Title: TinyML, IoT, and Monitoring Environment (TIME)

In an era where environmental challenges such as climate change, pollution, and habitat destruction are escalating, the need for advanced solutions in environmental monitoring has never been more critical. This workshop aims to explore the convergence of Internet of Things (IoT) devices, edge computing, and Tiny Machine Learning (TinyML) as a transformative approach to environmental surveillance and management. By leveraging these technologies, we can achieve unparalleled granularity in data collection, real-time analysis, and predictive modelling across various environmental parameters.

Workshop Rationale: Timeliness and Necessity

The importance of addressing global environmental challenges coincides with rapid advancements in technology. Traditional monitoring methods are often constrained by their scope, speed, and flexibility. The innovative integration of IoT, edge computing, and TinyML offers a promising solution, enabling scalable, efficient, and real-time environmental data analysis. This workshop is timely, aligning with the pace of technological evolution and the growing demand for sophisticated monitoring solutions driven by stricter environmental regulations. It presents an urgent and crucial platform for exploring how these technologies can be harnessed to enhance environmental health and sustainability.

- **Accelerating Environmental Challenges:** The rate at which environmental issues such as climate change, biodiversity loss, pollution, and habitat degradation are occurring requires immediate, innovative solutions. Traditional environmental monitoring methods often fall short in terms of granularity, speed, and adaptability.
- **Technological Advancements:** The rapid pace of technological advancements in IoT, edge computing, and TinyML presents new opportunities to address these environmental challenges more effectively. These technologies enable real-time data collection and analysis, predictive modelling, and immediate decision-making capabilities that were previously unattainable.
- **Regulatory and Societal Pressure:** Increasing awareness and concern over environmental issues have led to tighter regulations and a demand for more comprehensive and timely monitoring methods. This workshop is an opportunity to explore how cutting-edge technologies can meet these growing demands.
- **Data-Driven Decision Making:** There's a growing need for data-driven approaches to environmental management and policymaking. This workshop will discuss how to leverage these technologies to produce reliable, actionable data to inform better decisions.

Bridging Interdisciplinary Communities

This workshop is uniquely positioned to foster collaboration across diverse fields, bringing together environmental scientists, technologists, policymakers, industry practitioners, academic researchers, data scientists, and AI experts. Such interdisciplinary collaboration is essential for developing innovative, comprehensive solutions to complex environmental issues. The workshop will facilitate the exchange of ideas and knowledge between these communities, driving the advancement of environmental monitoring technologies and strategies.

- **Environmental Scientists and Technologists:** By bringing together environmental scientists with a deep understanding of ecological processes and technologists skilled in IoT, edge computing, and TinyML, the workshop fosters an exchange of domain-specific knowledge and technical expertise.
- **Data Scientists and AI Researchers:** The inclusion of data scientists and AI researchers will enable discussions around data analysis, machine learning algorithms, and the application of AI in interpreting vast amounts of environmental data, leading to innovative approaches to monitoring.
- **Policy Makers and Regulatory Bodies:** Engaging policy makers and representatives from regulatory bodies ensures that technological advancements are aligned with regulatory requirements and societal needs, facilitating the development of policies that encourage the adoption of sustainable technologies.
- **Industry Practitioners:** Professionals from industries related to environmental monitoring equipment, telecommunications, and computing infrastructure bring practical insights into the scalability, deployment, and commercial viability of these technologies.
- **Conservationists and Environmental NGOs:** Conservationists and representatives from environmental NGOs can provide a ground-level perspective on environmental challenges, priorities, and the potential impact of technology on conservation efforts.
- **Educators and Students:** Including educators and students encourages the dissemination of knowledge and the nurturing of future professionals who will continue to innovate in the field of environmental monitoring.

This interdisciplinary approach not only enriches the workshop's content and discussions but also creates a unique ecosystem for innovation, where insights from various fields converge to address complex environmental challenges through the lens of advanced technology.

Key Themes and Objectives

- **Integration of IoT with Environmental Monitoring:** Explore the deployment of IoT sensors and devices for comprehensive environmental data collection, focusing on their potential to monitor critical parameters across diverse ecosystems.
- **Edge Computing in Remote and Inaccessible Areas:** Discuss the role of edge computing in enabling real-time data processing close to the data source, particularly in remote or inaccessible areas where traditional data transmission faces challenges.
- **Empowering Devices with TinyML:** Examine how TinyML can be implemented in low-power, resource-constrained devices to perform on-site data analysis, enabling immediate decision-making and action without the need for extensive data transmission.
- **Quantification of Uncertainty surrounding TinyML Technologies:** Explore and discuss current methods for assessing confidence in the use of TinyML technologies for environmental monitoring and prediction, increasing the reliability of model results for real-life deployment.
- **Scalability and Sustainability:** Address the scalability of these technologies in environmental monitoring, including the sustainability of deploying a vast network of intelligent IoT devices in terms of energy consumption and maintenance.

- **Data Integrity and Privacy:** Tackle the challenges related to data integrity, privacy, and security in environmental monitoring networks, ensuring that the data collected is reliable and protected against unauthorised access.
- **Case Studies and Real-World Applications:** Share success stories and case studies where IoT, edge computing, and TinyML have been effectively combined to address environmental issues, highlighting lessons learned and best practices.

Workshop Format and Anticipated Outcomes

The workshop will feature a combination of keynote speeches, panel discussions, and interactive sessions. Participants will have the opportunity to engage with thought leaders, share research findings, and participate in hands-on demonstrations. It aims to foster collaborations between academia, industry, and environmental organisations, encouraging innovation and the exchange of ideas.

Anticipated outcomes include:

- A comprehensive understanding of the current state and future possibilities of using IoT, edge computing, and TinyML in environmental monitoring.
- Innovative strategies and solutions for addressing environmental challenges, emphasising practical applications and scalability.
- A roadmap for future research, development, and deployment of these technologies in environmental monitoring efforts.

Organisers:

Rameez Kureshi, Lecturer and Programme Director for online MSc AI, University of Hull, UK

Email: r.kureshi@hull.ac.uk , Google Scholar, Webpage

Bio: Rameez is a Lecturer and Programme Director for the Hull online MSc in Artificial Intelligence, with expertise in Artificial Intelligence (AI), Data Science, Edge Computing, Cyber Security, and the Internet of Things (IoT), enabling him to address important environmental and societal issues effectively. He holds a PhD from the University of Bradford, UK, where his research from 2019 to 2023 focused on using AI, IoT, and behavioural science to improve indoor air quality (IAQ). He also holds an MSc in Cyber Security from the University of Bradford (2017-2018) and has earned a Master's (MCA, 2014-2016) and a Bachelor's (BCA, 2011-2014) degree in computer applications from prestigious institutes in India, both with Distinction. Before joining the University of Hull, Rameez worked on European Commission-funded projects, including “Smart Cities and Open Data REuse (SCORE – £2.8M)” and “LifeCritical,” where he developed AI-driven healthcare solutions, machine learning calibrations for IoT devices, and AI-powered urban observatories. He also managed to work on the “Horizon Scanning project for Urban Planning with Net Zero Targets” with Digital Catapult (£15k funding).

Dr Sheen Mclean Cabaneros, Lecturer in Engineering, University of Hull, UK

Email: S.M.Cabaneros@hull.ac.uk ; Google Scholar ; Webpage

Bio: Sheen is a Lecturer at the University of Hull and is an expert in the fields of machine learning, uncertainty quantification, environmental modelling, and urban environments. He has authored many peer-reviewed articles focussing on the application of machine learning techniques in environmental systems including outdoor air pollution forecasting and airborne microplastics detection and monitoring. One of his publications is among the most downloaded and top-cited papers in the Environmental Modelling and Software journal in 2021. Before gaining a lectureship, he was involved with the EPSRC-funded project, "INTEGRATE: Integrating seasonal thermal storage with multiple energy sources to decarbonise thermal energy" (EP/T023112/1). He is currently involved as a Co-I with a pilot study funded by the NERC, "Development of the first global standard for airborne microplastic monitoring" (NE/X010201/1). His pivotal role in the project includes the development of an automated approach for identifying and counting airborne microplastics samples from microscopy images using machine learning.

Dr Venkata Maruti Gunturi, Lecturer in Computer Science, University of Hull, UK

Email: V.Gunturi@hull.ac.uk ; Google Scholar ; Webpage

Dr Gunturi is currently a Lecturer at the University of Hull. He obtained his PhD in 2015 from the University of Minnesota, USA in computer science. He has been working in the broad area of Geospatial data science for over 10 years. His research interests lie at the intersection of data science, smart cities and sustainability. His works are published in highly prestigious journals such as IEEE TKDE, GeoInformatica (Springer), Machine Learning (Springer) and IJGIS. His research work has been supported by both government (DST, India) and industry (Microsoft India). He has been active in participating in the review committees of several renowned Journals and Conferences, including ACM TODS, Information Sciences, Journal of Supercomputing, Transactions on GIS, WISE conference and DASFAA conference.

Professor Dhaval Thakker, Professor, University of Hull, UK

Email: D.Thakker@hull.ac.uk ; Google Scholar, Webpage

Bio: Professor Thakker is a Professor of Artificial Intelligence (AI) and Internet of Things (IoT) at the University of Hull. He is the Director of Research (DoR) in the school of computer science. At Hull, he also leads groups on Responsible Artificial Intelligence (RAI-Hull) and the Internet of Things (IoT-Hull). Dhaval is the Turing Academic Lead at the University of Hull, collaborating with the Alan Turing Institute. Dhaval has nearly twenty years of experience in researching and delivering innovative solutions through funded projects. His interdisciplinary research interests and expertise offer a balanced focus on advancing Artificial Intelligence (AI), with particular attention to Generative AI and the applications of Edge computing and Internet of Things (IoT) technologies. He aims to enhance AI's contribution to societal benefits under the 'AI for Social Good' initiative, embodying a commitment to developing AI technologies that are not only responsible but also prioritize explainability, safety, and fairness. Through this approach, he seeks to ensure that AI systems are transparent, secure, and equitable, thereby maximizing their positive impact on society. He has secured extensive funding (£5M total; £1.3M as PI) and has a proven track record

in applying AI for Social Good in areas such as Smart Cities, Digital Health, and the Circular Economy. He has extensive experience of co-organising conferences and been lead co-chair of 10+ workshops at International Semantic Web Conference (ISWC), European Semantic Web Conference (ESWC) and other AI and IoT conferences.

Professor Eiman Kanjo, Professor of Pervasive Sensing, Nottingham Trent University, UK

Email: eiman.kanjo@ntu.ac.uk; Google Scholar; Webpage

Bio: Professor Kanjo is a Professor of Pervasive Sensing and the Head of the Smart Sensing Lab at Nottingham Trent University. She has been appointed as the Provost's Visiting Professor in tinyML at Imperial College London starting- October 2023. She has also recently been honoured as one of the Top 50 Women in Engineering by the Women in Engineering Society. She is also a member of the Royal Society's Newton International Fellowships Committee, and one of the academic leads of the Turing University Network, Alan Turing Institute is UK's national institute for data science and Artificial Intelligence. Her team, the Smart Sensing Lab, has received the 2021 Vice-Chancellor's Outstanding Researcher Team Award under her leadership. With extensive experience, she has over 120 publications and she won several grants from various funders, including DCMS (5G Connected Forest, a £10m project in collaboration with Nottingham County Council and multiple industrial organizations), InnovateUK, EPSRC, DSTL, ERDF, MoD, and the Lottery Fund. She is dedicated to working closely with charities, local authorities, and industry. She works closely with tinyML Foundation and currently serves on the steering committee for tinyML EMEA and Co-Lead TinyML UK. She is also an editor at Data Centric Engineering Journal.

Professor Kirk Martinez, Professor of Electronics and Computer Science, University of Southampton, UK

Email: km@ecs.soton.ac.uk; Webpage

Bio: Professor Martinez is a Professor of Electronics and Computer Science at the University of Southampton. With over 161 publications, his research interests include environmental sensor networks, IoT and Imaging. He is a member of the Southampton Geospatial, Southampton Marine and Maritime Institute, and Web and Internet Science research groups. His current research projects include libVIPS, a high-performance image processing library that was initially developed through five EU projects but is now an internationally maintained package regularly used in commercial websites to process images, and a project funded by the Leverhulme Trust, "The role of subglacial soft bed hydrology on glacier response to climate change", that studies glaciers using sensor networks and new technologies. The latter was featured on BBC technology news and the BBC's News as it was the first wireless sensor network designed to be used in/under glaciers. Some of his previous projects include the EPSRC-funded GLACSWEB 2 and KTS-EPSRC IAA, and EU-funded Fing-Art-Print, Sculpteur, E-CHASE (ECS), SemsorGrid, and ARCOMEM-EU FP7. He is one of the founders of the Electronics and the Visual Arts: EVA Conferences. He helped to found the Earth and Space Science Informatics focus group of the American Geophysical Union, and has run ten annual sessions on applying sensor networks to earth science. In 2017 he received the AGU's Leptoukh award for contributions to this area.

Workshop Structure and Duration:

08:55 to 09:00: Opening remarks
09:00 to 09:45: Invited talk: TBA
09:45 to 10:45: Peer-reviewed oral presentations
10:45 to 11:00: Coffee break
11:00 to 11:30: Peer-reviewed oral presentations
11:30 to 12:15: Invited talk: TBA
12:15 to 13:30: Lunch break and poster sessions
13:30 to 14:15: Invited talk: TBA
14:15 to 15:45: Panel discussion: "*Integration of IoT, edge computing and TinyML technologies with traditional environmental monitoring methods: state-of-the-art, challenges, and future directions"*
15:45 to 16:30: Closing remarks, best paper and poster presentations announcement, and networking opportunity

Call for Papers Sample:

Topics of Interest:

- IoT Devices for Environmental Data Collection.
- Edge Computing for Real-Time Environmental Analysis.
- Implementing TinyML in Environmental Monitoring.
- Scalability and Sustainability of Environmental Monitoring Systems.
- Data Integrity, Privacy, and Security in Environmental IoT Systems.
- Case Studies and Real-World Applications.
- AI and Machine Learning Algorithms for Environmental Prediction.
- AI Safety and Uncertainty Quantification of Environmental Prediction Systems.
- Integration Challenges and Interoperability.
- Regulatory and Ethical Considerations.
- Future Directions and Emerging Technologies.

Submission Deadline: 01 May 2024 (AoE)
Decision Notification: 01 June 2024
Camera-ready Paper Due: 20 June 2024
Make your submission to track 'Workshop on TinyML, IoT, and Monitoring Environment (TIME)' on EasyChair https://easychair.org/conferences/?conf=ieeecoins2024

CFP Dissemination Plan:

- Distribution through academic mailing lists

- Social media promotion

- Collaboration with industry partners for broader outreach

Program Committee:

We have a balanced programme committee with members of all experience levels, global coverage, and representation from both industry and academia.

1. Agot Wante, IVL Swedish Environmental Institute, Sweden
2. Yen-Chia Hsu, University of Amsterdam, Netherlands
3. Sagnik Dey, Indian Institute of Technology, Delhi, India
4. Erik Svensson, City of Gothenburg, Sweden
5. Prof. Abdus Samad, Indian Institute of Technology, Madras, India
6. Prof. Nithya Venkatesan, Vellore Institute of Technology, India
7. Prof. Jeanette Rotchell, University of Lincoln, UK
8. Ben Williams, University of the West England, UK
9. Yuchen Zhao, University of York, UK
10. Matt Ellis, University of Sheffield, UK
11. Bhupesh Mishra, University of Hull, UK
12. Baseer Ahmad, University of Hull, UK
13. Sally Jones, Air pollution Office, Bradford Council, UK
14. Prof. Graham Sander, University of Loughborough, UK
15. Giuseppe Formetta, University of Trento, Italy
16. Jo Barnes, University of the West England, UK
17. Enda Hayes, University of the West England, UK
18. Joana Ferreira, University of Aveiro, Portugal
19. Elena Rada, Insubria University of Varese, Italy
20. Behzad Abdolmaleki, University of Sheffield, UK
21. Prosanta Gope, University of Sheffield, UK
22. Vasileios Vasilakis, University of York, UK
23. Siamak Shahandashti, University of York, UK