Book of Abstracts

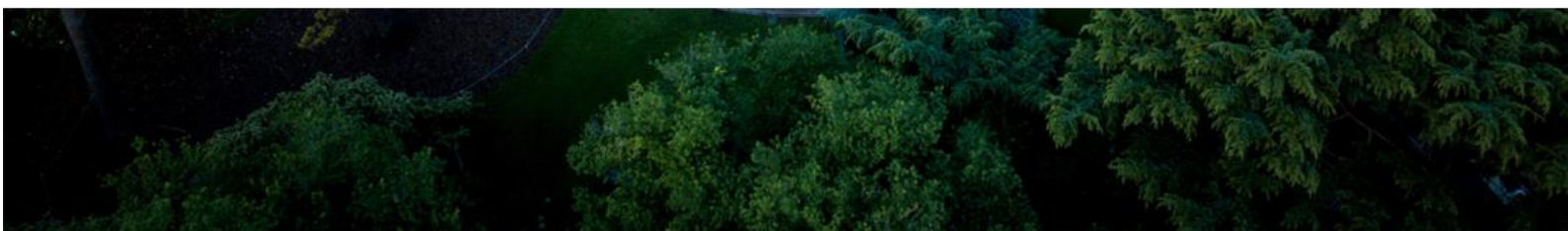
MIPAC 2023

Melbourne India Postgraduate Academy (MIPA) Conference – 2023

~ VENUE ~

Studio, Melbourne Connect

Ground floor, 700 Swanston Street, Carlton
https://goo.gl/maps/HiUvmmVHxwjceNdZ8



Contents

MIPAC-23 Organising Committee

Advisory

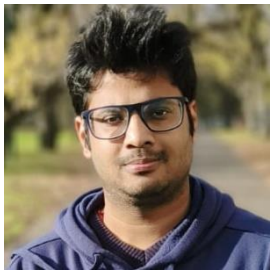

A/Prof. Meenakshi Arora


Dr Surinder Singh Chauhan


Dr Debnath Ghoshal

Students' Committee

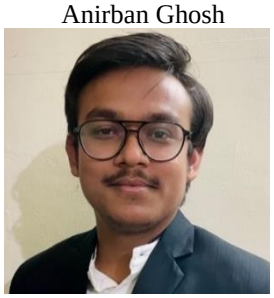

Aditya


Anirban Ghosh


Asif Ahmed Sardar


Chesta


Kunwar Abhishek Singh


Mehdi Alam


Sri Priyanka


Subhajit Chakraborty

Supported by


Dr Krishna Somaletha


Dr Mukesh Soni


Daniela Reichert

Rebecca Whitsed

MIPAC-23 Conference: Participants' List

Graduate Researchers

[R] Indicates remote/online attendance

Home Institute	Participants
IIT Kharagpur	1. Anirban Ghosh 2. Asif Ahmed Sardar 3. Joydeep Baral 4. Kunwar Abhishek Singh 5. Nimisha Kattumunda [R] 6. Subhrasankha Dey [R] 7. Ayyappan Murugesan, [R] 8. Hema Jha, [R] 9. Pradeep R, [R] 10. Snigdha Mohapatra, [R] 11. Soumendu Sarkar, [R]
IISc Bangalore	12. Chesta Chesta 13. Jagat Narayan Prajapati, [R] 14. Shilpa Koyyan
IIT Kanpur	15. Aditya Aditya 16. Ankit Bhadouriya 17. Ashwani Kumar 18. Mehdi Alam [R] 19. Sourav Ghosh 20. Sri Priyanka Kommula 21. Subhajit Chakraborty 22. Rajbala Purnima Priya [R] 23. Shreshtha Kumar Gupta
IIT Madras	24. Omar Zain Torres Rios [R]
IISER Tirupati	25. Sai Keertana K [R] 26. Ajmal Roshan [R] 27. Latika Joshi [R]
The University of Melbourne	28. Hossein Parineh 29. Farid Fazel

Participants from Indian Partner organisations

[R] Indicates remote/online attendance

Institute	Participants | Department
IIT Kharagpur	1. Prof Virendra Kumar Tewari |Director IIT Kgp, Agricultural and Food Engineering 2. Prof Rintu Banerjee | Dean Research, Agricultural and Food Engineering 3. Prof Debashish Chakravarty | Dean International, Mining Engineering 4. Prof Amit Kumar Das | Biotechnology 5. Prof Bharath Haridas Aithal | RCGSIDM [R] 6. Prof Brajesh Kumar Dubey | Environmental Eng./Civil Engineering [R] 7. Dr Dibyendu Kamilya | Agricultural and Food Engineering [R] 8. P. Ashis Patra | Chemical Engineering [R] 9. Dr Partha Sarathi Ghosal | School of Water Resources [R] 10. Prof Sonjoy Majumder |Department of Physics [R] 11. Dr Manoj Tiwari |Industrial and Systems Engineering
IISc Bangalore	12. Prof Abhishek Singh | Dean Office of International Relations, Materials Research Centre 13. Prof Ankur Chauhan | Materials Engineering [R] 14. Dr Arnab Barik | Center for Neuroscience [R] 15. Prof Sampath Srinivasan | Inorganic and Physical Chemistry [R]
IIT Kanpur	16. Prof Dhirendra S. Katti | Dean of International Relations [R] 17. Prof Animangsu Ghatak | Chemical Engineering 18. A/Prof Ashutosh Modi | CSE 19. Prof Ashwani Thakur | Biological Sciences and Bioengineering 20. Prof Dibyendu Das | BSBE 21. Dr Gaurav Tiwari | Civil Engineering 22. Dr Partha Narayan Mishra | Department of Civil Engineering 23. Dr Salil Goel | Civil Engineering 24. A/Prof Vaibhav Arghode | Aerospace Engineering 25. Dr Amarendra Edpuganti | Sustainable Energy Engineering [R] 26. A/Prof Arghya Das | Civil Engineering [R] 27. Prof Bharat Lohani | Civil Engineering [R]
IIT Madras	28. Prof Sujatha Srinivasan | Mechanical Engineering 29. Dr Lakshminath Kundanati | Department of Applied Mechanics and Biomedical Engineering [R] 30. A/Prof Nagabhushana Rao Vadlamani | Aerospace 31. Prof Sannasiraj Sannasi Annamalaisamy | Ocean Engineering 32. Dr Swathi Sudhakar | Applied Mechanics and Biomedical Engineering 33. Dr Ratna Kumar Annabattula | Mechanical Engineering [R] 34. Dr Vimalraj Selvaraj| Applied mechanics and biomedical Engineering
IISER Tirupati	35. Prof Santanu Bhattacharya | Director IISER T, Chemistry 36. Dr Annapurna Devi Allu | Biology 37. Dr Sreenivas Chavali | Biology

Participants from The University of Melbourne

Participants | Department
38. Prof Amanda Ellis | Dean, Faculty of Engineering and Information Technology
39. Prof Alex Johnson | School of BioSciences
40. A/Prof Alexander Idnurm | School of BioSciences
41. Prof Andrew Western | Infrastructure Engineering
42. Prof Andy Martin | Physics
43. Dr Anirudh Belwalkar | Infrastructure Engineering
44. Dr Arockia Jayaraj John Peter | IT
45. Prof Arvind Sinha | Aerospace
46. Dr Christian Brandl | Mechanical Engineering
47. Daniela Reichert | FEIT Partnerships officer
48. A/Prof David Jones | Chemistry
49. Dr Debnath Ghosal | Department of Biochemistry & Pharmacology
50. Prof Dongryeol Ryu | Infrastructure Engineering
51. Dr Eirini Goudeli | Chemical Engineering
52. Dr Ellie Hajizadeh | Mechanical Engineering
53. Emma Michelle | MIPA Student support
54. Prof Frank Vetere | Computing and information systems
55. Dr Garron Dodd | Anatomy and Physiology
56. Hasti Samadi | FEIT-CIS
57. Prof Ian van Driel | Department of Biochemistry and Pharmacology
58. A/Prof Jagannath Aryal | Infrastructure Engineering
59. Prof Jamie Evans| Pro Vice-Chancellor (Students and Education)
60. Jamie Gough | School of Agriculture
61. Dr Jegadesan Subbiah | Chemistry/Bio21 Institute
62. Prof Justin Zobel| Pro Vice-Chancellor, Graduate & International Research
63. Prof Justine Mintern | Biochemistry and Pharmacology
64. Kate Howell | SAFES
65. A/Prof Kathryn Mumford | Chemical Engineering
66. A/Prof Kourosh Khoshelham | Infrastructure Engineering
67. Lu Aye | Infrastructure Engineering
68. A/Prof Mahdi Disfani | Infrastructure Engineering
69. Prof Marcus Pandy | Mechanical Engineering - (Biomechanical Eng.)
70. Maria Roitman |Associate Director, International Research
71. Mark Gregory |Senior Advisor, International Research Strategy
72. A/Prof Meenakshi Arora | Infrastructure Engineering
73. Prof Mick McCarthy| Dean, Faculty of Science
74. Prof Mike Mcguckin| Deputy Dean, Faculty of Medicine, Dentistry and Health Sciences
75. Miriam Cahir |International Strategic Relationships
76. Dr Mukesh Soni | Biomedical Engineering
77. Naif Alsowaidi | Graduate Research Team (FEIT)
78. Prof Richard Sandberg | Mechanical Engineering
79. Rishwanth Darun Annamalaisamy Sannasiraj | Infrastructure Engineering
80. Prof Shanika Karunasekera | Computing and information systems
81. Shuai Shao | Melbourne School of Population and Global Health
82. Shubhrajit Maitra | Infrastructure Engineering
83. Soumyajyoti Ghosh | Infrastructure Engineering
84. Dr Surinder Chauhan | School of Agriculture

Participants | Department
85. A/Prof Tai Thai | Infrastructure Engineering
86. Prof Tansu Alpcan | Electrical and Electronic Engineering
87. Dr Tesfaye Molla | Mechanical Engineering
88. Dr Thuan Pham | School of Computing and Information Systems
89. Prof Trevor Smith | Chemistry
90. Dr Vijay Rajagopal | Biomedical Engineering
91. Dr William Umboh | CIS
92. Prof David Phillips | SGEAS [R]

Participants from Other Institutions

[R] Indicates remote/online attendance

Institute	Participants | Department
Others	93. Mr Abaran Deep, Co-founder RedCrew, IITAV 94. Anil Kumar | Agriculture Sciences 95. Dr Akash Gupta | Clinical Research Associate, OPIS (MIPA Alumni) 96. Dr Achyut Mishra (MIPA Alumni) 97. Ananth Sivaramakrishnan Malathi | Aerospace Eng. 98. Dr Dipali Wahi | Sr Systems Engineering Manager, Planet Innovation 99. Dr. Nandakishore | Postdoctoral Research Fellow, UoM (MIPA Alumni) 100. Dr Rachana Sharma | Director Eco Pacific Ltd. 101. Dr Sushil Kumar | Consulate General of India 102. Mr Ravi Singh | Chief Technical Officer, ESCO Pacific, IITAV 103. Dr Yogendra Vashishtha, Head of Future Networks, IITAV 104. Ranjeet Kumar Tiwary Khirod Prasad Tiwary | Geology [R] 105. Dr Sasidhar Gumma| Chemical Engineering, IIT Tirupati 106. Dr Shalini Suri, Div of veterinary anatomy [R] 107. Mr Tapas Kumar Gupta | (Chief Technical Advisor, West Bengal Pollution Control Board), Industry Collaborator via IIT Kharagpur [R] 108. Dr Venkataraman Pandurangan| Mechanical Engineering| IIT Tirupati

Program: MIPAC-23 Conference

Conference Venue:

Studio, Melbourne Connect
Ground Floor, 700 Swanston Street.

Remote / Online Presence via Zoom

Zoom meeting on 16-17 Nov, 2023 12:15 PM Canberra, Melbourne, Sydney
(It's a closed event, so please do not share the zoom link with unregistered people).

Download iCalendar (.ics) files to your calendar system:
https://unimelb.zoom.us/meeting/tZ0qd-mprzopH9yxFw0bVP9RRPk_Dn4Nmg9E/ics?icsToken=98tyKuGhqTsqG9WUsxyPRpx5B4igc-vzmH5egvpEhDnyUyJlUlrEBNJJDZZxRPbd

Joining link:
https://unimelb.zoom.us/j/89700111358?pwd=d25TZHFtbXoyV2F2VHZzZEVVSlJ5Zz09
Meeting ID : 89700111358
Password : 476726

Program: Thursday 16 November

10:30 – 11:30 AEST: Tour to Telstra Creator Space (TCS)

Join the facility tour to explore fabrication lab located in the University of Melbourne's innovation precinct, Melbourne Connect - space where technology and creativity combine to form innovative solutions!

11:45 – 12:15: Registration and lunch

Plenary session: 12:30 – 13:45 AEST (07:00 – 08:15 IST)

From	To	Min.	Event	Chair
12:35	12:40	5	Welcome: A/Prof Meenakshi Arora, Director, MIPA	A/Prof M Arora and Ms Chesta
12:40	12:48	8	Prof Justin Zobel, Pro Vice-Chancellor, Graduate & International Research, UoM	
12:48	12:56	8	Prof Virendra Kumar Tewari, Director, IIT Kharagpur	
12:56	13:04	8	Prof Mick McCarthy, Dean, Faculty of Science, UoM	
13:04	13:12	8	Prof Abhishek Singh, Dean International Engagement, IISc	
13:15	13:40	25	Dr Salil Goel, Assistant Professor, IIT Kanpur: Keynote address by MIPA alumni	
13:40	13:43	3	MIPA Report Launch	
13:43	13:50	7	Session changeover / short break	

Technical presentations – Session 1: 13:50 - 15:15 AEST (08:20 – 09:45 IST)

From	To	Presenter	Research title	Chair
13:50	14:00	Sourav Ghosh	Modelling of interface energy anisotropy of FCC/L12 Coherent interfaces in Ni-based superalloy	Mr Mehdi, Dr Salil Goel
14:00	14:10	Ankit Bhadouriya	Dynamics of ocean boundary layer under sea ice in the Southern Ocean	
14:10	14:20	Sri Priyanka	Automation in locating suitable sites for surface rainwater harvesting structures using LiDAR data and machine learning techniques	
14:20	14:30	Anirban Ghosh	Unidirectionality of non-equilibrium dynamics for non-hermitian quantum systems	
14:30	14:40	Asif Ahmed Sardar	Network resource allocation for industry 4.0 with delay and safety constraints	
14:40	14:50	Soumendu Sarkar	Secular thinning of subcontinental lithospheric mantle	
14:50	15:15	**Networking break with tea/coffee**		

Program: Thursday 16 November

Technical presentations – Session 2: 15:15 – 16:30 AEST (09:45 – 11:00 IST)

From	To	Presenter	Research title	Chair
15:15	15:25	Subhajit Chakraborty	Time-resolved microscopy	Mr Asif, Prof. Trevor Smith
15:25	15:35	Chesta	Solar energy harvesting and storage using photo-rechargeable Zinc-ion batteries	
15:35	15:45	Ayyapan Murugesan	Ballistic studies on SS410-Al2O3-SiC functionally graded armour material fabricated through laser cladding and hot pressing	
15:45	15:55	Nimisha	Improvement of fire performance of steel and bamboo reinforced composite structures using geopolymers	
15:55	16:05	Mehdi Alam	Soft rigid granular mixes	
16:05	16:15	Ashwani Kumar	Calibration of DWM 1001 using depth camera	
16:15	16:30	Day 2: Concluding remarks by Dr Debnath Ghosal		

Conference dinner: 18:00 – 21:30 AEST

From	To	Min.	Event
16:30	18:00	90	Transit to MCG
18:00	18:25	25	Welcome drinks and networking
18:25	18:35	10	Guests are seated
18:35	18:45	10	Welcome by Professor Jamie Evans, Pro Vice-Chancellor (Students and Education), University of Melbourne
18:45	19:15	30	Cultural performances by MIPA students (Entrée served)
19:30	19:40	10	Address by Dr Sushil Kumar, Consulate General of India
19:40	19:45	5	Address by Dr. Yogendra Vashist, IITaV President
19:45	19:50	5	Vote of thanks
19:50	21:00	80	Dinner served
21:00	21:30	10	Dinner closure, Tea/Coffee and departure from MCG

Friday 17 November

11:45 – 12:15: Registration and lunch

Plenary session: 12:30 – 13:45 AEST (07:00 – 08:15 IST)

From	To	Min.	Event	Chair
12:30	12:35	5	Welcome note by MIPA Director	Dr Debnath Ghosal and Ms Sri Priyanka
12:35	12:45	10	Prof Amanda Ellis, Dean, Faculty of Engineering and Information Technology, UoM	
12:45	12:55	10	Prof Santanu Bhattacharya, Director IISER Tirupati	
12:55	13:05	10	Prof Mike McGuckin, Deputy Dean, Faculty of Medicine, Dentistry and Health Sciences, UoM	
13:05	13:15	10	Prof Sujatha Srinivasan, IIT Madras	
13:15	13:25	10	Prof. Dhirendra S. Katti, Dean of International Relations, IIT Kanpur	
13:25	13:35	10	Session changeover / short break	

Technical presentations – Session 3: 13:35 – 14:50 AEST (08:15 – 09:20 IST)

From	To	Presenter	Research title	Chair
13:35	13:45	Kunwar Abhishek Singh	Water quality assessment using high resolution Satellite data	Mr Anirban, Dr. Annapurna Devi, IISER
13:45	13:55	Omar Zain Torres Rios	Directional spectra of waves and wave-breaking dissipation by means of explicit measurements and modelling	
13:55	14:05	Aditya	Urban Forest characterisation using MLS point cloud data through deep learning	
14:05	14:15	Shilpa Koyyan	Soil moisture retrieval from multi-polarization L-band synthetic aperture radar over wheat fields	
14:15	14:25	Latika Joshi	Investigation of molecular mechanisms underlying combined drought and heat stress responses in rice	
14:25	14:35	Shreshtha Kumar Gupta	Flame-wall interaction in the presence of intense turbulence	
14:35	14:40	Session changeover		

Friday 17 November

Technical presentations – Session 4: 14:40 – 16:00 AEST (09:20 – 10:30 IST)

From	To	Presenter	Research title	Chair
14:40	14:50	Joydeep Baral	Structure-function insight into the two-component DNA repair system of Mycobacterium tuberculosis	Mr Aditya, Prof. Dongryeol Ryu
14:50	15:00	Jagat Narayan Prajapati	An intra-brainstem circuitry for pain inhibition of itch	
15:00	15:10	Sai Keertana K	Conserved and emergent functional roles of protein regions with charged amino acid bias	
15:10	15:20	Hema Jha	Optimisation of hydrothermal carbonisation reactors for valorising lignocellulosic wastes as fuel	
15:20	15:30	Pradeep Ramesh	Environmental sustainability and economic viability of shrimp culture practices	
15:30	**16:00**	**30 Minutes: Tea/Coffee Break**		

Panel discussion and closing event: 16:00 – 18:00 AEST (10:30 – 12:30 IST)

From	To	Min.	Event	Chair
16:00	17:00	60	Panel discussion: Careers and development Panelists: • Dr. Akash Gupta, Clinical Research Associate, OPIS (MIPA Alumni) • Dr. Nandakishore, Postdoctoral Research Fellow, The University of Melbourne (MIPA Alumni) • Dr. Rachana Sharma, Director Eco Pacific Ltd. • Dr. Dipali Wahi, Sr. Systems Engineering Manager, Plant Innovation • Mr. Ravi Singh, Chief Technical Officer, ESCO Pacific, IITAV	Mr Kunwar Abhishek
17:00	17:15	15	Vote of thanks by Dr Surinder Chauhan	
17:15	17:30	15	Group photo	
17:30	18:00	30	Evening tea and networking	

Abstracts

Modelling of Interface Energy Anisotropy of FCC/L12 Coherent Interfaces in Ni-based Superalloy

Sourav Ghosh[1,2], Rajdip Mukherjee[1], Christian Brandl[2]

[1]Department of Materials Science and Engineering, IIT Kanpur
[2]Department of Mechanical Engineering, The University of Melbourne

Abstract

Superalloys are high temperature application alloys with a combination of mechanical strength and resistance to surface degradation. They are widely used for their applications in gas turbines, coal conversion plants, and chemical process industries, and for other specialized applications that require heat / corrosion resistance [1]. These materials performance requirements are enabled by the coherent or semi-coherent interface of the γ and γ' phases. The formation of typical cuboidal γ' is attributed to the elastic misfit strain (i.e., elastic free energy), which is required to form a coherent interface of cubic lattices (fcc, L12) with different lattice constants [2]. Faceting and precipitate morphology can also be controlled by anisotropic interface energy, which explains the emergence of Wulff-shaped morphology predominate in thermodynamic system without misfit strain energies [3]. Full anisotropy of coherent interfaces comes from the set of interface energies of different orientations. In this talk, I will discuss the development of interface energy anisotropy model of fcc/l12 coherent interfaces in Ni-based superalloy and its ability to capture the structure-property relation.

Keywords

Superalloys, Interfaces, Molecular Dynamics

References

[1] R. C. Reed; Cambridge University Press, 2006, 1-28
[2] G. Brunetti et al.; Micron, 2012, 43, 396-406
[3] A. Roy et al.; Philosophical Magazine, 2017, 97, 2705–2735

Influence of Ocean Mixing on the Winter Mixed Layer beneath Sea Ice in the Weddell Sea

Ankit Bhadouriya[1,2], Rakesh Kumar[1], Bishakhdatta Gayen[2]

[1]Department of Mechanical Engineering, IIT Kanpur
[2]Department of Mechanical Engineering, The University of Melbourne

Abstract

The formation of sea ice in the polar regions creates a dynamic interface where the ocean and atmosphere interact, exerting a profound influence on both global climate patterns and the delicate balance of marine ecosystems. In the Southern Ocean (SO), the winter-mixed layers beneath the sea ice engage in intricate interactions between the atmosphere and the ocean. Throughout the ice formation months (June-September), surface temperatures near-freezing coupled with the process of brine rejection leads to a relatively weak water column stratification. This condition creates a mixed layer (ML) that is cold and fresh immediately above the warm, saline, deep water, making it susceptible to convective instabilities. We have conducted convection resolving large eddy simulation (LES) to model the ML growth during the winter and characterize the mixing. The LES results found agreement with observational data and matched well with the ML properties. The results indicate that the ML experiences deepening during the earlier phase of winter. This is primarily attributed to the substantial conductive heat flux through thin sea ice, which accelerates sea-ice growth and increases brine rejection, subsequently leading to a significant deepening of the mixed layer. In the subsequent stage, when the sea ice is thick, the reduction in the rate of sea ice formation is due to a decrease in conductive heat flux, which, in turn, leads to slower ML deepening. The simulation unveils the pivotal role of fine-scale turbulent eddies in redistributing heat and salt within the mixed layer (ML) during sea-ice formation, exerting a significant influence on ML dynamics and sea-ice growth. The data from present study also suggest improvements required in the parameterization employed in large-scale ocean and climate models for the Southern Ocean (SO).

Keywords

Sea ice, winter-mixed layers, large eddy simulation

Automation in locating suitable sites for surface rainwater harvesting structures using high-resolution lidar data and machine learning techniques

K. Sripriyanka [1, 2] Bharat Lohani [1] Dongryeol Ryu [2] Stephan Winter [2]

[1] Department of Civil Engineering, Indian Institute of Technology, Kanpur, India.
[2] Department of Infrastructure Engineering, The University of Melbourne, Australia

Abstract

The scarcity of water has become a significant problem and an alarming issue these days. The fluctuations in monsoon accompanied by increasing demand for water have led to the depletion of groundwater in many parts of India. Artificially recharging aquifers may alleviate the issue, but only to a limited extent. A possible solution to water scarcity is finding suitable and sustainable substitutes for domestic water consumption. Rainwater harvesting (RWH) is gathering and storing rainwater that would have otherwise runoff through the stream networks. Determining the location of RWH is a critical part of establishing the RWH structure. However, traditionally it has relied on ad-hoc decision criteria, poor site information (e.g., geographic, geological, hydrological information), and manual synthesis of site information for inconsistent decision. Remote sensing and geographic information systems (GIS) techniques are recently adopted as essential tools to investigate RWH structures. Particularly, recent advances in high-resolution Light Detection and Ranging (LiDAR) can provide superior vertical accuracy and horizontal resolution. Combined with machine learning techniques that can effectively combine many layers of quantitative and categorical information, the high-resolution LiDAR data can provide valuable tools for mapping RWH site suitability.

This research will focus on developing an automatic technique for surface RWH site identification and setting out the accurate position of the structure on ground by using high resolution LiDAR data and machine learning algorithms: the Support Vector Machine (SVM) and Random Forest (RF). A decision support system integrating LiDAR derived terrain information with both the biophysical and socio-economic criteria to identify suitable zones for water harvesting structures will be modelled. The beneficiaries of the outcome will be the people who perform manual siting at field which is time consuming and expensive.

Keywords

Rainwater harvesting, LiDAR, Machine learning

References

[1] Ammar, A., Riksen, M., Ouessar, M., & Ritsema, C. (2016). Identification of suitable sites for rainwater harvesting structures in arid and semi-arid regions: A review. International Soil and Water Conservation Research, 4(2), 108-120.
[2] Holmes, D., McEvoy, J., Dixon, J. L., & Payne, S. (2017). A geospatial approach for identifying and exploring potential natural water storage sites. Water, 9(8), 585

Investigation of post-quench information spread in a non-Hermitian quantum model.

A. Ghosh[1,2], A. M. Martin[1], S. Majumder[2]

School of Physics, University of Melbourne, Victoria, 3010, Australia[1]
Indian Institute of Technology Kharagpur, Kharagpur, 721302, West Bengal India[2]

Abstract

C. Bender and colleagues established the possibility of representing quantum systems with non-Hermitian components in their pioneering theoretical work [1]. This paved the way for the study of novel physical systems that constitute gain and loss in different contexts. There has been a great deal of exotic physical phenomena observed in these settings [2]. Likewise, intriguing developments have been observed in non-Hermitian topological physics. Under non-equilibrium conditions, light cones formed by the spread of information have been observed in a topological system [3]. In this work, we have studied the post-quench information spread for an embedded non-Hermitian PT-symmetric system. A dramatic directional asymmetry in the transport of probability density has been found in the post-quench information spread light cones.

Keywords

Non-Hermitian, PT symmetry, Unidirectional transport

References

[1] Carl M Bender and Stefan Boettcher. Real spectra in non-hermitian hamiltonians having p t symmetry. Physical review letters, 80(24):5243, 1998.
[2] Ramy El-Ganainy, Konstantinos G Makris, Mercedeh Khajavikhan, Ziad H Musslimani, Stefan Rotter, and Demetrios N Christodoulides. Non-hermitian physics and pt symmetry. Nature Physics, 14(1):11{19, 2018.
[3] A. Ghosh, A. M. Martin, and S. Majumder. Quench dynamics of edge states in a finite extended su-schrieffer-heeger system. Phys. Rev. E, 108:034102, Sep 2023.

Network Resource Allocation for Industry 4.0 with Delay and Safety Constraints

Asif Ahmed Sardar[1,2], Marimuthu Palaniswami[1], Tansu Alpcan[1], Goutam Das[2]

Department of Electrical and Electronic Engineering, University of Melbourne, Australia[1]
Indian Institute of Technology Kharagpur, West Bengal India[2]

Abstract

We model a futuristic factory floor equipped with Automated Guided Vehicles (AGVs), cameras, and a Virtual Reality (VR) surveillance system; and connected to a 5G network for communication purposes. Motion planning of AGVs and VR applications is offloaded to an edge server for computational flexibility and reduced hardware on the factory floor. Decisions on the edge server are made using the video feed provided by the cameras in a controlled manner. Our objectives are to ensure factory floor safety and provide smooth VR experience in the surveillance room. Providing proper and timely allocation of network resources is of utmost importance to maintain the end-to-end delay necessary to achieve these objectives. We provide a statistical analysis to estimate the bandwidth required by a factory to satisfy the delay requirements 99.999 percent of the time. We formulate a nonconvex integer nonlinear problem aiming to minimize the safety and delay violations. To solve it, we propose a real-time network resource allocation algorithm that has linear time complexity in terms of the number of components connected to the wireless network. Our algorithm significantly outperforms existing solvers (genetic algorithm, surrogate optimizer) and meets the objectives using less bandwidth compared to existing methods.

Keywords

Industry 4.0, Automated Guided Vehicle, Network Resource Allocation

Secular thinning of sub-continental lithospheric mantle: A global perspective from xenocryst and xenolith data from kimberlites and lamproites

Soumendu Sarkar[1,2], Hayden Dalton[1], Andrea Giuliani[3], David Phillips[1], Sujoy Ghosh[2]

[1] School of Geography, Earth and Atmospheric Sciences, The University of Melbourne, Australia
[2] Department of Geology and Geophysics, Indian Institute of Technology Kharagpur, India
[3] Institute of Geochemistry and Petrology, Department of Earth Sciences, ETH Zurich, Switzerland

Abstract

The sub-cratonic lithosphere mantle (SCLM) is known for its chemical buoyancy and mechanical strength, which has facilitated its preservation for billions of years since formation. However, the thinning of lithospheric mantle beneath some cratons (e.g., North China craton, Sao Francisco craton), caused by extensive loss of thick cratonic roots, has raised doubts about the stability and longevity of the SCLM. Using the compositions of olivine xenocrysts sampled by global kimberlites and lamproites, we show that these magmas have progressively entrained Mg-rich lithospheric mantle from the Proterozoic to present day. Furthermore, the thickness of the lithosphere (derived from geothermobarometry of mantle xenocrysts/xenoliths) appears to have decreased over the past ~1200 Myr, implying long-term thinning of the SCLM with time. Combining these observations, we propose a secular evolution model whereby convective removal of the relatively Fe-rich (Mg-poor), metasomatically enriched lower part of the lithospheric mantle produced secular thinning, leading to the sampling of increasingly Mg-rich, shallower olivine by younger kimberlites and lamproites. These findings also hint at a causal link between kimberlite eruption frequency and lithospheric thinning over time, possibly indicating that the SCLM thinning has resulted in a broader kimberlite formation window in the asthenosphere, leading to a higher abundance of kimberlites in more recent times.

Keywords

Xenocryst/xenolith, lithosphere, kimberlites/lamproites

Optical Trapping Assisted Time Resolved Microscopy of Micro and Nanoscale Objects

Subhajit Chakraborty [1,2,3], Debabrata Goswami [1,4], Trevor A Smith [2,3]

Centre for Lasers & Photonics, Indian Institute of Technology Kanpur, India [1]
School of Chemistry, University of Melbourne, Australia [2]
ARC Centre of Excellence in Exciton Science, Australia[3]
Department of Chemistry, Indian Institute of Technology Kanpur, India[4]

Abstract

Optical trapping allows for the precise control and manipulation of micron and submicron sized objects in space while fluorescence lifetime imaging enables us to study its dynamic behaviour over real time. We combined optical trapping with a time resolved fluorescence microscopic arrangement, also known as fluorescence lifetime imaging. 1064 nm IR laser beam was used for trapping and a frequency doubled output at 400 nm from a Ti Sapphire laser system was used for the time resolved microscopy. 2-micron, 1 micron and 200 nm fluorescein coated polystyrene beads were trapped and their time resolved fluorescence measurements were performed simultaneously.

Keywords

Optical Tweezers, FLIM, Time Resolved Microscopy

References

[1] Ashkin, A., Dziedzic, J. M., Bjorkholm, J. E., & Chu, S. (1986). Observation of a single-beam gradient force optical trap for dielectric particles. Optics letters, 11(5), 288-290.
[2] Xu, Y., Zhou, J., & Smith, T. A. (2019). Time-resolved emission microscopy of light-induced aggregation of luminescent polymers. Methods and Applications in Fluorescence, 8(1), 014006.

Light-rechargeable Zinc-ion Batteries for Solar Energy Harvesting and Storage

Chesta[1,2], Jegadesan Subbiah[2], S. Sampath[1], David Jones[2]

Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore[1]
School of Chemistry, The University of Melbourne, Parkville, VIC-3010[2]

Abstract

Among the various renewable energy resources, solar energy has been considered as one of the most effective, promising, and clean sources to meet global energy demands. However, solar energy is intermittent in nature and depends on the time of the day and local weather conditions. This leads to the requirement for energy storage to maintain a balance between energy demand and energy production. Currently, solar panels are used to convert solar energy to electrical energy, and rechargeable batteries are used to store electrical energy in the form of chemical energy. Hence two individual devices are required for the overall energy harvesting and storage. These extra electronics introduce energy losses in the system and increase the overall cost. One alternate approach is to integrate the photoconversion system and energy storage within a single device to store excess solar energy efficiently. Photo-rechargeable batteries are a promising alternative to meet energy demands using solar energy, which can be directly charged using sunlight. It involves the use of a photocathode that both harvests and stores energy and hence reduces the extra electronics, device complexity and overall cost. There has been an emerging interest in exploring different organic and inorganic semiconductors as photoelectrodes in photo-rechargeable batteries. Aqueous zinc-ion batteries have gained particular attention for energy storage devices because of their intrinsic safety, high gravimetric energy density, cost-effectiveness, and environmental friendliness. In this poster, the performance of photo-assisted as well as photo-rechargeable Zinc-ion batteries will be discussed.

Keywords

Photo-rechargeable, Solar energy, Zinc-ion batteries

References

[1]. Boruah, B. D. et al. Energy Environ Sci 13, 2414–2421 (2020).

Ballistic studies on SS410-Al2O3-SiC functionally graded armour material fabricated through laser cladding

Ayyappan Murugesan[1,2], Tesfaye Molla[1], Koushik Biswas[2]

Department of Mechanical Engineering, University of Melbourne[1]
School of Nanoscience and Technology, Indian Institute of Technology Kharagpur[2]

Abstract

This project aims to study the ballistic testing of SS410-Al_2O_3-SiC system-based functionally graded material (FGM) through laser cladding. Laser cladding has been proved to directly fabricate the FGM coatings and components using a laser beam as the heat source. Laser cladding is a modern technology that integrates laser technology and computer-aided manufacturing technology. It is processed in complex physical, chemical and metallurgical processes. Also, it is a straightforward technique to prepare FGM structures with high density, complex shapes, and large sizes. The primary objective is to design and fabricate an SS410- Al_2O_3-SiC composite system using the laser cladding technique with the help of SS410, Al_2O_3, and SiC spherical powder (Particle size 50 to 100µm) and SS410 plate (150X150X5) is used as a substrate material. The laser spot diameter of 3.6mm with a continuous co-axial nozzle was chosen for the cladding process. The selected laser power was 2000W, the Scanning speed was 3-5mm/s, and the feed rate was 15g/min. The secondary objective is to study the ballistic performance of fabricated Fe-Al_2O_3-SiC composite compared to the other competing ceramic armors. Moreover, the microstructural characterization of FGM based SS410- Al_2O_3- SiC composite system was investigated through a scanning electron microscope (SEM with EDS). The presence of phases and their distribution were determined using an X-ray diffractometer (XRD). As part of the ballistic testing, the hardness and elastic modulus of the sample was tested through the Nanoindentation tester, and it was observed that the hardness value was 13GPa and the elastic modulus value was 280GPa. Ultimately, the ballistic performance needs to be analyzed using the Depth of penetration (DOP) test and the Fracture toughness test in the near future.

Keywords

Laser cladding, functionally graded material

References

[1] Neha Gupta, Bhanu Prasad V.V, Madhu V, Bikramjit Basu (2012) “Ballistic studies on TiB2-Ti functionally graded armor ceramics” Defence Science Journal, Vol 6, pp. 382-389

Improvement of fire performance of steel and bamboo reinforced structures using geopolymer

Nimisha KM[1,2], A/Prof Huu Tai Thai[1], Prof Duc Ngo[1], Prof Damodar Maity[2]

Infrastructure Engineering, The University of Melbourne[1]
Department of Civil Engineering, IIT Kharagpur[2]

Abstract

It is important to understand the fire resistance, fire design, and fire prevention measures of structures to make them meet the fire safety standards. It is one of the major durability criteria that should be followed by every construction technology. Therefore, understanding the behavior of reinforced concrete structures under elevated temperature conditions is crucial. Geopolymer is a type of innovative material that has gained attention for its potential benefits and sustainable properties. This study investigates the improvement of fire performance of steel and bamboo-reinforced structures using geopolymers. Comparing geopolymer to ordinary Portland cement-based concrete, the former has better fire resistance and can increase its strength after exposure to high temperatures.

The foundation of this study is the development of a modeling methodology to provide ideas about the residual strength of reinforced concrete members. The Finite Element (FE) analysis was conducted on ABAQUS software by developing constitutive law and validating the structural behavior of geopolymer-based composites. In order to record the thermal and structural responses during the heating phases, these analyses make use of material characteristics like conductivity, specific heat, stress−strain relationship, and thermal expansion. From the FE analysis, the load-deflection, moment- curvature, and bond strength-slip relations of the reinforcement structure are studied. The accuracy of preferred modeling and analysis approaches is validated by previous experimental research. The developed FE models can be an efficient tool for designing and developing geopolymer-based concrete structures in the future.

Keywords

Elevated temperature, Geopolymer, Finite element methods

References

[1] Amran, M., Huang, S. S., Debbarma, S., & Rashid, R. S. (2022). Fire resistance of geopolymer concrete: A critical review. Construction and Building Materials, 324, 126722.
[2] Razak, S. N. A., Shafiq, N., Guillaumat, L., Farhan, S. A., & Lohana, V. K. (2022). Fire-exposed fly-ash-based geopolymer concrete: effects of burning temperature on mechanical and microstructural properties. Materials, 15(5), 1884.

Soft rigid granular mixes

Mehdi Alam[1,2], Mahdi Miri Disfani[1], Arghya Das[2]

Department of Infrastructure Engineering, The University of Melbourne[1]
Department of Civil Engineering, Indian Institute of Technology, Kanpur[2]

Abstract

The numerical investigation of soft materials (derived from end-of-life tires) and rigid materials (such as crushed rock or conventional soil) using the Discrete Element Method (DEM) necessitates the development of a coherent contact model, especially when employing spherical particles. Previous numerical studies have utilized various contact models that fail to accurately simulate the macroscopic behaviour of these unconventional granular mixtures at varying volume fractions of soft materials. To address these limitations, a combination of the Hertz-Mindlin and linear rolling resistance contact model (HRR) has been implemented in PFC3D. This contact model takes into account the stiffness variation of particles as loading progresses and incorporates shape effects to some extent. The study focuses on four different samples with varying soft particle content by volume (0%, 20%, 40%, and 60%), subjected to 1D compression. Calibration efforts between experimental and numerical data, based on two macroscopic quantities (Modified void ratio parameter and constrained modulus) obtained from the literature, demonstrate a strong agreement between the two. A root mean square (RMS) analysis reveals values exceeding 0.95 for all soft content levels. This alignment between experimental and numerical results enables accurate prediction and comparison of the micro-scale behaviour of these mixtures, thereby elucidating the observed macroscopic behaviour. Furthermore, the study delves into various microstructural contact parameters, including packing intensity, orientation biases, and lateral pressure. It also explores the influence of different contact types and the soft content in the mix. The findings yield valuable insights into the microstructural behaviour of these mixtures under compressive loads.

Keywords

Soft rigid mixes, Discrete Element Method, Contact models

References

[1] Raeesi R, Asce SM, Amin Soltani ;, Disfani MM. Compressibility Behavior of Soft-Rigid Granular Mixtures Bound with Polyurethane Binder 2021. https://doi.org/10.1061/(ASCE)GM.1943-5622.0002237.
[2] Lee C, Shin H, Lee JS. Behavior of sand–rubber particle mixtures: experimental observations and numerical simulations. Int J Numer Anal Methods Geomech 2014;38:1651–63. https://doi.org/10.1002/NAG.2264.
[3] Asadi M, Mahboubi A, Thoeni K. Discrete modeling of sand–tire mixture considering grain-scale deformability. Granul Matter 2018;20. https://doi.org/10.1007/s10035-018-0791-4.

Detecting Zero Velocity period for Precise Indoor Pedestrian Positioning Using Ultra Wide Band (UWB) Sensors

Ashwani Kumar[1,2], Salil Goel[1], Kourosh Khoshelham[2]

Department of Civil Engineering, IIT Kanpur, India[1]
Department of Infrastructure Engineering, University of Melbourne, Australia[2]

Abstract

Foot-mounted inertial navigation is a significant challenge in indoor positioning tech with applications like navigation, mapping, and gait analysis. It involves using sensors like IMUs on a user's feet for localization, but IMUs have error issues leading to position drift. To counter this, Zero Velocity Update (ZUPT) is used, which identifies intervals of foot stillness (Zero Velocity Intervals or ZVIs) and corrects position errors. Traditional Zero Velocity Detectors (ZVDs) set fixed thresholds for detection but struggle with dynamic motion. Data-driven ZVDs using machine learning models like CNN, LSTM, and SVM require large training datasets, which are scarce and often lack proper labelling. Their effectiveness depends on data quality. This seminar proposes the integration of a foot-mounted IMU with a dual foot-mounted Ultra- Wide Band (UWB) sensor. Since foot mounted UWB sensors can provide distance between the feet at definite intervals which provides a means to model the variation of distance between the feet by using them. This obtained variation could then be used to correctly label the zero velocity periods without the use of any threshold-based detector or machine learning approaches. The preliminary experiments performed to test the potential of the UWB sensors to model this variation has shown promising results while some challenges remain which needs to be taken care of to perform zero velocity detection using foot mounted UWB sensors.

Keywords

Foot mounted pedestrian Positioning, Ultra-Wide Band, Zero velocity Potential Update (ZUPT)

Mapping of water quality in dynamic river reaches using remote sensing techniques and hydrodynamic modelling

Kunwar Abhishek Singh[1,2], Dongryeol Ryu[1], Meenakshi Arora[1], Manoj Kumar Tiwari[2], and Bhabagrahi Sahoo[2]

Department of Infrastructure Engineering, The University of Melbourne, Australia[1]
School of Water Resources, Indian Institute of Technology Kharagpur, India[2]

Abstract

The evaluation and continuous monitoring of essential water quality indicators play a crucial role in detecting fluctuations and long-term trends in water quality. This proactive approach allows for the timely identification and response to emerging water quality issues. In this context, remote sensing techniques offer significant advantages compared to traditional methods. These advantages stem from their cost-effectiveness, time efficiency, and the provision of a consistent and valuable source of data on a local to global scale. Nonetheless, a notable challenge lies in assessing water quality parameters in dynamic river environments and retrieving optically insensitive water quality indicators using remote sensing methods. The focus of this research is centered on the utilization of high spatial-temporal satellite data, such as Sentinel-2 and Landsat-8, to assess various water quality parameters. Additionally, this work aims to integrate existing hydrodynamic models to gain insights into the transport of contaminants within dynamic river reaches. The study will specifically demonstrate these methodologies in the lower Ganges River in India.

Keywords

Monitoring, water quality, remote sensing

References

[1] Brown, C.F., Brumby, S.P., Guzder-Williams, B. et al. Dynamic World, Near real-time global 10 m land use land cover mapping. Sci Data 9, 251 (2022). doi:10.1038/s41597-022-01307-4
[2] Cox, R. M., Forsythe, R. D., Vaughan, G. E., & Olmsted, L. L. (1998). Assessing Water Quality in Catawba River Reservoirs Using Landsat Thematic Mapper Satellite Data. Lake and Reservoir Management, 14(4), 405–416. https://doi.org/10.1080/07438149809354347
[3] Zhu, X., Helmer, E. H., Gao, F., Liu, D., Chen, J., & Lefsky, M. A. (2016). A flexible spatiotemporal method for fusing satellite images with different resolutions. Remote Sensing of Environment, 172, 165–177. https://doi.org/10.1016/j.rse.2015.11.016

Directional Spectra of Waves and of Wave-Breaking Dissipation by Means of Explicit Measurements and Modelling

Omar Zain Torres Rios[1,2], Alexander Babanin[1], S.A. Sannasiraj[2] , Ian Young[1]

Department of Infrastructure Engineering, University of Melbourne[1]
Department of Ocean Engineering, IIT Madras[2]

Abstract

The directional wave spectrum (DWS) is widely used in ocean engineering and naval architecture for analysis of the characteristics of ocean waves. Traditionally, it is estimated by an array of sensors or with remote sensors. In the former the directional spectra is gleaned from point measurements which yields uncertainty in the accuracy of spreading estimations. Using remote sensors, the whole sea surface can be used to estimate the DWS but has limited resolution in high frequencies.

Advancements in numerical modeling and higher-resolution measurements using stereo imaging techniques [1] have enabled more accurate assessment of spectral properties. This study aims to assess the accuracy of estimating the spreading distribution of DWS based on point measurements. We employ spectral estimation methods, including the Maximum Likelihood Method (MLM)[2], Maximum Entropy Method (MEM), and the Wavelet Directional Method (WDM)[3], in comparison with results obtained from applying the 2D Fast Fourier Transform (2FFT) to the water surface data.
This is done first by numerical simulations of the water surface for different sea states using a 3D fully nonlinear phase resolving model with a broad range of Fourier modes and subsequently with measurements of the water surface obtained from stereo-imaging techniques in a wave basin. Additionally, we investigate wave-breaking statistics, such as breaking probability and severity, and their directional distribution across the frequency spectrum.
The numerical analysis reveals that DWS obtained from MLM are statistically 19% broader than those derived from 2FFT. Conversely, DWS using WDM were 16% narrower compared to those obtained with 2FFT.

Keywords

Directional wave spectrum, spreading distribution, wave-breaking dissipation

References

[1] Benetazzo, A. (2006). Measurements of short water waves using stereo matched image sequences. Coastal engineering, 53(12), 1013-1032.
[2] Capon, J. (1979). Maximum-likelihood spectral estimation. Nonlinear methods of spectral analysis, 155-179.
[3] Donelan, M. A., Drennan, W. M., & Magnusson, A. K. (1996). Nonstationary analysis of the directional properties of propagating waves. Journal of Physical Oceanography, 26(9), 1901-1914.

Urban forest characterisation using mls point cloud data through deep learning

Aditya[1,2], Bharat Lohani[1], Jagannath Aryal[2], Stephan Winter[2]

Department of Civil Engineering, Indian Institute of Technology Kanpur[1]
Department of Infrastructure Engineering, The University of Melbourne[2]

Abstract

Amidst the deteriorating urban environment and expanding infrastructure footprints, urban forests are under critical stress. Continuous depletion of trees has rendered every standing tree significant. Therefore, geospatial mapping of trees in the urban environment is essential. Further, the three-dimensional structural information of trees has become a necessity for the stakeholders. Management of urban green space, time and resource constraints in the quantification of existing green infrastructure, and commitment towards various international conventions are some factors mandating research in this domain. Existing studies are rule-based, parameter-dependent, and works within some thresholds. In addition, most methods require the user to have some on-ground quantitative information about the trees.

This study will deliver a robust mechanism for vegetation points extraction from the mobile laser scanning point cloud data. A novel deep learning architecture dedicated for vegetation point segmentation will be developed. This will be followed by individual tree segmentation and morphological parameters identification. Utilisation of simulated data, employment of transfer learning and multiple study sites will provide the necessary confidence in research outcomes. Thereby, providing necessary solutions to the urban planners, utility service providers, governing bodies, and the local community.

Keywords
Urban forests, Deep Learning, Point cloud semantic segmentation

References

[1] Y. Zhao, Q. Hu, H. Li, S. Wang, and M. Ai, “Evaluating carbon sequestration and PM2. 5 removal of urban street trees using mobile laser scanning data,” Remote Sensing, vol. 10, no. 11, p. 1759, 2018.
[2] Q. Li, P. Yuan, X. Liu, and H. Zhou, “Street tree segmentation from mobile laser scanning data,” International Journal of Remote Sensing, vol. 41, no. 18, pp. 7145–7162, Sep. 2020.
[3] C. Zhang, Y. Zhou, and F. Qiu, “Individual Tree Segmentation from LiDAR Point Clouds for Urban Forest Inventory,” Remote Sensing, vol. 7, no. 6, Art. no. 6, Jun. 2015.

Surface soil moisture retrieval from multi-polarization L-band synthetic aperture radar over wheat fields

Shilpa Koyyan[1,2], D. Nagesh Kumar[1], Dongryeol Ryu[2]

Department of Civil Engineering, Indian Institute of Science, Bengaluru, India [1]
Department of Infrastructure Engineering, The University of Melbourne, Victoria, Australia [2]

Abstract

Soil moisture is a critical parameter for a wide range of agricultural applications, such as crop yield estimation, crop health monitoring, soil stress studies, and irrigation management [1, 2]. Microwave remote sensing has important advantages for satellite-based soil moisture measurement owing to the longer wavelengths of microwave channels that are less affected by the intervening atmosphere and clouds, unlike visible and infrared (IR) remote sensing. Microwave imagery from Synthetic Aperture Radar (SAR) can provide high-resolution soil moisture retrievals for actual field-scale agricultural applications. This is a crucial feature for monitoring soil wetness over large agricultural regions with numerous small-scale farms. However, most of existing SAR soil moisture algorithms still rely on vegetation parameters derived from ground measurements or optical satellites, which negates the all-weather capability of the microwave instrument. In this study, we develop a methodology for soil moisture retrieval using radar-derived vegetation parameters using multi-polarization SAR data. The semi-empirical Water Cloud Model (WCM) proposed by Attema and Ulaby in 1978 [3] was used for vegetation–soil system modelling followed by an inversion algorithm (Look-Up Table approach). The impact of using different radar-derived vegetation descriptors in the WCM for surface soil moisture (SSM) retrieval is the primary objective of this research. The analysis of retrieval accuracy for each polarization (VV, HH, and VH) showed superior performance of cross-polarization-based retrievals compared to those from co-polarization in the case of the wheat cropping fields.

Keywords

Soil Moisture, Multi-polarization, L-band Radar

References

[1] Y. Ma, S. Feng, and X. Song, “A root zone model for estimating soil water balance and crop yield responses to deficit irrigation in the North China Plain,” Agric Water Manag, vol. 127, pp. 13–24, 2013, doi: 10.1016/j.agwat.2013.05.011.
[2] P. M. Lawston, J. A. Santanello, and S. V. Kumar, “Irrigation Signals Detected from SMAP Soil Moisture Retrievals,” Geophys Res Lett, vol. 44, no. 23, pp. 11,860-11,867, 2017, doi: 10.1002/2017GL075733.
[3] E. P. W. Attema and F. T. Ulaby, “Vegetation modeled as a water cloud,” Radio Sci, 1978, doi: 10.1029/RS013i002p00357.

Unravelling the physiological and molecular mechanism underpinning response to combined drought and heat stress in rice

Latika Joshi[1, 2], Alex Johnson[2], and Annapurna Devi Allu[1]

[1] Department of Biology, Indian Institute of Science, Education and Research, Tirupati, India

[2]School of BioSciences, Faculty of Science, University of Melbourne, Australia

Abstract

Plants being sessile are frequently exposed to various abiotic stresses in their natural habitat. Among them, drought and heat are the most prevalent contemporary stressors that have severe impact on agricultural productivity[1]. Often in nature, these two stresses occur simultaneously having additive effect on plant growth and productivity[2]. Although previous studies were instrumental in gaining insights into the plant response to individual drought and heat stress, our curren t understanding of the plant response to the combination of these stresses is limited. An increase in the frequency in co-occurrence of these stresses is predicted to happen in the near future[3]. Hence, better understanding of the plant response to the combination of drought and heat stress is crucial to improve crop productivity under changing climatic conditions. For this, we aim to investigate the plant response to combined drought and heat stress in a time series manner at physiological, biochemical and molecular level in an important crop plant- rice (Oryza sativa L.) at both vegetative and reproductive stages.

Keywords

Climate change, Combined stress, Molecular regulatory networks, Crop productivity, Grain quality.

References

[1] Zandalinas SI, Fritschi FB, Mittler R. 2021, Trends in Plant Science 26: 588–599. [2] Ron Mittler, 2006, Trends in Plant Science, Volume 11, Issue 1, 15 – 19
[3] Mohammad Reza Alizadeh et al, 2020, Sci. Adv.6, eaaz 4571.

Flame-wall interaction in the presence of intense turbulence

Shreshtha Gupta[1,2], Mohsen Talei[1], Robert Gordon[1], Vaibhav Arghode[2]

Department of Mechanical Engineering, The University of Melbourne, Australia[1]
Department of Aerospace Engineering, Indian Institute of Technology Kanpur, India[2]

Abstract

In a gas turbine combustor with a high surface-to-volume ratio, the flame can exist in close contact with the wall liner. This phenomenon is commonly referred to as Flame-Wall Interaction (FWI). FWI lowers combustor efficiency, increases the production of harmful emissions such as carbon monoxide (CO), and decreases the wall's lifetime. This talk will present a direct numerical simulation (DNS) study of a turbulent premixed methane-air flame interacting with isothermal walls of at temperatures of 300K and 800K within a channel. As well as investigating the flame behaviour during FWI, the implications of the findings for CO modelling will be discussed.

Keywords

Direct numerical simulation, Flame-wall interaction, CO modelling.

Structure-function insight into the two-component DNA repair system of Mycobacterium tuberculosis

J.Baral[1,2,3,4], I.Rouiller[3,4], E.Hinde[2], A.Das[1]

[1]Department of Biotechnology, Indian Institute of Technology Kharagpur, India,
[2]School of Physics, University of Melbourne, Australia
[3]Department of Biochemistry & Pharmacology, University of Melbourne, Australia
[4]Australian Research Council Centre for Cryo-Electron Microscopy of Membrane Proteins, Australia

Abstract

Double-stranded break (DSB) is considered the most detrimental form of DNA damage encountered by living systems across species. If not readily repaired, one such break in the genomic DNA is sufficient to arrest all cellular processes and may further result in cell death. Thus, the reparation of DSBs is critical for genomic stability and sustenance of all living systems [1]. *Mycobacterium tuberculosis*, the causative agent of tuberculosis, spends a considerable part of its life cycle in dormancy within the host immune cells (macrophages) and proliferates only when the host becomes immunocompromised. The ability of *M.tuberculosis* to maintain a prolonged inactive state confers to its unparalleled resistance to the host immune system and antibiotics. The DSB repair machinery is an indispensable arsenal of the pathogen to cope with the host induced genotoxic stress and promote sustenance in dormancy [2,3]. In this study, we have employed *in silico* and *in vitro* tools to get a structural-function insight into the DNA repair machinery. We have implemented molecular dynamics simulation to understand the DNA protein interface and predict critical amino acid residues responsible for the stability of the complex. The computational findings were further validated *in vitro* with complementary biochemical and biophysical techniques to delineate the DNA protein interaction on quantitative parameters. Presently, we are focused to elucidate the three-dimensional structure of the DNA repair complex using X-ray crystallography and cryo-Electron microscopy.

Keywords

Mycobacterium tuberculosis, DNA repair, MD simulation

References

[1] Lieber M. R. The mechanism of double-strand DNA break repair by the non-homologous DNA end joining pathway. Annu. Rev. Biochem. 79, 181–211 (2010).
[2] Brissett, N. C. & Doherty, A. J. Repairing DNA double-strand breaks by the prokaryotic non-homologous end-joining pathway. Biochem. Soc. Trans. 37, 539–545 (2009).

An intra-brainstem circuitry for pain-inhibition of itch

Jagat Narayan Prajapati[1], Devanshi Shah[2], Arnab Barik[1], Stuart Mazzone[2]

Centre for Neuroscience, Indian Institute of Science, Bengaluru India[1]
Department of Anatomy and Physiology University of Melbourne[2]

Abstract

The ability of noxious (pain-causing) stimuli to modulate itch has been known for decades; however, the neural circuits that facilitate this phenomenon remain poorly understood[1]. Recent studies have shown that a select group of nociceptive neurons in the lateral parabrachial nucleus (LPBN) expressing Tacr1 ($LPBN^{Tacr1}$) is sufficient to suppress itch[2]. Here, we sought to understand the mechanism of $LPBN^{Tacr1}$ mediated itch modulation. We used mouse and viral-genetic tools to identify the neurons downstream of $LPBN^{Tacr1}$ cells in the rostral ventromedial medulla (RVM). Surprisingly, the $LPBN^{Tacr1}$ neurons were found to synapse with the Tacr1-expressing neurons in the RVM (RVM^{Tacr1}). In-vivo recordings from the RVM^{Tacr1} show that these neurons are tuned to noxious stimuli. We found that the chemogenetic activation of the RVM^{Tacr1}neurons inhibits itch. Importantly, inhibition of the RVM^{Tacr1} neurons abrogated pain inhibition of itch. Anatomical labeling with anterograde and retrograde transsynaptic viral strategies indicated that the RVM forms reciprocal connections with the LPBN. Together, we have unveiled a genetically circumscribed population of RVM neurons that are bidirectionally connected with the LPBN and play an essential role in suppressing itch by painful stimuli.

Keywords

Lateral Parabrachial Nucleus (LPBN), Rostral ventromedial medulla (RVM), Tac1 receptor (Tacr1)

References

[1] Chen, X. J. et al. The neurobiology of itch. Nat. Rev. Neurosci. 7, 1–10 (2006).
[2] Barik, A. et al. A spinoparabrachial circuit defined by Tacr1 expression drives pain. Elife 10, (2021).

Conserved and emergent functional roles of protein regions with charged amino acid bias

Keertana S Kappagantula[1,3], Anjali K Singh[1], Harikrishnan Ramadasan[1], Sourav Ganguli[2], Pavithra L Chavali[2], Alexander Idnurm[3], Sreenivas Chavali[1],

Department of Biology, Indian Institute of Science Education and Research (IISER) Tirupati, India[1]
CSIR-Centre for Cellular and Molecular Biology, Hyderabad, India[2]
Department of BioSciences, University of Melbourne, Australia[3]

Abstract

Proteins contain regions that show bias for one or few amino acids, known as low complexity regions (LCRs). Composition of LCRs is an important determinant of their conformation and function. While a few molecular studies have highlighted the functional roles of LCRs with charged amino acid bias[1,2], a systems-level understanding is lacking. Using Systems Biology approaches, we investigated the intra-species physiological roles of proteins with charged tracts (PCTs) in budding yeast and humans and inter-species roles in human-pathogen interactions. We observed that PCTs are involved in conserved fundamental biological processes, predominantly nucleic acid processing. With increase in organismal complexity, PCTs expand their functional repertoire by participating in binary interactions and formation of protein complexes and higher order assemblies. Acquisition of novel regulatory and functional roles and their augmentation through evolution makes these proteins physiologically important. They tend to interact with other physiologically important proteins and emerge to influence the topology of PPI network by enhancing crosstalk between diverse biological processes. Charged tracts also influence protein localization, cellular organization and molecular interactions of the PCT, as evidenced through experimental investigations in charged tract deletion mutants in human cell lines. With regards to intra-species roles, we analyzed human-pathogen protein-protein interaction network, which revealed that pathogens tend to interact more with PCTs, especially those that show high functional and regulatory interactions. Collectively, our findings suggest that PCTs (i) play crucial roles in physiology and pathology and (ii) gain novel physiological functions through evolution and charge tracts actively contribute to these functionalities.

Keywords

Low complexity sequences, charged tracts, evolution

References

[1] Hierro A, et al., Biochem. 2002, 41, 6408-6413.
[2] Holmstrom ED, et al., Nat Commun., 2019, 10, 2453.

Approaches for kinetic modelling of hydrothermal carbonization of biomass

Hema Jha[1,2], Kathryn Mumford[1], Meenakshi Arora[3], Brajesh Dubey[2]

Department of Chemical Engineering, University of Melbourne, VIC 3010, Australia[1]
PK Sinha Centre for Bioenergy, Indian Institute of Technology Kharagpur, WB 721302, India[2]
Department of Infrastructure Engineering, University of Melbourne, VIC 3010, Australia[3]

Abstract

Hydrothermal carbonization (HTC) is acknowledged as a promising and viable method for converting wet biomass into fuel and higher-value products. At present, this technology is in a transitional phase between pilot and industrial scale applications, with several challenges that remain to overcome [1]. One of the major bottlenecks is the lack of predictive models for optimization and control of the process. Kinetic modelling is important to unravel reaction mechanisms and establish the link between process parameters (e.g., temperature, reaction time, biomass loading) and product characteristics, such as hydrochar yield, carbon content etc. In this paper, a review of various approaches for kinetic modelling of HTC process is presented with their strengths and drawbacks. Many of the existing kinetic models often rely on first-order reactions based on Arrhenius's law, with only a limited attempt to develop higher-order kinetic models and thus limiting their applicability in real world. The hypothesized reaction pathway for these models highly affect the values of the kinetic parameters, as a result, it is difficult to compare the values of the kinetic parameters among the different models even for the same biomass [2]. In some studies, distributed activation energy model has also been applied to HTC for addressing non-isothermal and isothermal subsequent steps in the process. Other interesting approach is to assume HTC process in a stochastic way and account for average behaviour of random detachments of particles from the parent biomass by the application of Hill's equation and Markov process. Overall, the major constraint in developing a robust kinetic model in most studies is the need for experimental data from high-pressure reactors and restricted applicability to specific biomass.

Keywords

Hydrothermal carbonization, Biomass, Kinetic modelling

References

[1] P. Romano, N. Stampone, and G. Di Giacomo, "Evolution and Prospects of Hydrothermal Carbonization," Energies, vol. 16, no. 7, 2023
[2] G. Ischia and L. Fiori, "Hydrothermal Carbonization of Organic Waste and Biomass: A Review on Process, Reactor, and Plant Modeling," Waste and Biomass Valorization, vol. 12, no. 6, pp. 2797–2824, 2021

Environmental sustainability and economic viability of shrimp culture practices: Indian and Australian perspectives

Pradeep R[1,2], Dibyendu Kamilya[1], Giovanni Turchini[2]
Aquaculture Engineering division, Agriculture and Food Engineering Department, Indian Institute of Technology Kharagpur, West Bengal, India[1]
School of Agriculture, Food and Ecosystem Sciences, University of Melbourne, Australia[2]

Abstract

Sustainability in aquaculture has become essential to ensure the responsible and environmentally friendly production of aquatic products while meeting the growing global demand. Achieving true sustainability requires a comprehensive and balanced approach that considers environmental, economic, and social aspects simultaneously. The present study has been planned to conduct a sustainability assessment for a high-value commodity, shrimp, in two prominent aquaculture countries, India (export market-oriented) and Australia (domestic market-oriented). The study will focus on assessing the environmental impacts of various shrimp culture practices in India and Australia using the Life Cycle Analysis (LCA), including global warming potential, eutrophication, etc. Appropriate LCA software (e.g., SimaPro©) and databases (e.g., Agribylase, Ecovinent, etc.) will be used to model and compare the environmental impacts of different culture practices. A financial model will be developed for each shrimp farming practice, considering capital costs, operational expenses, labour, feed, energy, and production yields. Several techno-economic indicators (e.g., profitability index, return on investment, breakeven point, etc.) will be assessed, followed by a sensitivity analysis of each model. The social sustainability of different shrimp farming methods will be measured by assessing stakeholders' engagement and participation, community well-being and livelihood, quality of life, and other parameters. Finally, the sustainability results will be integrated, and recommendations will be suggested based on trade-off analysis. The research findings are expected to provide valuable information that will guide shrimp farmers, and other stakeholders in adopting practices that strike a balance between profitability and environmental responsibility, contributing to the long-term sustainability.

Keywords

Sustainability, life cycle assessment, techno-economic analysis

References

[1] Sun, Y., Hou, H., Dong, D., Zhang, J., Yang, X., Li, X., & Song, X. (2023). Comparative life cycle assessment of whiteleg shrimp (Penaeus vannamei) cultured in recirculating aquaculture systems (RAS), biofloc technology (BFT) and higher-place ponds (HPP) farming systems in China. Aquaculture, 574, 739625.
[2] Duy, D. T., Nga, N. H., Berg, H., & Da, C. T. (2023). Assessment of technical, economic, and allocative efficiencies of shrimp farming in the Mekong Delta, Vietnam. Journal of the World Aquaculture Society, 54(4), 915-930
[3] Campbell, L. M., Fairbanks, L., Murray, G., Stoll, J. S., D'Anna, L., & Bingham, J. (2021). From Blue Economy to Blue Communities: reorienting aquaculture expansion for community wellbeing. Marine Policy, 124, 104361.

Effect of riblet dimensions on the transitional boundary layers over high-lift turbine blades

S M Ananth[1], Massimiliano Nardini[2], Aditya Vaid[1], Melissa Kozul[2], Nagabhushana Rao Vadlamani[1] and Richard D Sandberg[2]

[1]Department of Aerospace Engineering, Indian Institute of Technology Madras, India
2Department of Mechanical Engineering, The University of Melbourne, Australia

Abstract

Substantial research exists in the literature on reducing the profile loss of transitional boundary layers over low-pressure turbine (LPT) blades via different mechanisms such as free-stream turbulence, upstream wakes, and surface roughness. These mechanisms have proven to be beneficial in mitigating the separation bubble-related losses in ultra-high lift blade designs, despite an increase in the loss due to increased turbulent wetted area (TWA). In this work, we adopt a strategy of employing surface roughness in the transitional regime to minimize the separation bubble-related losses and flush mounted riblets downstream to further mitigate the skin-friction drag and boundary layer losses due to an increase in the TWA. Several high-fidelity scale resolving simulations are performed on this 'rough-ribbed blade surface' to discern the effect of varying the riblet spacing (s+) and height (h+). The streamwise evolution of the skin-friction coefficient, boundary layer integral parameters and shape factor are compared and contrasted among riblets of different dimensions. The instantaneous flow features and second-order statistics such as the Reynolds stress, turbulent kinetic energy and its production are analysed for different test cases to determine the impact of riblets on these quantities. When compared to the roughness-alone configuration, the scalloped shape riblets with s+ =17 and h+ =22 reduced the net skin-friction drag by 7.3% and the trailing edge momentum thickness by 14.5% thereby demonstrating the efficacy of riblets in reducing the mixing losses under adverse pressure gradients. Through an analysis of flow blockage introduced by the application of riblets, the deleterious effects of increasing the riblet height along with the necessity of optimizing the riblet ramp are highlighted.