby General Hospital and operated by us in partnership with the National Capital District health authority. The World Health Organisation (WHO), the Australian High Commission PNG and Australian Medical Assistance Teams (AUSMAT) - all assisted us with its set up and operation. Soon after commencing the centre's set up, it became apparent that paper forms would not provide visibility across all patients' clinical condition nor assist with managing patient flow. A variety of technical solutions were considered, but none of the standard software programs used by medical facilities were suitable because:

- they did not meet our unique needs; and/or
- they were too complex, with too much unnecessary functionality; and/or
- they could be deployed and customised in time.

Hence the key requirements for the customised IT solution were identified as follows:

1. A 2-3minute training video
2. Record patient details
3. Record clinical treatments and test results
4. Record admission details
5. Record COVID specific case history
6. Calculate COVID specific metrics including estimated discharge date

7. Deployed on an 8” android tablet
8. Screen may be mirrored on a BENQ interactive smart whiteboard

Planning & implementation

Once the needs were identified, Pointing North was selected as our technology partner due to their capability, responsiveness and the suitability of the Samsung 8” tablet for use at the point of care. Fortunately, our confidence in Pointing North’s understanding of both the prehospital and developing nations environment allowed room for loosely described requirements. They provided the complete solution including:

- hardware (tablets, rugged cases and rolling stands)
- software (AMII Field Hospital)
- hosting (on AWS in Sydney)
- mobile device management (to push updates to the tablets and avoid inappropriate use)
- training (via 3 minute video)
- 24x7 support

Outcomes and future scope

The team at the Centre were trained on the first release of the software, AMII Field Hospital prior to admitting the first patients. The reaction of the team was universally positive with no aversion to the change from paper records. The system is being looked at for expanded use across the country by the W.H.O. so that overall bed space and clinical acuity evaluation and monitoring can occur. This system with future tweaks to improve compatibility with current electronic medical record systems will be integral to a future state of readiness in prehospital and disaster medical capacity in the Pacific region.

This project demonstrates the benefits of an agile approach to digitisation and what is possible as we adjust to the ever-increasing speed of change. The IT solution itself, AMII Field Hospital, is highly flexible and could be used whenever resources are being overwhelmed by demand and a solution is needed to manage organisational logistics and patient flow by severity, for example, when a service is asked to stand-up health monitoring centres or field hospitals following a disaster or medical mass casualty events.

Jacquie Hennessy is a specialist paramedic, educated and trained in NSW and is the Chief of Clinical Operations and Emergency Management at St John PNG. Currently, she heads up the teams responsible for clinical governance and operational innovation at St John PNG. With a strong IT interest, her focus is on bringing pre-hospital medical services into the 21st century with easy to use and functional IT systems to support a growing need for data collection and visibility.

Derek Welsh is the Director and Founder of Pointing North. He has worked on the cutting edge with machinery and robotics in manufacturing. As a process driven electrical engineer, Derek loves the challenge of analysing, processes and developing solutions using technology, to improve performance. Pointing North is an Australian owned start up, that focuses on bringing the best and most appropriate technology to the pre-hospital setting to enhance and improve the lives of first responders and the business processes of emergency medical services.

Internet of Things - Power Supplies

by Alan Harvey

Internet of Things (IoT) vary from an air conditioner remotely controlled by a smart phone, to an industrial plant, such as an oil refinery which has hundreds of sensors and control elements. Power supplies to the IoT devices, therefore, must cover a huge range of power levels (from microwatts for sensors to many kilowatts) and can vary from a simple disposable battery to environmental variable harvesting systems utilising wind, sunlight or electromagnetic radiation.

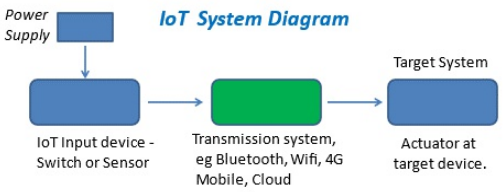


Figure 1. An IoT System

Input Devices

A large range of sensors can be used in IoT. Analog variables include physical inputs (e.g., movement), acoustic (sound), temperature, humidity, pressure, force, flow, angle deflection and electrical inputs (include voltage, current, power and frequency). Analog sensors such as temperature sensors require power to convert temperature data to digital form. Even binary devices require voltage supply to allow switch positions to be sensed.

Figure 2. Position sensors

Figure 3. Portable temperature sensor

Sensor Power Supplies

The type of electrical supply will be determined by the application of the device, whether it is domestic, industrial, portable system or whether it is operated in a remote environment. Household IoT/ automation systems may use low voltage power supplies from mains power or suitable disposable or rechargeable batteries. Smart house building automation or IoT systems can be used to control air conditioning, detect fire, home security, home media such as TV or audio systems, cooking or even garage doors. All these systems may be controlled by mobile phone or by local controls.

Remote IoT Power Supplies

The agricultural IoT systems need to provide power to sensors, data transmitters and actuators. Remote agricultural systems, such as vineyards, fruit crops or cereal crops, use remote watering control systems, making use of weather data and monitor ground moisture. In these instances, the local environment can be used to provide the required power to the devices. Solar cell arrays produce the highest power levels but wind, water flow

or even local radio signals can also be utilised. Batteries or power control ICs can also be used to provide many of the functions required in such systems. Table 1 provides the details of the harvested levels of power from local variables per unit area or volume. While RF power levels are in the microwatt levels, modern data logging systems which operate on a fraction of a milliampere, may be used for datalogging, if a suitably sized antenna were used for power harvesting.

Data Transmission Systems

While Wi-Fi from mobile phones is commonly used for smart home data transmission, lower power protocols such as Bluetooth and Zigbee would use less power, thereby enabling longer time of operation. To minimise power consumption, sampling frequencies and the number of quantization levels should be as low as possible to be consistent with system operation. For example, a lake level could be sampled every 15 minutes whereas a flow control application in an oil refinery would need several flow samples per second.

Energy Storage Systems

IoT systems which must operate continuously, must have a constant source of power. In populated areas, power grids are available. However in remote areas, energy harvesting systems must be sized to provide power to storage systems to allow enough energy to be stored to enable continuous operation. For example, a solar array would need to be sized to harvest enough energy even under adverse conditions to charge batteries to enable the IoT system to run indefinitely.

Dr Alan Harvey was a senior lecturer at RMIT Universty. He is the Director at Acupak Pty Ltd, which specialises in the distribution of lasers. He is the past Chair of Circuits and systems Chapter, IEEE Victorian Section, former UPLINK editor and current Chair of the Education Chapter.

Victorian Professional Engineer Registration Scheme - Update

by Enn Vinnal

In the last edition of Uplink, we had published an article on the Victorian Government's Professional Engineer Registration Scheme, which was due to come into operation on 1 July 2021 for building engineers. Consumer Affairs Victoria has announced that the Scheme began operation on the mentioned date this year. You can find more information about it on the website, if you scroll down to "Professional Engineers". Statutory registration becomes mandatory for electrical engineers on 1 July 2023. However, it appears that you can apply for early registration, if you like.

In simple terms, the Scheme requires registration for people that provide engineering services from Victoria (that is, you work in Victoria) or to Victoria (your work will be used in Victoria). The exception to this is, if you are supervised by an existing registered engineer, or you only follow prescribed standards to carry out your work. A supervising engineer is required to take personal responsibility for work carried out under that supervision. So for example, if you work in Victoria for an international company creating designs for use overseas, you will need to be registered. If you are on overseas person doing work specified by the Act for use in Victoria, then you will also need to be registered.

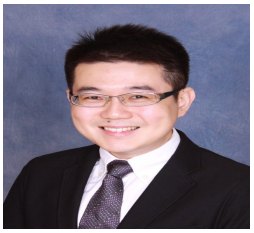
The Scheme states that electrical engineering "is concerned with the design, application, manufacture and maintenance of equipment, devices, plant and systems which use electricity, electronics, and electromagnetism." The main focus areas of electrical engineering under the scheme at present are listed as (1) power engineering, (2) control engineering, (3) electronics engineering, and (4) telecommunications engineering. So if you are an academic and do industry consultation, then our understanding is that registration will be required. The Scheme envisages that there will be mutual recognition between similar schemes in other jurisdictions, so you may need to register only once.

Publications Spotlight

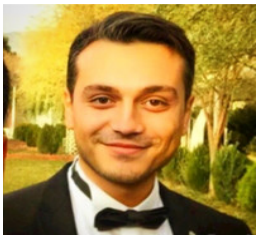
Here, for your interest, are some of the theses/ publications by IEEE Victorian Section members.

• ***Publication:*** Blockchain Security as “People Security”: Applying Sociotechnical Security to Blockchain Technology
Name: Kelsie Nabben
Field of Study: PhD (Media & Communications (Internet Studies))
Affiliation: RMIT University

• ***Thesis:*** Optimisation of small-cell deployment and backhaul network planning and dimensioning
Name: Ishita Akhter
Field of Study: PhD (Electrical and Electronic Engineering)
Affiliation: The University of Melbourne



• ***Publication:*** Developing a Digital Twin and Digital Thread Framework for an ‘Industry 4.0’ Shipyard
Name: Chi-Tsun (Ben), Cheng
Field of Study: Senior Lecturer (Information, Telecommunications and Electronics Engineering)
Affiliation: RMIT University



• ***Publication:*** Versatile and robust transient stability assessment via instance transfer learning
Name: Seyedali Meghdadi
Field of Study: PhD (Power Systems Engineering)
Affiliation: Department of Data Dcience and AI, Faculty of IT, Monash University

• ***Publication:*** Personalized Anatomic Modeling for Noninvasive Fetal ECG: Methodology and Applications
Name: Emerson Keenan
Field of Study: PhD (Electrical Engineering)
Affiliation: The University of Melbourne

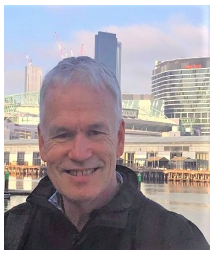
• ***Publication:*** Modelling the contribution that different sexual practices involving the oropharynx and saliva have on Neisseria gonorrhoeae infections at multiple anatomical sites in men who have sex with men
Name: Xianglong Xu
Field of Study: PhD (Modelling and simulation)
Affiliation: Monash University

Our People

Editor - Priya Rani

Priya Rani works as an associate research fellow at A2I2 at Deakin University. She completed her PhD in Electrical and Electronic Engineering from RMIT University in the field of biomedical image processing. In IEEE, she was the Co-Convenor and founding Chair of IoT Community at Victorian Section in 2020. Currently, she is serving as Treasurer of Women In Engineering and Engineering in Medicine and Biology Society at Victorian Section. She is also one of the STEM Ambassadors of 2021 selected by Science and Technology Australia.

Guest editors - Enn Vinnal and Yasmeen George



Enn Vinnal works for Wireless Frequency Studio and specialises in radio frequency management, interference analysis, co-ordination and regulatory support. His main interest is in the application of frequency spectrum sharing methodologies when examining the feasibility of co-existence among various systems. In IEEE, he has served as past Chair and past Treasurer of IEEE Victorian Section and past Chair of the AP-MTT Chapter.

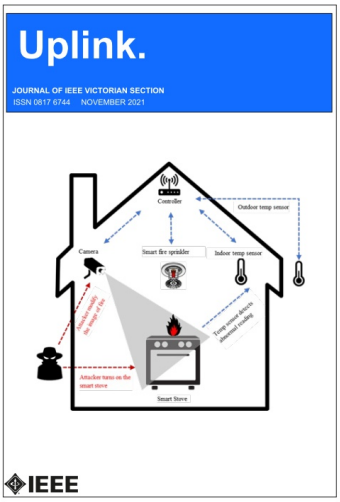
Yasmeen George is a research fellow with A2I2 at Deakin University. She received her B.Sc. and M.Sc. (by research) degrees in computer science at Ain Shams University, Faculty of Computer and Information Sciences (Egypt), in 2008 and 2013, respectively. She completed her Ph.D. in 2018 at the University of Melbourne (UoM), Department of Electrical and Electronic Engineering, working on medical image processing with application to psoriasis. Yasmeen's main areas of research interest are machine/deep learning, medical image analysis, computer visions and big data analytics.

About the next edition of UPLINK...

The next edition of Uplink is due out in November. We are aiming for another bumper edition featuring articles about things like Software Defined Radios, IoT Ecosystems, and Design for electronics manufacture, to name a few.

If you would like to contribute an article, we'd be very pleased. Please contact us at priya.rani@ieee.org. If you would like to try your hand at being a guest editor and learn how to use the free Scribus editing tool to put this publication together, then drop us a line as well.

Till next time, stay safe and stay well.



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