Melbourne India Postgraduate Program (MIPP)

with IISc, IIT Kanpur, IIT Madras and IIT Kharagpur

Training the next generation of Indian & Australian researchers, innovators & entrepreneurs

MIPPC 2017

MIPP Students' Conference

1st MIPP Conference

30-31 Jan 2017

Theatre 2, Level 1, Alan Gilbert Building, 161 Barry St, Carlton VIC 3053

MIPPC 2017
MIPP Students' Conference

Day 1 – 30th Jan, 2017

From	To	Event	Session chair
8:30 AM	9:00 AM	Registration	Conference Opening Session **Chair:** Prof Dick Strugnell
9:00 AM	9:05 AM	Prof. Ashok Muthupandian- About MIPP and Introduction of the Chair	
9:05 AM	9:15 AM	Prof Margaret Sheil, Provost - Welcome Note	
9.15 AM	9.20 AM	Prof. Dick Strugnell, PVC-Graduate & International Research	
9:20 AM	9:30 AM	Prof Karen Day, Dean, Faculty of Science	
9:30 AM	9:40 AM	Prof Peter Scales, Director of Engagement, Melbourne School of Engineering	
9:40 AM	9:50 AM	Prof. R. Nagarajan, Dean, International Affairs, IITM	
9:50 AM	10:00 AM	Prof. Bharat Lohani, IITK	
10:00 AM	10:10 AM	Prof. Goutam Das, IITKgp	
10:10 AM	10:20 AM	Prof. Ramasesha, IISc	
10:20 AM	10:30 AM	Dr. Meenakshi Arora -Vote of Thanks & Program Outline	
10:30 AM	**11:00 AM**	**Coffee break**	

Technical Session 1

11:00 AM	11:20 AM	**Rajesh:** Monitoring & Classifying neurological disorder movements from accelerometer signals in ICU.	Student Presentations **Chair:** Prof Saman Halgamuge **Co-chair:** Mukesh Soni
11:20 AM	11:40 AM	**Aakash:** Role of cell wall components in the pathogenicity of the dimor-phic fungus Talaromyces marneffei	
11:40 AM	12:00 PM	**Shitanshu:** Gaussian mixture model for the identification of psychogenicnon epileptic seizures using a wearable accelerometer sensor.	
12:00 PM	12:20 PM	**Nature:** Utilization of glycerol for mixotrophic growth of microalgae forlipid accumulation.	
12:20 PM	12:40 PM	**Nandakishore:** Analysis of vocal fold dynamics from laryngeal CT images	
12:40 PM	1:00 PM	**Neeta:** Heat Stress and Sexual Reproduction in Brassicaceae.	
1:00 PM	**2:15 PM**	**Lunch Break**	

Technical Session 2

2:15 PM	2:35 PM	**Himanshu:** Entrainment and interface dynamics of turbulent plumes.	Student Presentations **Chair:** Prof James Bailey **Co-chair:** Neeta Lohani
2:35 PM	2:55 PM	**Dileep:** Two-dimensional energy spectra in a high Reynolds number boundary layer.	
2:55 PM	3:15 PM	**Nitheesh:** Direct Numerical Simulation of Turbulent Plume in a Confined Region	
3:15 PM	3:35 PM	**Johnson:** Additive manufacturing of TiAl.	
3:35 PM	3:55 PM	**Prathap:** Preparation, microstructure and mechanical properties of Al-Nb insitu nanocomposites.	
3:55 PM	**4:00 PM**	**Closing Remarks: Day 1 – Prof Udaya Parampalli**	

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Day 2 – 31st Jan, 2017

Technical Session 3

From	To	Event	Session chair
09:00 AM	09:20 PM	**Shushma:** Experimental Investigation Of Air-Sea Gas Transfer Coefficient Across Air-Water Interface In A Wind Wave Tank.	Student Presentations **Chair:** Prof Udaya Prampalli **Co-chair:** Aakash Gupta
09:20 PM	09:40 PM	**Surabhi:** Probabilistic modelling for a vehicle negotiatingthe right of way with a pedestrian.	
09:40 PM	10:00 PM	**Gokul:** Robust Calibration-Friendly Model Predictive Controller for Diesel Air Path.	
10:00 AM	10:20 AM	**Vishnu:** Generator Induced Operational Limits in a PVRich Network:The Static Case	
10:20 AM	10:40 AM	**Pavan:** The relationship between Climate and Mechanisms of Tropical Cyclone Formation	
10:40 AM	**11:10 AM**	**Coffee Break**	

Technical Session 4

11:10 AM	11:30 AM	**Shashank:** Developement and application of ab-initio methods for strongly correlated and strongly spin-orbit coupled molecular nanomagnets.	Student Presentations **Chair:** Dr Meenakshi Arora **Co-chair:** Gokul Siva Sankar
11:30 AM	11:50 AM	**Chinchu:** Investigating Impact of Groundwater Depletion on Groundwater Dependent Agriculture.	
11:50 AM	12:10 PM	**Bosirul:** Development of a polymer inclusion membrane (PIM) with highstability and selectivity for Zn(II).	
12:10 PM	12:30 PM	**Shivansh:** Relating physico-chemical and Biological processes in Hyporheiczones.	
12:30 PM	12:50 PM	**Akhil:** The Dynamics of Functional Connectivity in the Human Brain.	
12:50 PM	**2:00 PM**	**Lunch Break**	

Technical Session 5

2:00 PM	2:20 PM	**Partha:** Design and implementation of Lightweight stream ciphers that are resistant to power analysis attacks.	Student Presentations **Chair:** Prof Ashokkumar Muthupandian **Co-chair:** Chinchu Mohan
2:20 PM	2:40 PM	**Salil:** Cooperative Localization of Unmanned Aerial Vehicles using lowcost sensors.	
2:40 PM	3:00 PM	**Debajit:** Reconstruction of incomplete functional data.	
3:00 PM	3:20 PM	**Sanjay:** Measuring the mass of galaxy clusters through gravitational lensing of the cosmic microwave background.	
3:20 PM	**3:30 PM**	**Closing Remarks – Prof Dick Strugnell**	
3:30 PM	**4:00 PM**	**Coffee**	

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Conference Venue / Map

Theatre 2, Level 1, Alan Gilbert Building, 161 Barry St, Carlton VIC 3053

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Participants

MIPP Students

Aakash Gupta
Achyut Mishra
Akhil Raja
Bosir Hoque
Chinchu Mohan
Debajit Datta
Dileep Chandran Padinjare Muttikkal
Gokul Siva Sankar Gowri Sankar
Himanshu Mishra
Jithin George
Johnson Jacob
Mukesh Soni
Nandakishor Desai
Neeta Lohani
Neture Poddar
Nitheesh George
Partha De
Pavan Harika Raavi
Prathap Chandran
Rajesh Ranjan
Salil Goel
Sanjaykumar Patil
Santa Maiti
Shashank Vittal Rao
Shitanshu Kusmakar
Shivansh Shrivastava
Sourav Mondal
Surabhi Gupta
Sushma Reddy
Vishnu Arayamparambil Vinaya Mohanan

Indian Institute of Technology – Madras

Prof Abhijit Chaudhuri
Prof Jitendra Sangwai
Ms Kavitha
Prof Muthuganapathy Ramanathan
Prof Nagarajan
Prof Ranjit Bauri
Prof Sridharkumar Narashimhan
Prof Sujatha Srinivasan

Indian Institute of Technology – Kanpur

Mrs Babita Lohani
Prof Bharat Lohani
Prof Gopakumar
Prof Subhra Sankar Dhar
Prof Vinod Tare

Indian Institute of Technology – Kharagpur

Prof Goutam Das
Prof Jayanta Mukhopadhyay
Prof Madan Kumar Jha
Prof Prasad K Bhaskaran
Prof Rintu Banerjee
Prof Sudeshna Sarkar

Indian Institute of Science

Prof Ramasesha Suryanaraya Sastry

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Participants

University of Melbourne

Dr Adrian Collins
Prof Alex Andrianopoulos
Prof Andrew Ooi
Dr Andrew Western
Prof Andy Martin
Dr Aurore Delaigle
Dr Brian Krongold
Dr Carmel Murphy
Prof Chris Manzie
Dr Christian Reichardt
Prof Doreen Thomas
Dr Gabriele Suder
Prof Ivan Marusic
Ms Jacqui Sbragia
Mr James Perry
Prof Janet Hergt
Prof Jim McCluskey
Dr Jimmy Philip
Prof Jon Woodhead
Prof Karen Day
Prof Kenong Xia
Prof Marimuthu Swami Palaniswami
Dr Meenakshi Arora
Prof Michael Stewardson
Prof Muthupandian Ashokkumar
Prof Peter Scales
Prof Ralf Haese
Dr Robyn Schofield
Prof Saman Halgamuge
Prof Sandra Kentish
Prof Simon Evans
Prof Stephan Winter
Prof Susan Elliott
Prof Udaya Parampalli

Guests

Hon. Mrs Manika Jain, Consul General of India Melbourne

Dr Ravi Singh, IITaV
Dr Nikhil Kumar, IITaV
Dr Raj Rajkumar, IITaV
Mr Dilip Desai, IITaV

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Index

Role of cell wall components in the pathogenicity of the dimorphic fungus *Talaromyces marneffei.*

Aakash Gupta[1], Alex Andrianopoulos[2]
School of Biosciences, University of Melbourne.

Talaromyces marneffei is an opportunistic, human pathogenic fungus endemic to Southeast Asia. It is a member the dimorphic group of fungi, most of which are pathogens of animal or plants. Thermally dimorphic fungi show two different cellular morphologies at two different temperatures. At 25°C, *T. marneffei* grows in a multicellular hyphal form that is capable of undergoing asexual development to produce conidia (infectious agent). At 37°C, *T. marneffei* grows in a unicellular yeast form that divides by fission and these yeast are the pathogenic form found in infected hosts.The hyphal-to-yeast transition of *T. marneffei* is considered to be a crucial for survival in the host and pathogenesis, residing within host macrophages, the yeast evade the host immune system or withstand macrophages killing. Recognition of pathogens by the host cell macrophages requires the identification of Pathogen-Associated Molecular Patterns (PAMPs) present on the conidial cell wall by specific proteins called Pattern Recognition Receptors (PRRs) present on the surface of the immune cells Here we focus upon the cell wall components of *T. marneffei* as these forms the first line of interaction between the host cell and conidia. This study focused upon two main component of cell wall α-glucan and β-glucan and their role in growth and pathogenicity.

The Dynamics of Functional Connectivity in the Human Brain.

Akhil Kottaram[1], Andrew Zalesky[2], Rao Kotagiri[3] and Leigh Johnston[2]
Department of Electrical and Electronic Engineering, University of Melbourne.[1,2]
Department of Computing and Information Systems, University of Melbourne.[3]

To date, most studies of resting-state functional connectivity implicitly assume that connections remain unchanged over time. However, recently, it has been shown that functional brain connections across a range of species exhibit time-varying behavior. In this context, we aim to characterize and model functional dynamics in the human brain, focusing on different resting state networks. Using data from the Human Connectome Project, we have identified rich spatio-temporal dynamics of different resting state networks. We hypothesize that these variations are composed of a few canonical states of different levels of connectivity, which are repeatedly visited over time. To identify these states, we model the network states with a Hidden Markov Model (HMM) using the observed dynamics of different networks. We further propose that this model could be used to characterize neurological disorders such as schizophrenia.

Development of a polymer inclusion membrane (PIM) with high stability and selectivity for Zn(II).

Bosirul Hoque[1], Robert W. Cattrall[2], Thiruvancheril G. Gopakumar[3], M.I.G.S. Almeida[2] and Spas D. Kolev[2]
School of Chemistry, University of Melbourne.[1,2]
Department of Chemistry, Indian Institute of Technology, Kanpur.[3]

Emerging as an alternative to traditional solvent extraction, PIM-based separation has been attracting considerable attention in recent years. The main reason behind the interest in PIMs is based on their better stability over other liquid membranes with the most popular among them being supported liquid membranes (SLMs), and also their capability of performing simultaneous extraction and back-extraction. In addition, PIMs have better mechanical properties and chemical resistance than SLMs, due to the extractant being immobilised in the polymer backbone, which minimises the loss of membrane liquid phase. With the aim of improving PIMs stability even further, the cross-linking polymerization approach has

been applied successfully by us in the manufacturing of di-(2-ethylhexyl)phosphoric acid (D2EHPA)-based PIMs, using Zn (II) as a model analyte. In the present study, this approach is further extended by including the manufacturing PIMs with poly(vinylidene fluoride-co-hexafluoropropylene (PVDF-HFP) and polyethyleneglycol di-methacrylate (PEG-DMA) as the base polymer and cross-linking polymer, respectively, and D2EHPA as the extractant. After dissolving all the PIM components in tetrahydrofuran, the membranes were casted and treated with UV-light in order to induce cross-linking. Different PIM compositions were prepared by varying the polymers ratio (PVDF-HFP:PEG-DMA) and the amount of D2EHPA, and the corresponding membranes were studied in terms of their ability to extract Zn (II) and their mass loss during extraction and back-extraction. Cross-linked PIMs showed to be more stable than their non-cross-linked counterparts. PIMs morphology was also examined to correlate membrane performance with its nanostructure. Roughness analysis from the topography images of different PIMs compositions before and after extraction and back-extraction showed that with increasing roughness, the extraction capability also increased. The PIM composed of 50 wt% D2EHPA with a 7 : 3 polymers ratio exhibited the best extraction performance.

Investigating Impact of Groundwater Depletion on Groundwater Dependent Agriculture.

Chinchu Mohan[1], Andrew Western[2] and Yongping Wei[2]
Department of Infrastructure Engineering, University of Melbourne.

Human interventions have drastically transformed the planet's surface by altering land use and land cover and have also significantly affected hydrology. Food requirements of the growing global population and their associated economic development has substantially increased water withdrawal. Critical development in associated water infrastructure has been a complementary development to the same. Furthermore, Climatic variations have led to the frequent occurrence of extreme events (such as flood and drought) as well as variations in temperature and precipitation which would compound the effect on groundwater depletion. Depletion of groundwater resources has become a big challenge to groundwater dependent agriculture. However the impact of groundwater depletion on global food production has not been studied yet. Therefore, the current study aims to investigate the impact of groundwater depletion on groundwater dependent agriculture and food security. The overall objective of the proposed study will be accomplished by improving the groundwater representation of the GlobWat model and then using it to evaluate groundwater storage variations with changing climate. The results from the modified model will be coupled with a Demand model and the impact on agricultural production in groundwater dependent areas due to groundwater depletion would be evaluated for different demand scenarios. The results of this study would give an insight into future groundwater supply and would help in planning and managing the resource for agriculture.

Reconstruction of incomplete functional data.

Debajit Dutta[1], Aurore Delaigle[2]
Department of Mathematics and Statistics, University of Melbourne.

This study is an extension of Delaigle and Hall's (2016) paper on approximation of fragmented functional data using Markov chains. In their work an important assumption was that the endpoints of the fragments were independent of the data itself. The methods suggested there were not considered in the case where the independence assumption does not hold. The objective of this study is to develop a modified framework which yields consistent estimators in the instances where their assumption is violated. The methods used here in the implementation of this new framework are heavily influenced by the inverse probability methods popularly used in missing data analysis.

Two-dimensional energy spectra in a high Reynolds number boundary layer.

Dileep Chandran[1], Rio Baidya[2], Jason Monty[2] and Ivan Marusic[2]
Department of Mechanical Engineering, University of Melbourne.

The current study measures the two-dimensional (2-D) spectra of streamwise velocity component (u) in a high Reynolds number turbulent boundary layer for the first time. A 2-D spectra shows the contribution of streamwise and spanwise length scales to the streamwise variance at a given wall height (z). 2-D spectra could be a better tool to analyse spectral scaling laws as it is devoid of energy aliasing errors that could be present in one-dimensional spectra. A novel method is used to calculate the 2-D spectra from the 2-D correlation of u which is obtained by measuring velocity time series at various spanwise locations using hot-wire anemometry. At low Reynolds number, the shape of the 2-D spectra at a constant energy level shows a square-root relationship between streamwise and spanwise length scales at larger scales which is in agreement with the literature. However, at high Reynolds number, it is observed that the square-root relationship gradually transforms into a linear relationship which could be caused by the large packets of eddies whose length grows proportionately to the growth of its width.

Robust Calibration-Friendly Model Predictive Controller for Diesel Air Path.

Gokul S. Sankar[1], Rohan Shekhar[2] and Chris Manzie[2]
Department of Mechanical Engineering, University of Melbourne.

Increasing stringency on emission standards and the need for improved fuel efficiency have resulted in equipping modern diesel engines with technologies and components such as exhaust gas recirculation (EGR) and variable geometry turbine (VGT). Actuators in the air path - the throttle valve, the EGR valve and the VGT influence the flows of fresh air and exhaust into the engine and thus provide control over fuel efficiency and the formations of particulate matter (PM) and NOx. Model predictive control (MPC) is an ideal choice of control architecture for multi-variable systems such as diesel engines with system and input constraints. A linear time-invariant (LTI) MPC formulation to regulate intake manifold (boost) pressure and EGR rate to the desired values whilst satisfying the physical actuator limitations and safety constraints on the boost pressure has been developed. MPC requires high degree of calibration effort to meet the desired time domain specifications (for instance, settling time, rise time, etc.) at the output for setpoint changes. As the number of measurements, actuators or controlled variables increase, the tuning difficulty increases exponentially. The number of tuning parameters and the non-intuitive relationships between the tuning parameters and the output responses make the controller tuning process a difficult task. Moase *et al.* [2015] have proposed an LTI MPC structure with exponential envelope constraints on the outputs. This reduces the number of effective tuning parameters and significantly lowers the calibration effort. For such MPC controllers with exponential envelope constraints, stabilising conditions to provide stability guarantees and recursive feasibility have been determined by Sankar *et al.* [2015].
The performance of MPC relies on the accuracy of the prediction model. However, mathematical models do not describe the behaviour of the physical system with absolute certainty. The uncertainties due to modelling errors and other external disturbances might cause constraint violation. The violation of envelope constraints would lead to an undesirable transient response while failing to satisfy the safety constraints might impair the engine. Hence, to provide robustness guarantees to handle the uncertainties, a robust formulation based on constraint tightening technique has been proposed. In the constraint tightening approach, the constraints are artificially tightened such that a margin is reserved for future feedback action that can be used to correct for errors due to uncertainties. The proposed robust MPC formulation incorporates a two-stage tightening policy for the envelope constraints. The first-stage of envelope constraint tightening is performed to account for the output deviations due to the state disturbances. In the second-stage, an additional tightening margin is reserved to handle the output uncertainties. Robust constraint satisfaction in the presence of state and output disturbances has been

verified on numerical illustrations.

Entrainment and interface dynamics of turbulent plumes.

Himanshu Mishra[1], Jimmy Philip[2] and Jason P. Monty[2]
Department of Mechanical Engineering, University of Melbourne.

Turbulent plumes form when a fluid of one density is injected into another quiescent fluid with a different density. From violent volcanic eruptions to the smoke rising from a cigarette, turbulent plumes are omnipresent in nature at wide range of scales. One of the fundamental aspects in the understanding of turbulent plumes is the process of 'entrainment', the mixing of surrounding fluid into the plume. Unlike non-buoyant flows, plumes pose a challenge in using common optical measurement techniques like particle image velocimetry (PIV) and planar laser induced fluorescence (PLIF), because of the local changes in refractive index, when two fluids mix. This has led to most of the previous research being focused on global measurements of entrainment, whereas the local measurements, which are required for clearer understanding the entrainment phenomenon are practically non-existent. One of the ways to circumvent this problem is to match the refractive index of two solutions while maintaining the density difference, by adding certain chemicals to them. Alternatively, a measurement technique named Background Oriented Schlieren (BOS), which uses the local refractive index changes to quantify the local density variations, can be used.
With the final aim of understanding the process of entrainment in turbulent plumes, we present preliminary results for two experimental studies. (i) Velocity measurements in a vertical round axisymmetric turbulent jet in a newly constructed experimental facility, and (ii) free settling sphere in a sharp density interface using BOS.

Additive manufacturing of TiAl.

Johnson Jacob[1], Kenong Xia[2] and Ranjit Bauri[3]
Department of Mechanical Engineering, University of Melbourne.[1,2]
Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Madras.[3]

There is a rich landscape of high-value applications, requiring near-gamma titanium aluminide alloys that could be manufactured using additive manufacturing. Conventional process is inherently associated with coarse lamellar grain, and the process modification is quite expensive to refine the grain size. Recently, additive manufacturing mainly EBM proved to be a promising alternative to casting of titanium aluminides alloys. Many studies on individual processes and resulting properties have been done, but a systematic study of the relationship of EBM processing parameters on micro-structure, and thereby its effect on mechanical properties of TiAl is yet to be developed. To date, there has been a relatively large EBM study done on Ti-6Al-4V, but not as much on TiAl alloys.

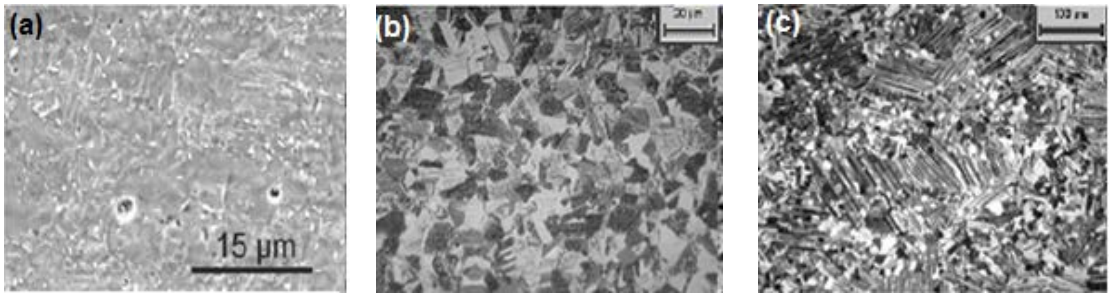

Figure 1: SEM micrograph of EBM processed TiAl, (a) As fabricated (b) Hot isostatic pressed and (c) Annealed at $(\alpha + \gamma)$ phase field.

Previous research has concentrated primarily on the influence of the process parameters on the product

properties such as the ductility, creep, and fatigue and oxidation resistance, or the feasibility of the EBM process for applications, for example, biomedical and aeronautical industries . Although the microstructure offers an understandable link between the process and the resulting mechanical properties, a systematic study that relate AM process and microstructure is yet be done. EBM has been studied as a feasible way to fabricate TiAl structural parts by Cormier et al. and Murr et al.

Figure 1 shows the microstructure of EBM TiAl sample in as- fabricated state and after post heat treatment. The as fabricated microstructure shows feathery massive gamma structure. After hot isostatic pressing the microstructure is equiaxed with around 20m grain size. The duplex structure after heat treatment is lamellar colonies with grain size 100m and a lamellar fraction around 40%. A high niobium content alloy was also investigated for blade production and mechanical testing by G. Baudana et al. In the as-built condition, the Ti45Al8Nb2Cr alloy develops a fully lamellar microstructure with lamellar grains of about 100 m.

Research Problem: The fully lamellar microstructure in TiAl that having good high temperature creep properties and fracture toughness consists of, alternating 2 (Ti3Al) and (TiAl) lamellae, and its room temperature ductility and strength appears to be lower than those in the duplex microstructure. Recent studies show that, the ductility and strength of fully lamellar TiAl alloys can be considerably increased by refining lamellar colony size and inter lamellar spacing by novel post processing. The possibility of producing a fine lamellar micro-structure in additive manufacturing of TiAl has not been explored yet.
To meet the full potential of AM processes, continued development of the machines and deep understanding of the material's behavior under process is essential. Overall aim of this research is to fabricate TiAl parts by EBM/SLM process and study the effect of EBM/SLM process parameters on microstructure and mechanical properties.

Analysis of vocal fold dynamics from laryngeal CT images.

Nandakishore Desai[1], Marimtuthu Palaniswami[2], Jayavardhana Gubbi[2] and Jayanta Mukhopadhyay[3]
Department of Electrical and Electronic Engineering, University of Melbourne.[1,2]
Department of Computer Science and Engineering, Indian Institute of Technology, Kharagpur.[3]

In humans, vocal folds are responsible for phonation/speech production. Vocal fold disorders may affect the quality of speech, thus significantly impacting their quality of life. Laryngeal endoscopy, laryngeal electromyography, laryngography, and others are generally used to assess the dynamics of the affected vocal folds. These approaches provide only surface visualization, lacking any objective measurement. In addition, they fail to capture the 3D movements of the vocal folds. The recent advancements in Computed Tomography (CT) scanners, using X-ray beams, have made it possible to acquire high-resolution images capturing the dynamic movements of vocal folds with good temporal resolution and providing 3D volumes of the scan. This research focuses on developing automated techniques to investigate the dynamics of vocal folds from the CT images of larynx. The experimentations are carried out against the CT images collected from subjects with Parkinson's disease.

Utilization of glycerol for mixotrophic growth of microalgae for lipid accumulation.

Nature Poddar[1], Ramakrishna Sen[3] and Greg Martin[2]
Department of Chemical and Biomolecular Engineering, University of Melbourne.[1,2]
Department of Biotechnology, Indian Institute of Technology, Kharagpur.[3]

Biofuels derived from microalgae have the potential to play a role in achieving energy security and environmental sustainability by mitigating industrial CO_2 emissions. However, economically viable production of microalgal biofuels is a challenge that requires technological innovation. One potential option to improve the economics is the use of mixotrophic algae cultivation in which the algae grow using both

dissolved organic carbon (e.g. glycerol) and inorganic carbon (CO_2) via photosynthesis. This has the potential to utilize glycerol, a by-product of the biodiesel industry, to increase biomass productivity and enhance the accumulation of the lipids that can be converted to biofuel.
This research aims to understand the effect of glycerol and light availability, under nitrogen replete and deplete conditions, on triacylglycerol (TAG) accumulation in algal cultures of Scenesdesmus sp., Chlorella sp., and Nannochloropsis sp. In addition, detailed consideration will be given to understanding interactions between bacteria and algae during mixotrophic growth, which have been largely unexplored to date. Preliminary lab experiments on the aforementioned strains have validated their ability to uptake glycerol as a sole source of carbon. Also, at higher concentration of glycerol (1.0 g/L) the proliferation of heterotrophic bacteria was unavoidable resulting in undefined interactions between the populations.
The future work of this project will focus on quantitative and qualitative assessment of lipid accumulation in the presence of glycerol and under nitrogen stress in algal cultures. Additionally, the bacterial-algal co-cultures will be considered to study their interactions in a mixotrophic culture. ^{13}C radioactive labelling technique will also be taken in account to establish the uptake of glycerol in an algal metabolism. The understanding of the interactions of two populations and the uptake of glycerol in algae will be beneficial in developing a new mathematical model to optimize mixotrophic growth regimes.

Heat Stress and Sexual Reproduction in Brassicaceae.

Neeta Lohani[1], Prem Bhalla[2] and Mohan Singh[2]
Faculty of Veterinary & Agricultural Science, University of Melbourne.

Plants being sessile in nature often encounter unfavourable environmental conditions that affect their growth and development. Among the various environmental stresses, elevated temperature is a primary factor limiting the plant growth and productivity. Even a short spell of heat stress hampers the crop yield, which has a great impact on the agricultural economy. During plant development, reproductive phase has been identified to be the most vulnerable stage to heat stress. Several studies focused on understanding the effect of heat stress on plant sexual reproduction and productivity discovered that the altered male gametophyte development results in yield losses under heat stress. Despite these observations, the molecular mechanisms underlying the heat stress response during male gametophyte development still remains to be elusive. Towards this end, our study aims at unravelling the regulatory mechanisms involved in male gametophyte development in the economically important crop plants such as *Brassica napus* and *Brassica oleracea* under terminal heat stress conditions. Further, identified key regulatory genes will be used to produce transgenic Canola plants with improved productivity under heat stress.

Direct Numerical Simulation of Turbulent Plume in a Confined Region.

Nitheesh George[1], Andrew Ooi[2], Daniel Chung[2] and Jimmy Philip[2]
Department of Mechanical Engineering, University of Melbourne.

We present direct numerical simulations (DNS) of a turbulent line plume in a confined region with adiabatic side, top and bottom walls. The plume originates from a line heat source of spanwise length, L, located at the centre of the bottom wall and rises until it impinges on the top wall and spreads laterally to produce a buoyant fluid layer. Since the region is confined, the continuous supply of buoyant fluid forces the layer downwards, until it reaches the bottom wall, where the flow is said to be at the asymptotic state. The buoyant fluid layer advects downwards in a way analogous to the first front in the filling box model of Baines and Turner (1969). This model predicts the rate at which the front advance into the environment. Presently, two Reynolds numbers, 3840 and 7680, are selected for plume lengths, L/H = 1, 2 and 4, where the Reynolds number of the plume is based on box height (H) and the buoyant velocity scale, $F_0^{1/3}$, where F_0 is buoyancy flux per unit length. We measured the temporal evolution of the first front position and validated with the analytical model presented by Baines and Turner (1969).

Design and implementation of Lightweight stream ciphers that are resistant to power analysis attacks.

Partha De[1], Udaya Parampalli[2] and Chittaranjan Mandal[3]
Department of Computing and Information Systems, University of Melbourne.[1,2]
Department of Computer Science and Engineering, Indian Institute of Technology, Kharagpur.[3]

Internet of things is the emerging networking development where smart devices are connected to the Internet via wire or wireless without the human intervention. In many applications, the sensitive data passes through these devices and hence security is the most important requirement for these devices. The challenges of deploying a security solution for these devices are three-fold: (i) hardware for a security solution must be minimal given the limited memory and computing capacity of these devices. (ii) power consumption must be kept minimal in order to increase battery life. (iii) the latency of communications must be small to enforce desired performance for end users . To develop the secure solutions that meet the above requirements we need efficient cryptographic algorithms. A new research direction called lightweight cryptography has been established focusing on designing novel cryptographic ciphers for resource-constrained environments. The lightweight ciphers appear in two main categories- block ciphers and stream ciphers. A stream cipher which uses linear or nonlinear feed back shift register as the basic building block is used to encrypt individual characters of the plaintext using an encryption sequence that varies with time. Some of the popular lightweight stream ciphers are Grain, Tivium and MICKEY. The operation of the hardware implementation of these ciphers can be monitored to reveal the secret key that is responsible for the confidentiality of the data. One of the predominant method by which an attacker reveals the systems secret key is by power analysis attack.Power analysis attacks (PAAs) are major threats to cryptographic devices since data dependent power consumption can be statistically analyzed to reveal the secrets in use. There are broadly two types of countermeasures for PAAs based on their level of application algorithm level and cell level. Algorithmic level counter measures have the disadvantages of a high computational overhead, disturbing the later two challenge of lightweight cryptography. On the other hand, cell level countermeasures are broadly accepted for their lower hardware area requirement and speedy completion of encryption and decryption processes. Majority of cell level methods employ dual-rail pre-charge logic to produce complementary outputs while discharging output capacitors periodically in order to resist PAAs. In this work we develop and study lightweight stream cipher algorithms with minimal and compact hardware implementations such that they are resistant to side channel attacks. The circuit design principles developed to combine Binary Decision Diagram (BDD) based circuit synthesis technique with dual-rail pre-charge logic will be employed to realise the design. Our circuit synthesis approach will have four stages Stage-1: Converting a basic cipher function into a Boolean function Stage-2: Designing BDDs with identical critical path lengths from Boolean functions Stage-3: Realizing BDDs into circuits and insertion of pre-charge generation logic Stage-4: Voltage scaling and leakage power minimization to improve overall circuit performance By extensive experimentation we will compare our design implementation with competitive methods.

The relationship between Climate and Mechanisms of Tropical Cyclone Formation.

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Tropical Cyclones form under certain climatological atmospheric and oceanic conditions such as sea surfaces temperatures greater than 26.5 degrees, low-level relative vorticity, moist mid-troposphere and moderate vertical wind shear (Gray *et al.*, 1968, 1979). Conceptual models of observed tropical cyclone formation have recently been aided by the *'marsupial pouch'* concept defined within tropical waves over Atlantic and Pacific regions (Dunkerton *et al.* 2009; Montgomery *et al.* 2012). This innovative work recognizes that tropical cyclones form only in relatively rare, favorable conditions and provides a new paradigm that explains how these conditions occur. The maintenance of an area of closed circulation,

where the entry of outside air is inhibited, enables the storm to exist in an environment favorable for further development, sheltered from disruptive influences. This presentation reviews the literature on tropical cyclone formation and outlines research related to the linkage of climate to an occurrence of an enclosed environment favorable for cyclone formation.

Preparation, microstructure and mechanical properties of Al-Nb insitu nanocomposites.

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Mechanically alloyed Al with immiscible elements such as Nb can lead to a uniform distribution of nanoscaled precipitates which are highly stable compared to conventional alloying and with excellent interface, resulting in significant increase in strength without problems associated with nano ceramic particles in metal matrix composites. Although immiscible, Nb can be alloyed with Al through mechanical milling, forming trialuminide (Al_3Nb), either directly or upon subsequent precipitation, which possesses high strength, stiffness and stability at elevated temperatures. In the present study, Al-5 at.% Nb supersaturated solid solution was formed after prolonged ball milling and Al_3Nb was precipitated in the form of nano particles after ageing at 530°C for one hour. The milled Al-Nb powder was heat treated and consolidated by equal channel angular pressing (ECAP) at 400°C, resulting in a uniform distribution of nanoscaled Al_3Nb particles in the Al matrix.

Monitoring and Classifying Neurological Disorder Movements from Accelerometer Signals in Intensive Care Units.

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Throughout the world, millions of people are affected by neurological disorders.In patients suffering from a neurological disorder such as Parkinson's disease, Huntington disease, Tourette syndromes and others, various movement disorders are recognized, such as voluntary movements tremor, myoclonus, dystonia, and out of context movements for instance dyskinesia and tic. In an Intensive care unit (ICU), number patients are admitted with neurological disorders, requiring continuous monitoring and identification based on the type of disorder. In the current situation, identification of such movement disorder is carried out by nurses and clinical experts by observing the patient's physiological activity which is cumbersome and time taking. Study on the identification of neurological disorder such as tic, dyskinesia and myoclonus are still in nascent stage, requiring further investigation into appropriate assistive movement analysis for speedy diagnosis and monitoring .Tic and dyskinesia show out of context movement which is tougher to distinguish from normal movements.A typical challenge will be the classification of different movement disorder with accelerometer-based measurement with a single system because most of them lie in the identical frequency range. Thus, a need has been identified to develop a model to recognize and classify them according to different movement disorder types and based on the severity level of each of them. This research focuses on the development of new design methods and automated tool for investigating various movements disorder in neurological disorder patients in an ICU setting.

Cooperative Localization of Unmanned Aerial Vehicles using low cost sensors.

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Networks of small, low cost Unmanned Aerial Systems (UASs) have the potential to improve responsiveness and situational awareness across an increasing number of applications including defense, surveillance, mapping, search and rescue, disaster management, mineral exploration, assisted guidance, and navigation etc. These ad hoc UAS networks typically have the capability to communicate with each other and can share data between the individual UAS nodes. Thus, these networks can operate as robust and efficient information acquisition platforms. For any of the applications involving UASs, a primary requirement is the localization i.e. determining the position and orientation of the UAS. The performance requirements of localization can vary with individual applications, for example: mapping applications need much higher localization accuracy as compared to the applications involving only surveillance. The sharing of appropriate data between UASs can prove to be advantageous when compared to a single UAS, in terms of improving the positioning accuracy and reliability particularly in partially or completely GNSS denied environments. This research aims to integrate low cost positioning sensors and cooperative localization technique for a network of UASs. Our hypothesis isthat it is possible to achieve high accurate, real-time localization of each of the nodes in the network even with cheaper sensors if the nodes of the network share information among themselves. This hypothesis is validated using simulations and the results are analyzed both for centralized and distributed estimation architectures. At first, the results are studied for a two-node network which is then expanded for a network containing more number of nodes. Having more nodes in the network allows us to study the properties of the network including the effect of size and shape of the network on accuracy of the nodes.

Measuring the mass of galaxy clusters through gravitational lensing of the cosmic microwave background.

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Galaxy clusters are the largest gravitationally bound objects in the Universe and provide crucial insight to the standard model of cosmology. The abundance of these as a function of mass and redshift is highly sensitive to the cosmological parameters such as amplitude of matter fluctuations and dark energy equation of state parameter.
While galaxy clusters yield tremendously powerful tests of dark energy, their cosmological constraints are currently limited by a 15% mass uncertainty. Future surveys like LSST and eROSITA will build ever larger cluster samples; our ability to fully realise the potential of these samples depends on better mass estimates. Gravitational lensing is widely considered the gold standard in mass estimation.
The next suite of Cosmic Microwave Background (CMB) polarization experiments are expected to be able to normalize cluster masses to 3% (a fivefold improvement!) by looking at the gravitational lensing signal in CMB polarization. In this talk we present first ever lensing measurement of galaxy cluster mass using CMB polarization data. We take data from the current SPTpol experiment, and use a maximum likelihood approach to extract the CMB cluster lensing signal from a catalog of Sunyaev-Zel'dovich effect selected galaxy clusters. We consider several sources of potential systematic error, and quantify their effect using mock data.

A Conceptualisation of Vehicle Platoons and Platoon Operations.

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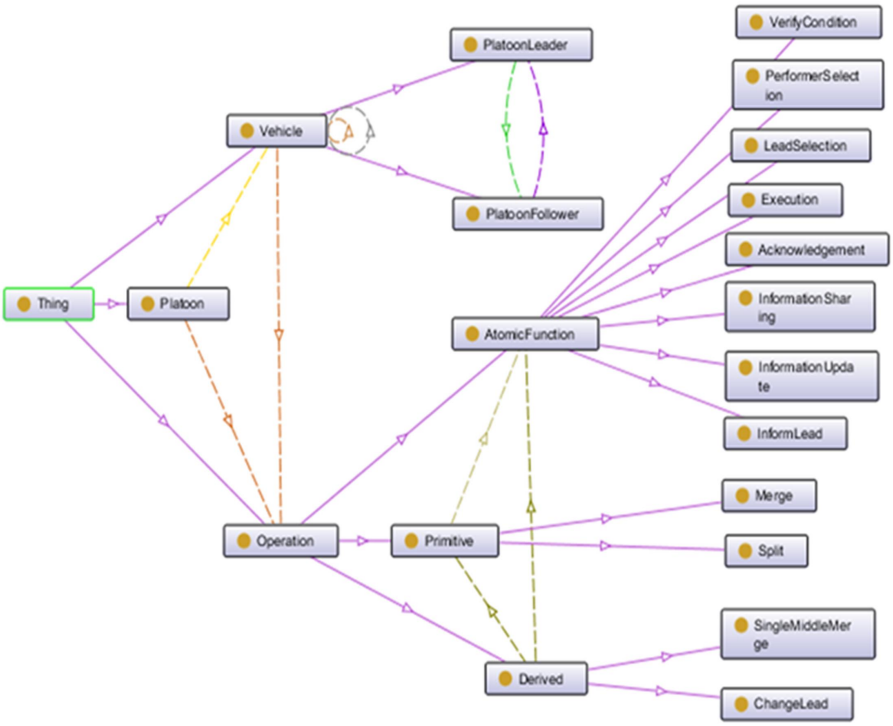
Introduction: Vehicle platooning addresses current transport challenges. But in order to form platoons in an ad-hoc manner the vehicles have to 'speak the same language', which is in current practice

limited to vehicles of particular manufacturers. This work aims to fill this fundamental gap by developing a formal model of platooning concepts. The research proposes an ontological model of platooning objects and properties and abstract basic building blocks of platoon operations that can then be aggregated to complex platooning behavior.

Research Problem: Literature addresses platooning objects and some platoon operations, in the context of control, communication or simulation. Gap is observed towards an agreed formalization of the platooning objects, the platoon properties, and the platoon operations. The research challenges addressed are - abstraction of a platoon, defining platoon properties, identification, and abstraction of platoon operations.



Proposed platoon ontology

Methodology: This research conceptualized the platooning objects and platoon properties with the help of ontology. Different platooning objects, platoon operations, and platoon properties are collected from the different platooning projects, and analyzed in order to find the minimal set that is necessary and sufficient to represent all platoon operations. Platoon objects PlatoonLeader and PlatoonFollower are defined as follows.

PlatoonLeader $\sqsubseteq$ Vehicle $\cap$ $\forall$controls

PlatoonFollower $\sqsubseteq$ Vehicle $\cap$ $\leq$1hasLeader.PlatoonLeader $\cap$

$\geq$1hasLeader.PlatoonLeader $\cap$ $\forall$ontrolledBy.PlatoonLeader

Platoon properties (e.g. ID, role, location, speed, route, gap, capacity) like platoon involved in various platoon operations are determined and defined in individual vehicle level and platoon level. Platoon operations are abstracted as 1) Atomic function the basic building block of operation 2) Primitive operation - composed by atomic functions 3) Derived operations - aggregation of primitive operations and atomic functions.

Conclusion: In this work, platooning objects, platoon properties, and platooning operations are conceptualised and formally specified in the OWL ontology. An implementation has been done to see how objects, properties, and operations interact to enable any complex behaviour. The defined platooning atomic functions and primitive operations are capable of representing all platoon behaviours reported in the literature.

Developement and application of ab-initio methods for strongly correlated and strongly spin-orbit coupled molecular nanomagnets.

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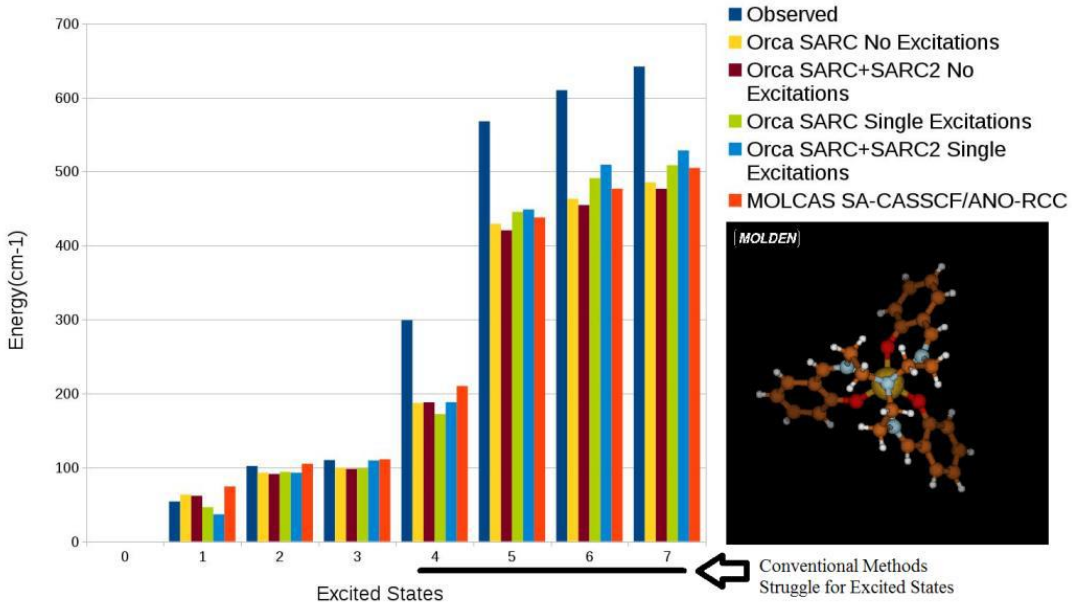
School of Chemistry, University of Melbourne.



Energies of lowest energy Kramers Doublets of J=15/2 multiplet wrt. Ground State (0), Inset: Structure[3] of Er(trensal)

The present study has two objectives:

1. To test the limits of existing multiconfigurational/multireference ab-initio methods for strongly correlated and strongly spin-orbit coupled molecules, such as lanthanide-based single molecule magnets (Ln-SMMs), and to use these methods to elucidate electronic structure in novel Ln-SMMs.

2. To implement molecular integrals on a Gaussian type orbital basis for selected scalar-relativistic and mean-field spin-orbit theories within the quantum chemistry package CERES4(Computational Emulator of Rare Earth Systems) developed in our group, and to test the code against existing software.

In this study we will try to understand the properties that make these compounds of fundamental interest in chemistry. We will then try to understand the advantages and limitations offered by the popular methods available in quantum chemistry packages. And use them to study the difficult case of Ln(trensal) family of molecules by Eva Lucaccini et al1. and subsequently the Ln(II) family of molecules synthesized in several complexes by Evans et al2 where the CASSCF/RASSI-SO (Complete Active Space with State interaction through spin orbit coupling) method struggles to generate experimental observations.

We will see that that both of these families of molecules represents challenging systems for CASSCF/RASSI-SO and call for the development of methods of flexible partitioning of active spaces for the Configuration Interaction-Spin Orbit Coupling matrix such as those that are being developed by our group within the framework of CERES3. In particular, we shall study the implementation of certain molecular integrals and their use in calculation of properties of lanthanide complexes.

Gaussian mixture model for the identification of psychogenic non-epileptic seizures using a wearable accelerometer sensor.

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Any abnormal hypersynchronus activity of neurons can be characterized as an epileptic seizure (ES). A broad class of non-epileptic seizures is comprised of Psychogenic non-epileptic seizures (PNES). PNES are paroxysmal events, which mimics epileptic seizures and pose a diagnostic challenge with epileptic seizures due to their clinical similarities. The diagnosis of PNES is done using video-electroencephalography (VEM) monitoring. VEM being a resource intensive process calls for alternative methods for detection of PNES. There is now an emerging interest in the use of accelerometer based devices for the detection of seizures. In this work, we present an algorithm based on Gaussian mixture model (GMMs) for the identification of PNES, ES and normal movements using a wrist-worn accelerometer device. Features in time, frequency and wavelet domain are extracted from the norm of accelerometry signal. All events are then classified into three classes i.e normal, PNES and ES using a parametric estimate of the multivariate normal probability density function. An algorithm based on GMMs allows us to accurately model the non-epileptic and epileptic movements, thus enhancing the overall predictive accuracy of the system. The new algorithm was tested on data collected from 16 patients and showed an overall detection accuracy of 91% with 25 false alarms.

Relating physico-chemical and Biological processes in Hyporheic zones.

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Over the last century, excessive use of nitrogen based fertilizers and combustion of fossil fuels have tremendously accelerated the levels of bio-available nitrogen in rivers. Higher nitrogen levels results in eutrophication of water bodies, N_2O emissions and also prove fatal to human infants. Rivers provide an important ecosystem service of nitrogen cycling, in which the various nitrogenous forms are converted back to nitrogen gas and subsequently removed from an aquatic system. Nitrogen removal depends upon various physical, chemical and biological factors. There is limited understanding on interplay of these factors, which act in synergy and control N-cycling. Among these factors, hydraulic conductivity and temperature are crucial. Hydraulic conductivity controls the supply of initial substrates required for N-reactions. Physical clogging of stream bed can substantially reduce this supply while bioturbation can compensate for clogging. Temperature is known to affect the nitrogenous reaction kinetics through Arrhenius relationship. However, it can have significant effect on rates and end product of these reactions indirectly by altering dissolve oxygen levels and hydraulic conductivity. This study aims at understanding the complex relationship between temperature, bioturbation, hydraulic conductivity and their combined effect on nitrogen removal in hyporheic zone. Lab experimentation for physical clogging and bioturbation will be done in moving fresh water (lotic) flumes and statistical analysis will be performed on collected data to understand inextricable linkage between above mentioned biotic and abiotic components of hyporheic zone.

Probabilistic modelling for a vehicle negotiating the right of way with a pedestrian.

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Pedestrians in their intention to cross the road engage with car drivers in some interaction, and do so at unmarked locations but often even at marked pedestrian crossings or signalled intersections. This higher social attention and negotiation among road users is a challenge for self-driving cars, as much as for pedestrians being confronted with a self-driving car.

Self-driving cars in their current state do not hold the capabilities to understand signals from other road users and are rather reactive to pedestrian behaviour, which may result overall in slower traffic flow. This work will focus on developing a vehicle-pedestrian interaction model describing the perception and processing of negotiation signals from both parties, and the vehicles probabilistic inference from such external signals so that the vehicle can (also) indicate its desire to pass and does not have to stop every time it encounters a pedestrian heading to cross the road.

Assuming that the goal of anautonomous vehicle (Agent 1) and a pedestrian (Agent 2) at an uncontrolled intersection is to get the right of way to pass an intersection, the hypothesis for this research is that the intersection throughput can be increased if the vehicle can negotiate with the pedestrian for the right of way as compared to its current state of always stopping for the pedestrian to cross.

The negotiation concept in this hypothesisis defined as (i) the vehicle shall pass if it perceives a sufficient safe gap to pass without conflicting with its estimated pedestrians future trajectory, and shall indicate this intention; (ii) the vehicle shall pass if it interprets signals from the pedestrianto let it pass (with indication); (iii) in case of any uncertainty in the above two cases the vehicle shall stop or slow down (with indication) to allow the pedestrian to cross. The pedestrians behaviour to be considered are the movement trajectory, the viewing direction, and gestures.

Experimental Investigation Of Air-Sea Gas Transfer Coefficient Across Air-Water Interface In A Wind Wave Tank.

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Air-sea exchange of heat, momentum, and mass are critical components of the Earths climate system. Gas exchanges are important in terms of global budget of many gases like the uptake and/or release of carbon dioxide, oxygen, nitrous oxide, methane, dimethylsulfide and volatile toxic pollutants. Gas exchange between ocean and atmosphere influences air quality, weather and water quality. Gas exchange is also important in atmospheric radiative transfer due to the flux of dimethylsulfide which acts as precursor to cloud condensation nuclei, which in turn affects the radiative forcing through direct and indirect aerosol effects. Thus it is important to accurately parameterize the exchange for application in numerical models for estimating fluxes. The major processes influencing the air-sea transfer of gases are wave breaking, small and large scale turbulence, waves, bubbles, spray, surfactants, and rain, chemical and biological properties. At high wind speeds, wave breaking takes place which induces spray and bubbles. Past studies revealed that bubble mediated gas transfer is higher for insoluble gases compared to that of soluble gases but the effect of spray is yet to be studied. The transport mechanism of mass transfer is planned to study using Extreme Air Sea Interaction Facility at high wind speeds.

Generator Induced Operational Limits in a PV Rich Network: The Static Case.

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Technological advancements and government policies fuel the adoption of renewable energy resource into the power system network. Under pressure from the public climate change debate, governments have adopted policies and incentives that promote the adoption of renewable energy resources. The renewable energy target of Australia for 2020 is 23.5the total electricity needs. As the generation characteristics are different from traditional systems , the incorporation of more and more renewable resources to both the transmission and distribution network poses various technical challenges. The present scale of PV and wind energy has already a profound effect on the power system network to the extent that grid stability could be tested. Steady state and transient stability, reverse current flow, and loss of protection coordination are some of the key issues mentioned in the literature. The aim of this work is to find the various impacts of high level penetration of renewable resources on the existing power grid and to find its maximum possible penetration level considering the grid stability. As an extension of this, our third objective is the development of control method for increasing the maximum penetration limit of renewable resources. As a preliminary step of the work, we have analyzed the static stability of a synchronous generator operating in a distribution network having high PV penetration. We have simulated a simple distribution network with synchronous generator by considering various level of PV penetration. One of the interesting observation was, the voltage stability limits are not the main concern, rather the thermal plant limits and synchronous generator excitation field limits are the essential active constraints when PV generation is high. We are now working on the dynamic analysis of the same system.

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