Book of abstracts

MIPAC-2025

Melbourne India Postgraduate Academy Conference (MIPAC- 2025)

~ VENUE ~

Melbourne Business School

Location Info: https://maps.app.goo.gl/CgpFbuSHV98Sx7xB8

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A/Prof. Debnath Ghoshal

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Dhiren Swain

Subham Verma

Sai Vikas Kona

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MIPAC-25 Conference: Participants' List

Graduate Researchers

[R] Indicates remote/online attendance

Home Institute	Participants
IIT Kharagpur	1. Kunwar Abhishek Singh [R] 2. Nimisha Kattumunda 3. Hema Jha 4. Subham Saha [R] 5. Susithra Sureshkumar 6. Joydeep Baral [R] 7. Subham Verma 8. Pradeep Ramesh [R]
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IISER Tirupati	23. Sai Keertana K [R]
The University of Melbourne	24. Omar Zain Torres Rios 25. Saurav Mandal

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Home Institute	Participants
IIT Kharagpur	26. Prof Suman Chakraborty |Director IIT KGP 27. Prof Brajesh Kumar Dubey| Engineering and Information Technology 28. Dr Swambabu Varanasi |
IISc Bangalore	29. Dr Das Bhowmik Rajarshi | Engineering and Information Technology 30. Prof Dasika Nagesh Kumar | Engineering and Information Technology
IIT Kanpur	31. Prof Bushra Ateeq| Medicine, Dentistry and Health Sciences 32. Dr Deepashree Sheshadri | 33. Prof Sandeep Verma | Medicine, Dentistry and Health Sciences 34. Prof Rakesh Kumar | Engineering and Information Technology 35. Mrs Shirolly Anand |
IIT Madras	36. Dr Sreeparvathy Vijay
IISER Tirupati	37. Prof Santanu Bhattacharya | Director IISER Tirupati 38. A/Prof Annapurna Devi Allu| Science 39. A/Prof Balaraman Ekambaram| Science

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Participants | Department
40. A/Prof Jagannath Aryal | Engineering and Information Technology
41. Prof Meenakshi Arora | Engineering and Information Technology
42. Prof Muthupandian Ashok kumar | Director Melbourne Global Centre (Delhi)
43. A/Prof Debnath Ghosal | Medicine, Dentistry and Health Sciences
44. Prof Alexander Babanin| Engineering and Information Technology
45. A/Prof Alexander Idnurm|Science
46. Prof Amanda Ellis| Engineering and Information Technology
47. Prof Andrew Western| Engineering and Information Technology
48. Dr Christian Brandl | Engineering and Information Technology
49. Prof Dongryeol Ryu | Engineering and Information Technology
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51. A/Prof Hafiz Suleria | Science
52. Dr Jegadesan Subbiah | Science
53. Prof Tai Thai | Engineering and Information Technology
54. Prof Justine Mintern | Medicine, Dentistry and Health Sciences
55. Dr Melissa Kozul | Engineering and Information Technology
56. Prof Richard Sandberg | Engineering and Information Technology
57. Prof Richard (Dick) Strugnell | Medicine, Dentistry and Health Sciences

60. Prof Stuart Ralph | Medicine, Dentistry and Health Sciences
61. Prof Colette Boskovic | Science
62. Prof Georgina Such | Science
63. Prof Margie Danchin | Medicine, Dentistry and Health Sciences
64. Dr Melissa Kozul | Engineering and Information Technology
65. Dr Serene Ho | Engineering and Information Technology
66. Prof Stan Skafidas | Engineering and Information Technology
67. A/Prof Surinder Chauhan | Science
68. Prof Alexander Babanin | Engineering and Information Technology
69. A/Prof Haripriya Rangan | Science
70. Ms Miriam Cahir |
71. Ashwin Srikanth |
72. Priya Kumar |

Participants from Other Institutions

Participants
73. Dr Sushil Kumar | Consul General of India – Melbourne
74. Mr Ravi Jain | President, IITAV
75. Mr Abaran Deep | Vice-president IITAV
76. Dr Surjeet Dhanji | Fellow at the Australia India Institute, The University of Melbourne
77. Prof Sujatha Srinivasan | Professor in Mechanical Engineering and Head of the TTK Center for Rehabilitation Research and Device Development (R2D2) at IIT Madras, India
78. Prof Zaffar Sadiq | Engineering and Information Technology (Honorary)
79. Dr Sourav Ghosh | MIPA alumni
80. Ms Nikita Chopra

[R] Indicates remote/online attendance

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Program: MIPAC-25 Conference

Conference Venue:

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MIPAC-2025

Program: Day 1- 12 November 2025

Location: Melbourne connect, Manhari Room - Level 7, 700 Swanston Street, Carlton

Plenary session: 9:00 – 17:00 AEST

From	To	Event
9:00	9:10	Welcome by Prof (Ashok) Muthupandian Ashokkumar - Director Melbourne Global Centre (Delhi)
9:10	9:35	Introductions
9:35	9:55	Overview of MIPA and MIPA Recruitment Process including Discussion on Call for Proposals
9:55	10:55	Brief Research pitches by UoM and Partner Institutions Senior Academics on Engineering, Medicine and Science
10:55	11:20	Morning tea
11:20	12:20	Small group discussion (Theme based)
12:20	13:30	Lunch
13:30	15:00	Visits to various departments and lab tours
15:00	17:00	Free time

MIPAC-2025

Program: Day 2- 13 November 2025

Location: Melbourne Business School, Mawby Theatre - 200 Leicester Street, Carlton

From	To	Event
9:00	11:45	Departmental Visits
12:00	13:00	Lunch

Plenary Session – Keynote Speakers: 13:00-14:00PM AEST (7:30-8:30AM IST)

From	To	Event
13:00	13:10	A/Prof Jagannath Aryal – Director of Melbourne India Postgraduate Academy (MIPA)
13:10	13:20	Prof Bhattacharya Santanu – Director IISER Tirupati
13:20	13:30	Prof Debashish Chakravarty – IIT Kharagpur, Vice President (Online)
13:30	13:40	Prof Margie Danchin – Associate Dean, International (MDHS)
13:40	13:50	Prof Ramray Bhat – IISc Bangalore, Chair Office of International Relations (Online)
13:50	14:00	Short break

Technical presentations – Session 1: 14:00 – 17:30 AEST (08:30 – 11:30 IST)

From	To	Presenter	Research title	Chair
14:00	14:10	Zain Torres	Directional Spectra of Waves and of Wave-Breaking by Means of Explicit Measurements and Modelling	Mr Sai Vikas Kona
14:10	14:20	Hema Jha	Enthalpy generation during Hydrothermal Carbonization of Food Waste	
14:20	14:30	Vivek Kumar Yadav	Causality in Hydrometeorological Systems: Process Understanding and Predictions	
14:30	14:40	Kunwar Abhishek Singh [R]	Towards Robust Monitoring of Turbidity in the Ungauged Urban Reaches of Downstream Ganges River, India, using Sentinel-2 and Machine Learning Approaches	
14:40	14:50	Sumit Shankar Sarvankar	On the efficacy Of Riblets in mitigating losses due to wake induced tr ansition over T106C blade	
14:50	15:00	Subham Saha [R]	Reconfigurable Resistive Switching in Halide Perovskite-based Memristors for Neuromorphic Computing	
15:00	15:20	Networking break/afternoon tea		

Technical presentations – Session 2: 15:20 – 16:20 AEST (09:50 – 10:50 IST)

From	To	Presenter	Research title	Chair
15:20	15:30	Mehdi Alam	Soft-rigid bonded granular mixes	Mr Shubham Verma
15:30	15:40	Aditya Aditya [R]	Vegetation Segmentation from Aerial LiDAR Point Clouds	
15:40	15:50	Nimisha Kattumunda	Effect of activators on the performance of one-part alkali activated materials	
15:50	16:00	Sri Priyanka Kommula [R]	Data-Driven Rainwater Harvesting Site Selection: A Machine Learning Approach	
16:00	16:10	Sai Keertana Kappagantula [R]	Charged low complexity protein regions regulate fungal pathogenesis in Cryptococcus neoformans	
16:10	16:20	Day 2: Concluding remarks		

Conference dinner: 17:30 – 21:00 AEST

Venue: The Upper East Room, University House, 53 Professors' Walk, The University of Melbourne, Parkville VIC 3010

How to get there: **University House**

From	Event
17:30	CLIENT ACCESS COMMENCES
17:50	Bar ready for early arrivals
18:15	Opening welcome: A/Prof Jagannath Aryal, Director, MIPA
18:20	Dr Sushil Kumar, Consul General of India (Melbourne)
18:30	Entree served
18:50	Presentation from AICC: Nikita Chopra, President, AICC
19:00	Singing Performance
19:10	Main served
19:20	Vote of Thanks, A/Prof Debnath Ghosal, Faculty Lead, MIPA (once main is served)
20:00	Dessert served
20:20	Tea and coffee served
21:00	Event concludes

MIPAC-2025

Program: Day 3- 14 November 2025

Location: Melbourne Business School, Mawby Theatre - 200 Leicester Street, Carlton

From	To	Event
9:00	11:45	Departmental Visits
12:00	13:00	Lunch

Plenary Session – Keynote Speakers: 13:00-14:00PM AEST (7:30-8:30AM IST)

From	To	Event
13:00	13:10	A/Prof Debnath Ghosal – MDHS Lead, Melbourne India Postgraduate Academy (MIPA)
13:10	13:20	Prof Collette Boskovic – Associate Dean (Graduate Programs), Faculty of Science.
13:20	13:30	Dr Annapurna Devi Allu – Associate Dean of International Relations. IISER Tirupati
13:30	13:40	Prof (Ashok) Muthupandian Ashokkumar - Director Melbourne Global Centre (Delhi)
13:40	13:50	Dr Sreeparvathy Vijay – Assistant Professor at IIT Madras (Online)
13:50	14:00	Prof Stan Skafidas - Deputy Dean Engagement (Faculty of Science)

Technical presentations – Session 3: 14:00 – 15:00 AEST (08:30 – 09:30 IST)

From	To	Presenter	Research title	Chair
14:00	14:10	Sai Vikas Kona	Improving streamflow record reliability through heteroscedastic error modelling and detection of rating curve shifts	Ms Nimisha Kattumunda
14:10	14:20	Susithra Sureshkuma	Cellulose Nanofiber-Based Gel Polymer Electrolytes: Influence of Functionalization on Ionic Conductivity for Na^+ and Li^+ Batteries	
14:20	14:30	Poornima Posa [R]	Evolving Spatiotemporal Dependence of Flood Extremes across Australia: A MaxStable Process Approach	
14:30	14:40	Baral Joydeep [R]	Minimal but mighty: structural and functional dissection of NHEJ in Mycobacterium tuberculosis	
14:40	14:50	Dhiren Swain	Digitalization of Slum lands: Effects of Digitalization on the Community and State Spaces	
14:50	15:00	Shilpa Koyyan [R]	Assessing the transferability of L-band UAVSAR soil moisture retrieval parameters across agricultural crops	
15:00	15:20	Networking break/afternoon tea		

Technical presentations – Session 4: 15:20 – 16:10 AEST (09:50 – 10:20 IST)

From	To	Presenter	Research title	Chair
15:20	15:30	Srujan Shetty Kundapura	Ultrastructural Analysis of the Oral Microbiome Using Cryo-Electron Tomography	Mr Dhiren Swain
15:30	15:40	Ashwani Kumar [R]	Stride length estimation using UWB sensor aided by inertial sensors	
15:40	15:50	Subham Verma	Oxygen facilitated visible light mediated Iniferter RAFT Polymerization	
15:50	16:00	Shruti Agnihotri [R]	Potential of electrospun PCL-PANI-Gelma Scaffold for osteogenic differentiation through electrical stimulation	
16:00	16:10	Santanu Soe [R]	The Golden Ratio Primal-Dual Algorithm with Adaptive Step-size Rule for Convex Concave Saddle Point Problems	

Panel discussion on personal development: 16:10 – 17:10 AEST (10:40 – 11:40 IST)

From	To	Min.	Event	Chair
16:10	17:10	60	Panel discussion: Professional Development in Postgraduate Studies Panelists: • Prof. Meenakshi Arora, Associate Dean (Graduate Research) at the Faculty of Engineering and Information Technology, University of Melbourne, Professor in Environmental Engineering, The University of Melbourne • Prof. Sujatha Srinivasan, Professor in Mechanical Engineering and Head of the TTK Center for Rehabilitation Research and Device Development (R2D2) at IIT Madras, India • A/Prof. Alice O'Connor Kesminas, Enterprise Senior Fellow at Department of Infrastructure Engineering at the University of Melbourne. • A/Prof. Haripriya Rangan, Principal Fellow at the School of Geography, Earth and Atmospheric Sciences; Principal Consultant, Government Projects at the Australia India Institute, The University of Melbourne • Dr. Surjeet Dhanji. Honorary Postdoctoral Fellow at the Asia Institute and an Academic Fellow at the Australia India Institute, The University of Melbourne	Ms Hema Jha Mr Sai Vikas Kona
Closing remarks				

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Abstracts

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

Zain Torres[1,2], Alexander Babanin[1], S.A. Sannasiraj[2] …
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Abstract

Estimating wave directionality remains a challenge in the spectral analysis of ocean waves because most in situ measurements rely on point sensors that provide limited spatial information. This makes it difficult to resolve the full directional distribution of wave energy. In this study, we evaluate three adaptive methods for their performance in reproducing directionality: the Maximum Likelihood Method (MLM), the Maximum Entropy Method (MEM), and the Wavelet Direction Method (WDM). We assess these methods using spectra obtained from Fourier analysis of numerically simulated sea surfaces as a baseline. We develop transfer functions for each method and validate them against laboratory measurements taken in a wave basin. The results show that MLM produces spectra that are 14\% broader than the baseline, while MEM and WDM yield spectra that are 6\% and 3\% narrower, respectively. WDM demonstrates the best performance in the frequency range of 0.8 to 1.15 f/f_p, whereas MEM is more accurate at frequencies above 1.3 f/f_p. Notably, stereo-image estimates tend to be slightly broader than those obtained from probe-based measurements, a discrepancy attributed to plane correction transformations. Breaking analysis indicates that wave steepness has a minimal effect on directional breaking but significantly influences the geometry of whitecaps, with lower steepness resulting in longer crest lengths. These findings provide quantitative guidance for selecting appropriate methods for directional estimation, balancing accuracy and stability, and present a relationship between wave-breaking and spectral directionality.

Keywords (*max 3*)

Directional-frequency wave spectrum,Spreading transfer function, Wave-breaking

Enthalpy generation during Hydrothermal Carbonization of Food Waste

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Abstract

Hydrothermal carbonization (HTC) is a technique to convert waste biomass into useful biocarbon. It is a mild thermochemical treatment that operates at temperatures of 180-260°C for 1-6 hours under autogenous pressure. During HTC, biomass undergoes a combination of reactions, including hydrolysis, decarboxylation, dehydration, polymerization, and aromatization. It has been established in the literature that the overall reaction is exothermic; however, the enthalpy released is not readily available. Enthalpy is a useful parameter in modeling this three-phase system and understanding the heat transfers involved inside the reactor. This understanding will lead to optimized energy recovery in industry-scale operation of HTC [1].
In this work, food waste was hydrothermally carbonized in micro-scale stainless steel crucibles using high-pressure differential scanning calorimetry. This method of enthalpy determination for HTC was previously assessed by researchers and was found advantageous in generating reproducible and precise information, along with an understanding of the heat release profile [2]. The results indicate a 0.657 MJ/kg enthalpy release from the system for food waste. This value will be used to establish mass and energy balances across the HTC system in future work

Keywords

Hydrothermal Carbonization, Enthalpy, Food Waste

References

[1] M. Pecchi, F. Patuzzi, D. Basso, and M. Baratieri, “Enthalpy change during hydrothermal carbonization of biomass: a critical review,” *J. Therm. Anal. Calorim.*, vol. 141, no. 4, pp. 1251–1262, 2020, doi: 10.1007/s10973-019-09117-4.

[2] G. Ischia, M. Cazzanelli, L. Fiori, M. Orlandi, and A. Miotello, “Exothermicity of hydrothermal carbonization: Determination of heat profile and enthalpy of reaction via high-pressure differential scanning calorimetry,” *Fuel*, vol. 310, no. PA, p. 122312, 2022, doi: 10.1016/j.fuel.2021.122312.

Causality in Hydrometeorological Systems: Process Understanding and Predictions

Vivek Kumar Yadav[1,2], Bramha Dutt Vishwakarma[1], Murray Peel[2], Keirnan Fowler[2], Dongryeol Ryu[2]
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Abstract

Identifying the drivers of a process or phenomenon is central to understanding and predicting its future state. In hydrological systems, a variable like surface soil moisture can have multiple drivers along with other correlated variables (1). Thus, a method to identify robust drivers is imperative. While machine learning methods have gained popularity in hydrology, they primarily rely on correlations rather than causation, which can lead to misleading results under changing conditions such as climate change.

In this work, we review state-of-the-art methods for cause-and-effect (causal) discovery (2). Then, we demonstrate their application for identifying drivers of surface soil moisture. We contrast the results with a non-causal method, the Pearson correlation coefficient. Results show that causal discovery methods identify robust and parsimonious drivers. Which leads to better predictions, especially under different climatic conditions like drought. Thus, we demonstrate the efficacy of causal discovery methods in identifying robust drivers. The results are relevant for climate change studies where the relationship among variables is expected to change.

Keywords

Hydrology, Causal Inference

References

[1] Seneviratne, Sonia I., et al. "Investigating soil moisture–climate interactions in a changing climate: A review." Earth-Science Reviews 99.3-4 (2010): 125-161.
[2] Peters, Jonas, Dominik Janzing, and Bernhard Schölkopf. *Elements of causal inference: foundations and learning algorithms*. The MIT press, 2017.

Robust Monitoring of Turbidity in Ungauged Urban Stretches of the Ganges Using Sentinel-2 and Machine Learning

Kunwar Abhishek Singh[1,2], Dongryeol Ryu[1], Meenakshi Arora[1], Manoj Kumar Tiwari[2,3], Bhabagrahi Sahoo[2]

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Abstract

Turbidity is a vital parameter reflecting both the physiological and aesthetic health of river systems. Conventional monitoring methods rely on manual sampling and laboratory analysis, which are laborious and spatially limited. Remote sensing offers a scalable alternative; however, the accuracy of turbidity retrievals is often hindered by cloud contamination during high-flow seasons. This study presents a robust approach for turbidity monitoring under both cloudy and non-cloudy conditions using Sentinel-2 Level 2 imagery integrated with machine learning algorithms. The framework was applied to an ungauged urban reach of the lower Ganges River in Kolkata, India, where water quality is strongly affected by urban effluents and suspended sediments. A Gaussian Mixture Model (GMM)-based statistical resampling was used to identify and correct cloud and shadow-affected pixels. Two models—Partial Least Squares Regression (PLSR) and Random Forest Regression (RFR)—were trained using in-situ data from the West Bengal Pollution Control Board. PLSR and RFR achieved R^2 values of 0.82 and 0.76, with RMSEs of 29.51 NTU and 33.76 NTU, respectively. SHAP and VIP analyses revealed key spectral predictors. The study underscores the importance of effective image preprocessing and machine learning for reliable turbidity prediction in ungauged river systems.

Keywords

Remote Sensing, Machine Learning, Gaussian Mixture Model

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

ON THE EFFICACY OF RIBLETS IN MITIGATING LOSSES DUE TO WAKE INDUCED TRANSITION OVER T106C BLADE

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Abstract

A series of implicit large-eddy simulations (ILES) is performed on the T106C, an ultra-high-lift low-pressure turbine (UHLPT) cascade at $Re_C = 0.9\times10^5$ to investigate boundary layer transition and loss mechanisms. Four configurations are considered: baseline (BL), baseline with wake passing (BLW), post-reattachment riblets (PoReRib), and peak-suction riblets (PeSuRib). In all cases except BL, upstream wakes were introduced to generate unsteady perturbations, to investigate their effects on the suction-side separation bubble, skin-friction behavior, and profile losses. The PoReRib and PeSuRib configurations further incorporate riblets on the suction side of the blade to study the combined effect of wakes and riblets on boundary layer transition and drag reduction. BLW offered the largest benefit with a decrease in total pressure loss of 14.1% compared to BL. Despite achieving lower skin-friction in the turbulent regime, ribbed blades are found to incur higher losses due to the early transition. Compared to the BLW, the PoReRib case increased losses by ≈ 10% whereas the PeSuRib case showed an overall increase of ≈ 30%

Keywords

Wake-induced transition, Ultra High-Lift Low-Pressure Turbine (UHLPT), Implicit Large Eddy Simulations (ILES)

References

1. Himmel, C. G., 2010. "*Ultra-high lift blades for low pressure turbines*". PhD thesis, University of Cambridge.
2. Ananth, S., Nardini, M., Vaid, A., Kozul, M., Rao Vadlamani, N., and Sandberg, R. D., 2024. "*Effects of riblet dimensions on the transitional boundary layers over high-lift turbine blades*". Journal of Turbomachinery, 146(3).
3. Denton, J. D., 1993. "*Loss mechanisms in turbomachines*", Vol. 78897. American Society of Mechanical Engineers.

RECONFIGURABLE RESISTIVE SWITCHING IN HALIDE PEROVSKITE-BASED MEMRISTORS FOR NEUROMORPHIC COMPUTING

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Abstract

Artificial intelligence has become an integral part of modern society, increasing the demand for energy-efficient hardware systems that integrate memory and computing. However, traditional von Neumann computing architectures struggle to replicate these characteristics due to the inherent separation between memory and processing units, resulting in latency and massive energy consumption. Neuromorphic computing offers a promising solution by mimicking the parallel processing of biological neural networks, and specifically, memristors emerged as a key component for such platforms due to their simple structure for high-density integration. Inorganic halide perovskites emerged as a promising material for memristor-based optoelectronic synapses due to their mixed electronic/ionic conductivity, low activation energy of halide vacancy, and long carrier diffusion length. Here, we demonstrate a reliable approach to tune the resistive switching characteristics in Ag/$CsPbBr_3$/PEDOT: PSS/ITO memristors by precisely controlling the ionic migration and filament formation. The digital switching exhibits a high ON/OFF ratio of 10^3, stable endurance for 500 cycles, and a long retention time of over 4000s with low SET and RESET voltages of 1.2V and -1.8V, respectively. The analog switching is utilized to mimic essential synaptic functions, including short-term plasticity (STP), long-term plasticity (LTP), paired-pulse facilitation (PPF), and spike rate-dependent plasticity (SRDP) with energy consumption as low as 206 nJ/mm^2 per spiking event. These results highlight the potential of perovskite-based memristors for both data storage and neuromorphic computing applications, paving the way for energy-efficient computing systems.

Keywords

Memristor, Halide perovskite, Neuromorphic computing

References

[1] S. Saha, B. Roy, T. Dey, C. Ganguly, J. Bullock, R. R. Unnithan, S. K. Ray, Adv. Mater. Technol., 2025, 10 (19), e00720.

SOFT-RIGID BONDED GRANULAR MIXES

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Abstract

Three phase granular mixes consisting of soft (recycled tyre) and rigid (crushed rock) materials bonded with flexible or semi-flexible binders are gaining momentum as a solution for waste tyre crisis. Experimental works suggest macro-scale responses of these mixes are dependent on both soft and binder content in the mix. However, the underlying mechanisms governing these responses remain unclear. The present study focuses on exploring the contact mechanics of three-phase granular mix composed of soft and rigid particles bonded with flexible binders using Discrete Element Method (DEM). Advanced contact models are necessary to understand the macroscopic behaviour of these three-phase granular media. Given the flexible nature of the binder in this study, the 'softbond model' is employed to simulate the behaviour of the three-phase mix [1-2]. The softbond model is enhanced to better simulate the contact behaviour of these mixes by addressing different properties of the constituents of the mix. The new modified model can accurately predict the constrained modulus evolution against axial stress as found in one-dimensional compression experiments in the literature [3]. Microstructural analysis of these mixes provides valuable insights into bond breakage, force distribution, and strong force chains. Bond breakage alters the force chain distribution in these mixes, and despite the presence of bonds with higher stiffness, unbonded contacts begin to dominate the force chain. The variation in microstructural properties indicates that the behaviour of these mixes depends not only on the binder content but also on the proportion of soft particles in the mix.

Keywords

Wate tyres, DEM, Softbond model

References

[1] Alam, M., Das, A., Disfani, M.M.: Numerical Simulation of Flexible-Bonded Granular Assembly Using DEM. IOP Conf Ser Earth Environ Sci. 1480, 012097 (2025). https://doi.org/10.1088/1755-1315/1480/1/012097

[2] Jiang, M., Shen, Z., Wang, J.: A novel three-dimensional contact model for granulates incorporating rolling and twisting resistances. Comput Geotech. 65, 147–163 (2015). https://doi.org/10.1016/J.COMPGEO.2014.12.011

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VEGETATION SEGMENTATION FROM AERIAL LIDAR POINT CLOUDS

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Abstract

Accurate large-scale vegetation segmentation is fundamental for ecological conservation, carbon assessment, and sustainability initiatives. Airborne laser scanning (ALS) point clouds, with their extensive coverage and fine structural detail, have emerged as a valuable resource for this task. At the same time, advances in deep learning (DL) hold significant potential for enhanced vegetation segmentation at scale. However, leading DL models for vegetation segmentation from ALS illustrate variability across datasets with limited accuracies. Additionally, vegetation-specific GreenSegNet with consistent and state-of-the-art performance for mobile laser scanning segmentation, also behaved in an inconsistent manner with ALS. To address this research gap, we present a new DL architecture explicitly designed for vegetation segmentation from ALS point clouds. The model builds on the foundation of GreenSegNet while introducing ALS-specific feature learning mechanisms. The model is comprehensively evaluated on three benchmark ALS datasets: Eclair, Dales, and WHU-Urban3D. The model achieves state-of-the-art performance across all datasets, with ten-fold cross-validated mean intersection over union scores of 96.56% (Eclair), 94.29% (Dales), and 80.87% (WHU-Urban3D). Statistical analyses confirm its effectiveness, while ablation studies validate the design choices. While the parameter count is slightly higher than that of GreenSegNet, the model remains lighter than other leading models. Overall, the proposed architecture delivers consistent and state-of-the-art performance across diverse geographies, setting a new standard for ALS vegetation segmentation.

Keywords

Vegetation Segmentation, Airborne LiDAR, Deep Learning

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Effect of activators on the performance of one-part alkali activated materials

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The significant contribution of ordinary Portland cement (OPC) to global greenhouse gas emissions has prompted the development of alternative cementitious systems that does not compromise the performance. Alkali-activated materials (AAMs), formulated from industrial by-products such as ground granulated blast furnace slag (GGBFS) and fly ash (FA), provide a sustainable, cement-free pathway. This study investigates one-part AAMs activated by solid sodium metasilicate (SMS) and sodium carbonate (SC) across three precursor ratios (GGBFS/FA: 50/50, 75/25, 100/0) under ambient curing conditions. SMS/SC proportions were systematically varied (100/0 to 0/100) to evaluate their influence on reaction kinetics and early-age properties. Characterization through isothermal calorimetry, flowability, and compressive strength testing revealed that SMS-dominated mixes exhibited superior performance, particularly at high GGBFS content. The cumulative heat release was generally correlated with compressive strength, though efficient early gel formation was also found to be a critical factor in strength development. FA-rich mixtures demonstrated limited reactivity under ambient curing and required stronger activation (SMS-rich blends) or thermal curing to achieve adequate performance. The findings highlight the synergistic role of precursor chemistry and activator composition in governing hydration reactions and mechanical properties. Overall, the results underscore the potential of SMS/SC based one-part AAMs as viable alternatives to OPC, offering both environmental benefits and robust structural performance.

Keywords

One-part alkali activated materials, sodium metasilicate, sodium carbonate

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Data-Driven Rainwater Harvesting Site Selection: A Machine Learning Approach

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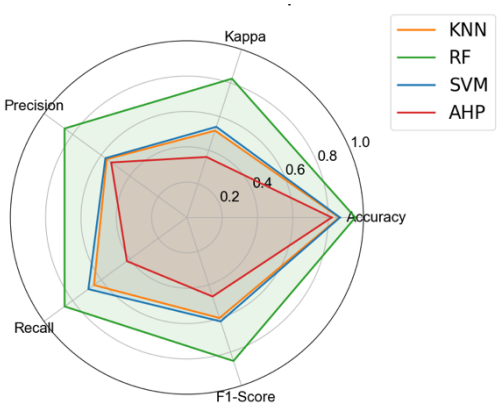
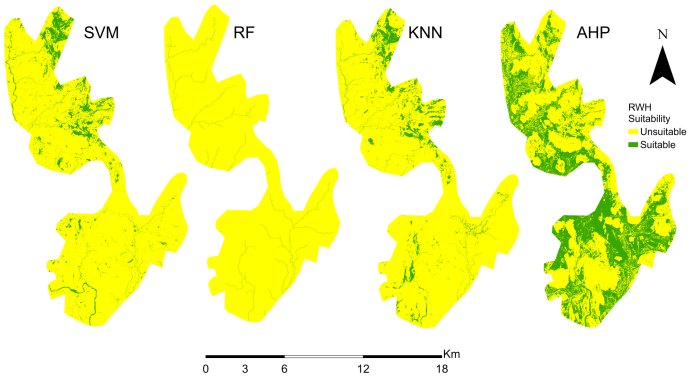
Abstract

Rainwater harvesting (RWH) plays a critical role in mitigating water scarcity, and the success of these systems is largely dependent on the strategic placement of harvesting structures. However, determining suitable sites across expansive areas remains a complex task. Traditionally, decision-support methods such as the Analytical Hierarchy Process (AHP) have been applied. With the advent of data-driven approaches, there is a growing need to evaluate the efficacy of machine learning (ML) techniques for this purpose. This study investigates the use of ML models to enhance the identification of suitable RWH locations—specifically check dams—in the region of Odisha, India, by utilizing high-resolution geospatial datasets. Seven key biophysical parameters were considered: elevation, slope, soil type, land use/land cover, geology, geomorphology, and modelled annual streamflow. Three ML classifiers—Support Vector Machine (SVM), Random Forest (RF), and K-Nearest Neighbour (KNN)—were trained using a dataset of 666 validated RWH sites. Model performances were assessed using overall accuracy (OA) and Cohen's kappa (κ) statistics. The OAs for SVM, RF, and KNN were 0.87, 0.95, and 0.86, respectively. All models demonstrated prediction capabilities for RWH suitability mapping. The AHP-based approach yielded an OA of 0.82, reflecting lower predictive accuracy and agreement than the ML models. Hence, this study suggests superior RWH site selection with ML. An additional advantage of ML is lesser subjectivity in comparison to the AHP, which depends on expert's opinion.



Model performance



Suitability maps generated by each classifier at 10-m resolution

Keywords

Rainwater harvesting, machine learning (ML), site suitability

Charged low complexity protein regions regulate fungal pathogenesis in *Cryptococcus neoformans*

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Protein sequences contain regions that show bias for one or few amino acids, which are known as low complexity regions (LCRs). Previous studies have shown that charged LCRs influence protein functions and interactions [1-3]. However, little is known about their role in human infections. To address this, we compared 22 non-pathogenic and 23 human-pathogenic fungal proteomes and observed that proteomes of human-pathogenic fungi have higher proportions of proteins with charged tracts (PCTs), and higher numbers of charged tracts (CTs) per protein, suggesting potential role(s) of CTs in mediating pathogenesis. We analyzed the influence of PCTs on the physiology/pathogenicity of *Cryptococcus neoformans*, an opportunistic human pathogen which causes cryptococcal meningitis. Systems-level investigation of diverse publicly available large-scale datasets spanning sequence, regulation and evolution shows that PCTs are upregulated during infection, regulate growth in diverse host environments and aid in establishment of infection. To delineate the molecular roles of charged tracts in pathogenesis, we generated charge-scrambled mutations using *Agrobacterium*-mediated gene manipulation in the GATA family transcription factor, GAT201, that regulates various virulence factors in *C. neoformans*. Charge-scrambled mutants show (i) impaired growth on nutrient-rich and nutrient-deficient media and (ii) defective melanin synthesis, both of which are crucial virulence factors. Collectively, these results illustrate the importance of proteins with charged tracts and that not only their presence but also the arrangement of charged residues within CTs is crucial for fungal pathogenesis. Our findings highlight hitherto unknown roles of protein regions in fungal pathogenesis which can be used for designing therapeutic interventions.

Keywords

Low complexity regions, *Cryptococcus neoformans*, host-pathogen interactions

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IMPROVING STREAMFLOW RECORD RELIABILITY THROUGH HETEROSCEDASTIC ERROR MODELING AND DETECTION OF RATING CURVE SHIFTS

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Abstract

Streamflow is often estimated using stage–discharge rating curves, which are affected by channel morphologic dynamics and vary over time [1]. Conventional approaches typically assume either constant or linearly varying error variance [2], overlooking the complex heteroscedastic nature of rating-curve uncertainty. Building on unique high-frequency area–velocity discharge datasets, this study introduces a data-driven framework that models nonlinear residual variance and adaptively detects rating shifts to improve streamflow estimation. This study aims to (a) automatically detect change points in the rating relationship, (b) develop segmented rating-curve models for distinct periods of stability, and (c) quantify the resulting improvement in flow prediction accuracy. The methodology is applied at two gauging stations with distinct flow regimes in the Mahanadi and Godavari basins in Peninsular India. For comparison, a stationary baseline was constructed using an adaptive Bayesian model over the period 1986–2018, with error variance expressed as a power function of predicted discharge. To account for nonstationarity, the framework employs a Sequential Bayesian Change Point Algorithm (SBCPA) to identify periods of hydraulic stability. For each segment, deterministic rating curves are fitted, and residual variance is modeled using Locally Estimated Scatterplot Smoothing (LOESS). The findings reveal that integrating nonlinear residual variance modeling with rating-shift detection yields up to 45% higher estimation accuracy relative to the stationary baseline. This framework highlights the importance of densely recorded gaugings and offers a robust approach for enhancing streamflow monitoring under hydrometric uncertainty.

Keywords

Rating Curves, Heteroscedasticity, and Segmentation.

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Cellulose Nanofiber-Based Gel Polymer Electrolytes: Influence of Functionalization on Ionic Conductivity for Na^+ and Li^+ Batteries

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Abstract

Cellulose Nanofibers (CNF) offer a renewable scaffold for solid/gel polymer electrolytes. However, the native charge on CNF limits ion transport and cation/anion correlation. Here, we graft 3-Aminopropyltriethoxysilane (APTES) onto CNF to create a CNF-siloxane network that enhances salt dissociation and biases charge transport toward the working cation. FTIR analysis and modestly negative zeta potential (~-10 mV) indicate siloxane/amine incorporation and weak anion association without excessive trapping. At room temperature, the ionic conductivity increases from 0.07 mS/cm to 0.60 mS/cm for APTES-CNF with Li systems and 1.62 mS/cm for Na systems. The Li^+ transference number increases from 0.85 (CNF) to 0.89 (APTES-CNF), reducing $(1-t^+)$ by ~27% and thereby mitigating concentration polarization. In symmetric Li || electrolyte || Li testing at j = 0.1 mA/cm^2 with 5 h plating/stripping steps, the APTES CNF electrolyte maintains millivolt-level steady plateaus (median ≈ 4.5 mV), near-zero nucleation excursions, and ~2000 h of stable operation without any short circuit. These results are consistent with a transport mechanism that combines an increased mobile-ion population, reduced tortuosity, and partial anion retardation, which elevates transference numbers. The simple, scalable aminosilane modification thus couples' materials sustainability with cation-selective, low-loss transport, positioning APTES–CNF as a promising bio-derived electrolyte platform for both lithium- and sodium-ion batteries.

Keywords

APTES-functionalized cellulose nanofibers, Gel-polymer electrolytes, sodium and lithium-ion batteries

Evolving Spatiotemporal Dependence of Flood Extremes across Australia: A Max-Stable Process Approach

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Abstract

Flood extremes are among the most destructive natural hazards, with their frequency, magnitude, and spatial footprint projected to intensify under climate change and natural variability. Traditional flood analyses have largely focused on univariate or temporal trends, often overlooking how spatial and temporal dependencies evolve together. Using annual maximum flood (AMF) records from 325 minimally disturbed catchments across 12 Australian hydro-climatic regions (1973–2021), we assess the potential of three modeling approaches, non-stationary Generalized Extreme Value (NSGEV) models, spatial max-stable process (MSP) models, and spatio-temporal MSP models, to capture evolving flood behavior. A 30-year moving-window framework is applied to quantify changes in 2-year (frequent) and 25-year (rare) return levels as well as spatial dependence. Results reveal contrasting patterns for frequent and rare floods. Frequent floods are intensifying along the east coast and monsoonal north but declining across southern and western Australia, with decreasing trends at 57–65% of stations. In contrast, rare floods are strengthening along the east coast, north, and southeast but weakening in the west, with increasing trends at 63–70% of stations. Extremal coefficients show strengthened spatial dependence in eastern regions, including the East Coast and Murray Basin, but weakened patterns across southern areas and tropics. Study shows that spatio-temporal MSPs best reproduce coherent regional patterns, spatial-only MSPs capture interconnectivity without temporal dynamics, and NSGEV models yield fragmented, site-specific trends. By integrating spatial and temporal dependencies, this study advances understanding of flood interconnectivity under a changing climate and provides critical evidence for flood risk assessment and climate adaptation.

Keywords: Spatial dependency, Extremal coefficient, Max-stable process

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Minimal but mighty: structural and functional dissection of the two-component DNA repair pathway of *Mycobacterium tuberculosis*

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Abstract

DNA double-strand breaks (DSBs) pose a major threat to genome stability, with even a single unrepaired break sufficient to kill a cell. In *Mycobacterium tuberculosis* (Mtb), repair relies on a minimal non-homologous end joining (NHEJ) pathway mediated by Ku (mKu) and the multifunctional Ligase D (LigD) [1]. Here, we integrate cryo-electron microscopy, hydrogen–deuterium exchange mass spectrometry (HDX-MS), molecular dynamics simulations, and live-cell imaging to uncover the structural basis of this essential repair system. Cryo-EM structures reveal that mKu encircles DNA ends and promotes synapsis through β-hairpin–driven oligomerization. Functional assays show that disrupting this β-hairpin compromises synaptic stability and repair efficiency. Complementary HDX-MS analyses demonstrate that DNA-binding and mKu–mKu interfaces remain protected over a 0–100 min time course, underscoring the robustness of the synaptic state. Furthermore, we identify a regulatory mechanism in which the mycobacterial proteasomal ATPase Mpa mediates Ku turnover, preventing persistent DNA end tethering. Together, these findings establish the structural and dynamic framework of bacterial NHEJ, revealing how *M. tuberculosis* executes DNA repair with only two core components. This work expands our understanding of bacterial genome maintenance and suggests that targeting NHEJ could provide a novel therapeutic strategy for combating persistent mycobacterial infections.

Keywords

DNA repair, Structural biology, *Mycobacterium tuberculosis*

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Digitalization of Slum lands: Effects of Digitalization on the Community and State Spaces

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Abstract

In the current century the usage of technology for governance has witnessed a sharp rise all over the world. In India various flagship programs like digital India mission, national e-governance plan was launched to ensure the transition of governance from analogue, paper based to the digital. Under programs of land digitization various smaller initiatives at provincial government levels were started. In one of the states in India, Odisha led digitization titling and mapping of the slum lands through JAGA mission and OLRSD law. Such technology led governance and development activities unsettled earlier 'Rhythms' of land, everyday life and governance.

This study suggests the digitalization and mapping of the slum lands in Odisha opened two kinds of contestations. First, the program faced contestations at the bureaucratic-state space. The chapter discusses how the urban development ministry in Odisha led the JAGA project even though the initiative was centred around land. Such distribution of authority overlooked the role of revenue department that led to contestation and power struggles in the state space. Second, the program faced challenges in engaging with the community. The digitization efforts through UAVs and GIS were supposed to be participatory and community led. Especially, the community demands for larger housing plots, religious space matters in the background of land digitization and fixed land allocation brought to fore the contests that took place at the community engagement space. The chapter goes on to discuss the difficulties that such digitalization and mapping poses to the paper-based land knowledge rhythms of the local community. The chapter analyses the matrix of contestations in terms of spatial legibility, authority, knowledge practice and negotiations.

Keywords
Community Spaces, State Spaces, Land digitalization, Spatial Rhythms

Assessing the transferability of L-band UAVSAR soil moisture retrieval parameters across agricultural crops

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Abstract

Synthetic Aperture Radar (SAR) offers high-resolution surface soil moisture in all weather conditions, allowing continuous Earth observation. Spatially distributed soil moisture information has a wide range of applications in global hydrological and environmental studies. Satellite-derived soil moisture products are now used extensively for various applications such as irrigation modelling, flood monitoring, drought monitoring, and hydrological modelling. Recent studies [1, 2] have shown that the Water Cloud Model (WCM) [3] can be calibrated to be applicable for a range of canopy, polarisation, and surface conditions over wheat fields, provided the incidence angle is within a similar range, implying parameter transferability. This study examines whether the parameter transferability of the WCM model extends to different agricultural crops—corn, soybean, wheat and canola—using SMAPVEX12 L-band UAVSAR data. The potential transferability of retrieval parameters is examined by analysing the posterior distribution of calibrated parameters obtained using the Markov Chain Monte Carlo (MCMC) method. Application of WCM parameters trained for a specific crop to other types of crops resulted in increased SM retrieval error (ubRMSE) by 5-38%. It is also expected that the methodology developed using airborne data can be adopted for WCM-based soil moisture retrievals by SAR satellites such as Sentinel-1 (C-band) and the NASA-ISRO Synthetic Aperture Radar (NISAR) and ROSE-L (Radar Observing System for Europe in L-band) missions.

Keywords

Soil Moisture, L-band SAR, Water Cloud Model

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Ultrastructural Analysis of the Oral Microbiome Using Cryo-Electron Tomography

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Abstract

The human oral microbiome is a highly complex ecosystem comprised of more than 700 bacterial species, along with diverse fungi, viruses, and archaea. This dynamic, multispecies community is integral to maintaining health and dysbiosis is implicated in a wide range of diseases. Although previous studies have visualized oral microbes using conventional, low-resolution imaging techniques, the fine ultrastructural and molecular details of polymicrobial assemblies have yet to be fully resolved.

In this study, we employed cryo-electron tomography to visualize the native ultrastructure of selected understudied oral bacterial species in their planktonic state. We obtained high-resolution tomograms that enabled visualization of previously inaccessible ultrastructural features and molecular assemblies within these species. To the best of our knowledge, these tomograms represent some of the first and most detailed three-dimensional reconstructions for these taxa. Our data demonstrate interesting internal structures and nanomachines likely involved in intercellular interactions and maybe biofilm formation; however, the functional roles of these features will require further investigation. These findings offer new perspectives on the machinery facilitating cell-to-cell contact and community assembly in the oral cavity. Our findings are limited to planktonic bacteria, and ongoing work aims to compare these observations with bacteria in biofilm contexts, to understand how ultrastructural adaptations contribute to functional behaviour and oral ecosystem stability.

Keywords

Oral microbiome, Cryo-electron tomography, Ultrastructure

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Stride Length Estimation using UWB sensors aided by Inertial Sensors

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Abstract

Accurate stride length estimation is essential for gait analysis, with applications spanning both positioning and clinical domains. In positioning systems such as pedestrian dead reckoning (PDR) and inertial navigation, stride length directly affects the accuracy of trajectory reconstruction and displacement measurement. Reliable estimation is particularly critical in indoor environments where global navigation satellite system (GNSS) signals are unavailable, such as hospitals, airports, and shopping malls.

This study introduces a novel approach to stride length estimation using Ultra-Wideband (UWB) sensors mounted on the user's shins. UWB distance measurements, sampled at 10 Hz, were smoothed and segmented into gait cycles by detecting heel strike and toe-off events with inertial data. Because UWB captures stride dynamics at the shin level, motion capture data was employed to calibrate the measurements to actual foot-level stride lengths via a linear regression model. The model was trained on data from three experimental sessions and evaluated using root mean square error (RMSE), coefficient of determination (R^2), and paired t-tests.

Results show that the calibrated UWB-based method aligns closely with motion capture reference data, achieving an RMSE of 0.057 m and an R^2 of 0.897 on test datasets. Compared to an IMU-only approach, the UWB method yielded a significantly lower mean error (0.036 m vs. 0.082 m). These findings highlight the potential of UWB sensors, when properly calibrated, as an effective and practical solution for wearable stride length estimation.

Keywords (*max 3*)

Ultra-Wide Band, Stride Length, Inertial sensor

MIPAC-2025

Oxygen facilitated visible light mediated Iniferter RAFT Polymerization

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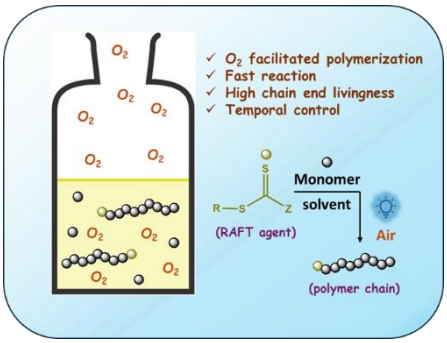
Abstract

The utilization of low energy visible light to mediate controlled living radical polymerization (CLRP) offers additional advantages over conventional thermally initiated CLRP such as better control over molecular weight and its distribution, temporal control (polymerization controlled by switching light source “on” and “off”), and high chain end fidelity achieved at high conversion rates (>90 %) [1]. However, these CLRP techniques require stringent degassing processes including physical deoxygenation via inert gas sparging, implication of specialized equipment such as glove boxes, and freeze-pump-thaw cycles to eliminate oxygen from the system prior to polymerization, as oxygen rapidly quenches the propagating radicals and produces inactive peroxy side products [2]. This renders the reaction unsuitable for large scale synthesis and surface chemistry such as coatings. Our work demonstrates to utilize oxygen as a precursor for conducting polymerization under blue light irradiation, hence facilitating the process under open-to-air conditions.



Keywords (*max 3*)

Visible light mediated controlled polymerization, oxygen facilitated polymerization.

References (*max 3*)

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Potential of electrospun PCL-PANI-Gelma Scaffold for osteogenic differentiation through electrical stimulation

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Abstract: Non-union fractures and impaired bone healing remain significant clinical challenges, often arising from poor vascularization, infection, or mechanical instability. Conventional treatments such as bone grafting and fixation techniques are constrained by donor scarcity, risk of infection, and limited regenerative capacity. Since the human skeletal system is naturally electrically active (1–2 mV/mm), an electroactive scaffold offers a promising strategy to restore regenerative potential at non-union sites by offering both mechanical support and bioelectrical cues for osteogenic differentiation. To address this, a composite scaffold integrating synthetic, natural, and conducting polymers was designed, combining mechanical strength of polycaprolactone (PCL), extracellular matrix (ECM)-mimicking properties of methacrylated gelatin (GelMA), and electrical conductivity of polyaniline (PANI, ~20 mV). This combination imparts biocompatibility, antimicrobial potential, and electroactivity, enabling enhanced cell attachment, proliferation, and differentiation under electrical stimulation. GelMA and PANI synthesis was confirmed by FTIR, with characteristic peaks for amide (1240 cm−1) groups and asymmetric vibrations (1118 cm−1). Electrospinning of pure PCL, PCL–GelMA (7:3), and PCL–GelMA–PANI (7:2.5:0.5) blends produced nanofibrous scaffolds, where SEM revealed smoother, beadless fibers for the PCL–GelMA–PANI composite, indicating improved miscibility and uniform charge distribution, critical for forming ECM-like fibers. Optimizing the PANI concentration is essential to balance electroactivity and biocompatibility. Future studies will evaluate physicochemical properties (swelling, degradation, etc) and the scaffold's impact on osteogenic cell behavior under electrical stimulation. Taken together, this approach aims to create a well-designed electroactive nanofibrous scaffold that mimics natural bone cues, creating a route for bone regeneration and revascularization at non-union sites.

Keywords: Polyaniline (PANI), Electrical stimulation (ES), Osteogenic differentiation

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The Golden Ratio Primal-Dual Algorithm with Adaptive Step-size Rule for Convex-Concave Saddle Point Problems

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Abstract

In this work, we develop an adaptive step-size strategy for the extended Golden Ratio primal-dual algorithm (E-GRPDA) designed to address structured convex optimization problems in finite-dimensional real Hilbert spaces. This strategy eliminates the need to compute the Lipschitz constant of the gradient of the function to run the algorithm without involving backtracking. One important feature of the adaptive step-size strategy is that it recovers from poor initializations and typically requires little to no hyperparameter tuning. We show that E-GRPDA achieves an ergodic sublinear convergence rate with this adaptive step-size rule, measured by the function-value residual and constraint violation rather than by the so-called primal-dual gap function. We demonstrate the effectiveness of our approach on various convex optimization problems and compare its performance with existing methods.

Keywords

Golden Ratio; Adaptive Step-size; Primal-Dual Algorithms