Northumbria University
NEWCASTLE

Engineering & Environment

Postgraduate Research Conference

22nd & 23rd May 2023

Welcome and Introduction

Welcome to the Faculty of Engineering and Environment Postgraduate Research Conference 2023. At Northumbria University, we take pride in our reputation as a research-driven institution. Our focus is to produce knowledge that has a real-world impact. As a postgraduate researcher in the fields of engineering and environment, you are an integral part of our research community. Our research themes and facilities reflect our commitment to sustainability and environmental responsibility.

One of the unique aspects of our postgraduate research is our focus on interdisciplinary research. We encourage collaboration across different academic disciplines, as we believe that this is the key to tackling complex environmental challenges. Our interdisciplinary approach means that you will have access to a range of research expertise, and you will be encouraged to think creatively to develop innovative solutions.

As a postgraduate researcher at Northumbria University, you are part of a diverse and inclusive community. We are proud of our reputation as University of the Year for being a welcoming and supportive institution. Our research students come from all over the world, bringing with them different perspectives and experiences. We are committed to providing a supportive environment where all students can thrive, regardless of their background.

The organisation of the conference is not without hard work and commitment. We would like to thank Faculty Pro-Vice Chancellor, Professor John Woodward and Deputy Faculty Pro-Vice Chancellor of Research & Knowledge Exchange, Professor Esther Akinlabi for supporting the conference in every way.

In conclusion, we would like to reiterate how delighted we are to welcome you to the Faculty of Engineering and Environment Postgraduate Research Conference. We are excited to see the research that you produce in the fields of engineering and environment, and we look forward to supporting your work. Together, we can make a difference and create a more sustainable future for all. We hope you will enjoy the conference and pick up some fresh innovative ideas for your research.

The Organising Committee,

Dr Lesley McIntyre
Dr Fouad Khelifi
Dr Holly East
Dr Craig Warren
Dr Linzi Dodd
Professor Wai Lok Woo

Northumbria University NEWCASTLE

Department of Architecture & Built Environment

Year 1 Students

Ashley Van Huis

Year: 1
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Dr. Richard Laing

BEING IN THE CITY: VISUALISING THE EXPERIENCE OF URBAN SPACE

Abstract: The development of strategies and techniques toward more equitable and effective participatory urban development processes has been the subject of rigorous academic enquiry since the participatory turn. Diverse tactics are currently employed to capture and communicate local knowledge and aspirations, but increasingly affordable and accessible technologies that facilitate both real-time data capture and creative community engagement could enable more meaningful and effective communication of citizen and community perspectives and proposals in urban design and planning. Previous research has addressed this theme through quantitative methods such as affective sensing and smartphone data to gauge citizens' emotional responses to urban spaces, and qualitative methods employing technology to facilitate mixed-method creative citizen engagement and in situ data capture linked directly to place. In contrast to this research, the present work will employ reality capture and GIS technology in a creative community engagement project. This work aims to contribute to the literature by exploring the role of reality capture in enabling the capture of citizens' emotional responses to urban spatial characteristics and communicating aspirations within urban development processes.

Eda Seyok

Year: 1
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Prof. Ashraf Salama

EXAMINING QUALITY OF URBAN LIFE IN POST-INDUSTRIAL CITIES

Abstract: This research aims to examine Quality of Urban Life (QoUL) in deprived neighbourhoods of post-industrial cities. This research defines post-industrial cities as the emerging set of urban forms and functions due to deindustrialisation and the economic restructuring since the 1960s. The problem of deprivation is more detrimental in large post-industrial cities that have historically had large heavy manufacturing and mining industries in the UK. More people are living in the most deprived conditions than the least in these cities. The uneven development of post-industrial cities has resulted in economic, political, physical, and social challenges; these should be addressed by policymakers to provide equal opportunities and life chances. The QoUL concept was developed to monitor change over time to generate knowledge on enhancing Quality of Life (QoL) through more effective social policies (Andrews, 1989). Most previous QoL studies aimed for a universal measurement to examine people's life satisfaction. Although there are aspects of life that are similar across the world, unique qualities of each urban setting should not be neglected. Consequently, it is necessary to include context-specific parameters such as housing, public spaces, accessibility, and other related issues while developing measurement tools to examine the quality of urban environments. This research addresses this knowledge gap by developing a validated index

for examining QoUL in the context of deprived neighbourhoods of post-industrial cities. The developed index aims to benefit local communities identifying their needs and priorities and may also be used by policymakers and urban planners to develop more effective policies.

Emmanuel Eze

Year: 1
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Ernest Effah Ameyaw

BLOCKCHAIN-ENABLED SMART CONTRACTS ADOPTION AND IMPLEMENTATION FRAMEWORK IN LONG-TERM INFRASTRUCTURE PROJECTS UNDER PUBLIC-PRIVATE PARTNERSHIPS

Abstract: Long-term infrastructure projects procured through Public-Private partnerships (PPPs)/Private finance initiatives (PFI) like every other construction project are characterised by uncertainties and they are risk-laden. The high numbers of stakeholders involved, poor risks analysis/ skewed risks allocation, lack of trust and transparency, poor services/product quality, contractual compliance issues, imperfect contracts (due to paper-based contracting nature), inaccurate demand forecasts, project approval delay, and government/users' payment default; have led to the failures/terminations of PPPs contracts / projects globally. Blockchain technology and smart contracts promises to address some of the drawbacks in the delivery of PPP contracts in infrastructure projects. Smart contracts are driven by blockchain to increase transaction efficiencies, better infrastructure assets liquidity, better transparency, data auditability, transfer of value and trust. Despite the potential benefits of blockchain-enabled smart contract, its use in construction is still meagre, and researchers and academics have ignored modern technological-driven solutions to improve the performance of long-term infrastructure PPPs contracts. This study aims to develop and validate a framework for the successful adoption and implementation of smart contracts (SC) enabled by blockchain in infrastructure PPPs. This study will be guided by pragmatism philosophical stance, and qualitative and quantitative data will be collected using interview and questionnaire from experienced stakeholders in the industry. Arrays of descriptive and inferential statistical methods will be used to analyse data using AMOS SPSS and NVivo. The developed framework will be useful in facilitating efficient financial management process, efficient collaborative working and savings in operating cost and time of long-term infrastructure PPPs contract delivery

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Fereshteh Ahmadi

Year: 1
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Dr SeyedReza RazaviAlavi

A DECISION SUPPORT SYSTEM FOR IMPROVING RESIELIENCE OF MAINTENANCE OPERATIONS OF BUILT ASSETS

Abstract: Maintenance management can account for a significant portion of an asset's life-cycle cost, which could be up to 85%. Therefore, it is crucial to investigate disruptions that can affect the operation and maintenance of built assets, including buildings and infrastructure facilities.

Even though some disruptions in maintenance operations are unpreventable, 'resilience' has emerged as a potential way to reduce systems' vulnerability and economic losses caused by major disruptions. A system can be said to be resilient: if it can cope with continuous and unpredictable changes and still maintain its vital operations. This research investigates the concept of resiliency in the maintenance operation of built assets by identifying the root causes of major disruption events to maintenance operations and intends to develop a decision-support system for improving their resiliency.

Kathleen Gatward

Year: 1
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Paul Ring

ADAPTIVE REUSE: A METHODOLOGY FOR THE CONTINUED OCCUPATION OF HERITAGE BUILDINGS.

Abstract: We are currently at risk of our heritage buildings becoming objects/monuments that can only be seen as places of memory and redundant vessels rather than spaces to be experienced. At a time when sustainability is a critical agenda for all aspects of life, a discussion on how we develop and continue to make use of our built heritage must be included. The debate on the best approach to building conservation or restoration started with Viollet-le-Duc and John Ruskin's opposing views and continues today. Recently researchers and practitioners have adopted adaptive reuse as a design methodology to continue the occupation of heritage buildings. While there have been several successful examples of this approach, Heritage Organisations within the UK are hesitant to employ this design methodology.

This research project aims to encourage heritage organisations within the UK to see adaptive reuse strategies as appropriate methods for the continued protection of the UK's heritage buildings. The project will investigate adaptive reuse strategies that have previously been employed and identify the strategies that are applicable within the UK's heritage sector. To achieve this the project will analyse case study examples, run workshops with subject practitioners and experts, and test strategies within a UK heritage setting through physical installations/exhibitions. These methods will result in the curation of a toolkit that outlines 5 or 6 design strategies that demonstrate adaptive reuse as an effective methodology for continuing the protection of heritage buildings within the UK.

Wahib Saif

Year: 1
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Dr SeyedReza RazaviAlavi

CONNECTED CONSTRUCTION SITES IN INFRASTRUCTURE PROJECTS: A DIGITAL TWIN SOLUTION FOR TOTAL PROJECT CONTROL

Abstract: Construction sites, especially of infrastructure projects, are faced with various

onsite issues, including lower productivity, project delays, cost overruns, unsatisfied clients, and increased rate of accidents which all can damage the company's reputation and, consequently, the loss of new contracts. Such problems can be effectively addressed by capturing, analyzing, and visualising onsite data in real or near real-time to continuously and effectively monitor and control onsite operations. This objective can be competently achieved by adopting the concept of Digital Twin (DT).

DT can be described as an umbrella concept that builds upon a range of information and communication technologies such as BIM, Cloud Computing, IoT sensors and Data Analytics to form and connect together a physical asset or process to its digital replica for enabling a range of decision-making capabilities. Although DT has been recently investigated by researchers and industry professionals in the Built Environment, their work has been extensively focused on the operational phase of already built assets. In contrast, the construction phase has been overlooked.

This project aims to develop and test a DT holistic approach for connected construction sites of infrastructure projects that enable contractors to monitor and control all metrics related to the accomplishment of safe, efficient, high-quality, and compliant construction. To date, this aim has not been fully achieved as the few studies investigated DT for construction site applications concentrated on individual use cases (e.g., equipment monitoring, progress measurement, material delivery, etc.).

Ziana Namboori Madathil

Year: 1
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Nadia Bertolino / Cameron McEwan

A TYPOLOGICAL STUDY TO CRITICALLY ASSESS PRACTICES OF SOCIAL AND ENVIRONMENTAL CARE IN BRITISH ECO-COMMUNITIES.

Abstract: This research investigates practices of social and environmental care in three specific British eco-communities that have comparable agendas yet differ in their architectural setting. A typological study of spatial arrangement reflects on the influence of architecture in structuring various aspects of communal life. This study develops a discourse about eco-communities through a theoretical framework that links care, ecology and typology. It analyses how these paradigms overlap and creates entanglements to critically assess practices of social inclusion, co-existence and environmental care in such communities.

In communities, 'care is a collective effort'. Spatial care investigates social relationships in communities and tries to 'identify and collectively objectify weaknesses in the ecumene' (Lussault, 2017) which is formed by the long-term interaction of humans & non-humans intentionally. Spatial care highlights the involvement and empowerment of stakeholders while investigating the type of reciprocal relationship they form. Community ecology analyses the 'organization and functioning of communities, which are assemblages of interacting populations of the species living within a particular area or habitat' (Thompson, 1 August 2022).

Eco-communities are not always extroverted in nature, with the ability to bring about drastic changes in society. Some of them trigger the need for social change while acting within their boundaries (Sager, 2018) This research thus questions how architectural practices embody and replicate agencies of care and ecology implemented in these communities. Being qualitative in nature, it relies on ethnographic methods such as mapping the existing spatial arrangements and social structure to reflect on community engagement strategies. Open-ended discussions with community members give an insight into their perspective of community care.

Year 2 Students

Alkis Lathouras

Year: 2
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Prof. Paul Greenhalgh

HOW DO POCKET PARKS AFFECT THE LOCAL REAL ESTATE AND THE COMMUNITY? A CASE STUDY IN MANCHESTER'S CITY CENTER.

Abstract: Cities are expanding rapidly. Property development controls growth action, gradually resulting in negative effects on the urban environment, physical and mental health, social/community relationships, and human well-being. New financial actors have rapidly led to social inequalities, displacement, and gentrification. Cities do not reflect anymore the model humanity is trying to shape, concentrating a plethora of urban justice issues. The research seeks answers to how pocket parks can maximize benefits and eliminate negative externalities in a fair financial and funding mechanism towards a sustainable city's future. The research addresses the question if a sustainable matrix of pocket parks can be a major tool toward the Goals of the United Nations Agenda 2030. Mixed methods of research evaluate the intervention performance and the spatial involvement, exploring the meanings and social issues of the individuals' perception and providing the main datasets for statistical analysis. Interpretivism as a philosophical paradigm perfectly supports the attempt to assess, evaluate, and interpret the intervention performance through the eyes of the research sample and the human being's meanings. The Abduction approach is adopted as less theory-driven and a more social perspective is needed. As no evidence exists about the intervention's negative externalities and any property premium, exchangeable or not, that lead to housing financialization and displacement, a Performance Index for comparison and generalization creates an indicator of spatial equality and urban (in)justice. Finally, evaluating for first-time the intervention under the "free-rider" problem prism, the research addresses the multiple and deep cracks in socio-spatial equalities and urban justice.

Oluwadamilola Aboderin

Year: 2
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Dr Kelechi Anyigor

FLEXIBLE WORKING IN CONSTRUCTION PROJECT MANAGEMENT: SUSTAINING TEAM COHESIVENESS FOR EFFICIENT PERFORMANCE

Abstract: Many project teams are recognized to be shifting from working physically onsite to embracing flexible working, that is, a blend of onsite and virtual working. The evolution of flexible working seems to have heightened, especially since the advent of covid-19, as most teams were compelled to work remotely. Some surveys notably reported more employees working remotely during the early stages of the pandemic. Even when the mobility restrictions were eased at the latter stages of the pandemic, more project organisations were observed to change policies on remote working by offering staff the chance to work from anywhere. As a result, more teams opted for flexible working patterns. The experiences of home working during

the pandemic, had somewhat, influenced preferences for flexible working in the future. It is, therefore, important to delve deeper into current thinking around flexible working, to ensure cohesiveness is optimized among teams in such working environments. For this research therefore, the focus will be given to flexible working that involves the blend of remote and on-site work. This research aims to develop a model for sustaining project team cohesiveness in the current flexible working environments, which will require a critical evaluation of the theoretical factors contributing to the attitudes of project teams in the current flexible working environments and the perceptions employers have about managing it effectively. This is useful to make a series of empirically derived recommendations that can support project team members when working in flexible work environments to maximize good practice and effectiveness.

Dean Ireland

Year: 2
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Paul Jones

"TURNING HOUSES INTO HOMES - WHAT SYSTEMS EMPOWER FORMERLY HOMELESS PEOPLE TO LEAD HEALTHY AND FULFILLED LIVES IN CONTEMPORARY SOCIAL HOUSING?"

Abstract: Through education, training, employment, and independent living, the YMCA helps 572,000 adults aged 18 to 30 across the country. YMCA supports nearly 20,000 people experiencing homelessness each year, making it the largest voluntary sector provider of assisted housing for young people in England and Wales.

YMCA Newcastle want to design a social housing pilot scheme using existing Newcastle City Council housing stock that would help NCC to provide additional moving on accommodation in Newcastle, and to 'move on' their high needs users once they have been fully supported. The YMCA Newcastle, with the help of Northumbria University, have acquired a grant from the People's Lottery for £250K that will fund the renovations. This will be transformative for the doctorate, in effect guaranteeing that the refurbishment of the stock donated by Newcastle Council will go ahead.

The YMCA's aim is to assist residents to gain the tools and skills they need to achieve stability, independent living, promising futures, and connection to their communities.

Preeti Pansare

Year: 2
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Prof Ashraf M. Salama

URBAN FORM AND INCLUSION A CORRELATIONAL STUDY

Abstract: This research asserts that inclusivity is a crucial factor in the design and assessment of public open spaces (POS). In this study, inclusivity is regarded as a value that is inherent in

POS. An inclusive public open space is one that recognizes and respects the needs of every individual, providing them with a positive experience regardless of their background. Despite the importance of inclusivity in urban environments, there has been limited understanding of how urban form impacts inclusivity in POS beyond physical accessibility.

To address this gap, a walking tour assessment procedure is utilized as an observation tool to quantify a set of indicators associated with urban form and inclusivity in a selection of public open spaces in Glasgow, Scotland. The United Nations report (UN2030) emphasizes the importance of eradicating social exclusion and promoting social integration and social inclusion to build more cohesive societies. Sustainable Development Goal #11, which focuses on Sustainable Cities and Communities, seeks to create inclusive, safe, resilient, and sustainable cities and human settlements.

Furthermore, a Likert Scale is implemented to examine the reciprocal relationship between the user and the space, the activities, and the sense of positive experience. This research aims to develop an index that examines human behavior in relation to urban form while integrating inclusivity as a key parameter for research and design.

Telsi HewaWellage

Year: 2
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Dr. Onaopepo Adeniyi

OVERCOMING DATA UTILIZATION CHALLENGES FOR BUILT ASSET FLOOD RESILIENCE: STRATEGIES AND BEST PRACTICES

Abstract: Flood resilience in built assets is a critical challenge facing communities worldwide. Amongst various efforts to built asset flood resilience, the conception towards data utilization becomes popular with enormous technological advancements. Built assets create varieties of data at larger volumes throughout the life cycle signifying that the importance of these data in the context of flood resilience cannot be ignored. However, the challenges associated with built asset data for flood resilience are numerous and complex. Despite the power of data, these challenges impede the greatest opportunities that exist for resilience. Thus, identifying these challenges with timely relevant strategies is a significant need. One of the best ways to tackle these challenges is viewing them through the lens of data life cycle stages of built assets. Based on this, this study identifies the challenges of built asset data in each stage of the data life cycle; acquisition, management, classification, and utilization, with strategies to overcome them. The use of advanced sensing technologies, cloud-based storage solutions, data governance policies, and the development of predictive models are some of the consequential strategies outlined in this study. These findings provide valuable insights and guidance to facilitate the built asset data utilization for flood resilience.

Year 3 (+) Students

Abhinav Mishra

Year: 3+
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Jiayi Jin

EXPERIENCE DESIGN INSIGHTS FOR MIXED REALITY MUSEUM EXHIBITS: LEARNINGS FROM PROFESSIONAL CURATORS, DESIGNERS, ARTISTS, AND RESEARCHERS.

Abstract: Mixed Reality (MR) has not yet seen widespread adoption in museum spaces compared to other popular visitor-facing digital technologies. Previous research highlights MR's potential to improve visitor engagement, but there is a lack of understanding of human-computer interaction (HCI) design-related challenges faced by museum professionals participating in the design and planning process of such experiences. The study collects qualitative data in the form of semi-structured interviews from expert curators, designers, artists and researchers in the field and codes them through a grounded theory approach to reveal themes informed by spatiality, narrative, usability and more to characterise critical challenges concerning the design for HCI of on-site MR experiences in museums. At the same time, the study identifies experience design, process, device, and media-related considerations emerging in the practice. The insights include the importance of designing interactions that are grounded in the physical nature of the exhibition space to anchor the narrative and enhance immersion and engagement with visitors. These insights will help frame recommendations for designing effective MR experiences embedded within museum environments.

The proposed presentation will have three parts. The first part with introduce the background of the study and its methodology. The second part will introduce the challenges faced by the participants of the study. The third part will describe the experience design recommendations emerging from the study for on-site MR exhibits in museums.

Emad Alyedreessy

Year: 3+
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Prof. Ruth Conroy Dalton

THE RELATIONSHIP BETWEEN SPATIAL ORGANISATION, SOCIAL CAPITAL, AND SOCIAL SOLIDARITY IN LARGE-SCALE CONTEMPORARY COLIVING COMMUNITIES.

Abstract: In recent times, urban Coliving has raised the demand for housing with shared facilities in major cities across the world, with coliving operators asserting that their spaces promote a sense of community amongst residents. It is a new shared living urban typology targeted at Millennials, who are reported to be markedly lonely and far less trusting of other people than previous generational cohorts.

The pursuit of social solidarity is a concept that has often driven architectural design and it is through the routine activities of everyday life that individuals encounter each other in the situated contexts that are central to forming social organisations. With research showing that social isolation indicators are closely associated with loneliness and that social solidarity provides significant benefits towards individual wellbeing, this thesis asks: “To what extent does the spatial organisation of large-scale coliving environments influence the building of social capital, and the strengthening of social solidarity, within such communities?”.

Habib Ghasemi

Year: 3+
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Dr Tara Hipwood

ENABLING OWNER-OCCUPIERS TO RETROFIT: A PRACTICE-BASED STUDY OF ARCHITECTS' EDUCATIONAL ROLE IN THE COMMUNITY OF DOMESTIC RETROFITTING

Abstract: Reducing energy demand in existing owner-occupied houses in the UK is critical to decarbonising the building sector and mitigating the impact of climate change. However, this poses a particular problem, as the decision to accept low-carbon retrofit measures remains with owner-occupiers. To encourage homeowners to retrofit, recent practice-theory-based studies have explored different angles to the often-used psychological models of behaviour change and drawn attention to the sociality of retrofitting. However, understanding subjectivity as an autonomous individual property or dissolved in social practices has created a gap regarding how subjective reflexive capabilities arise from the interplay with practice complexes. Accordingly, despite the emphasis on the role of building experts in encouraging domestic retrofitting, particularly architects, there is a lack of background theory to frame this role within the inter-subjective space. This research draws on works around the 'practice turn' in education, which sees learning in a broader context and through communicative space. It explores architects' educative role in their exchanges with owner-occupiers around home improvement projects (five observations). Data is collected by asking architects (ten interviews) and owner-occupiers (six interviews) about their practices and experiences. By conducting rigorous line-by-line analyses of talks and interviews, this paper provides an argument and illustration of architects' position in the community of domestic retrofitting. The findings show that the educational role architects play in enabling owner-occupiers to retrofit depends on the position of homeowners in the community of practices. The result argues that these positions and roles should be recognised in future ways of professionalism.

Hidayati Ramli

Year: 3+
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Dr Zahirah Mokhtar Azizi and Dr Niraj Thuraijah

EXPLORING THE IMPACT OF SUSTAINABLE SMART CITY TECHNOLOGIES ON ENERGY CONSUMPTION BEHAVIOUR AT HOUSEHOLD LEVEL

Abstract: The Newcastle Future Needs Assessment Local Profile estimates that its population is expected to increase over the foreseeable future to 310,906 by 2030, even rising to 315,038 by 2040 (NFNA City Profile, 2021). As a result, with such population growth necessitates even more urgent decarbonisation initiatives to prevent urban carbon from exacerbating existing issues on the way to achieving the United Kingdom's national net-zero carbon agenda by 2050. As a result, technological innovations, and digitisation such as Smart City technologies, are among the innovations that the city values as having the potential to not only lower energy bills for residents and improve the comfort of home occupants, but also achieve decarbonisation targets towards more urban sustainable transformation. Much of these strategies are technocratic approach to transitioning from fossil-fuel-based household heating to a low-carbon energy system. However, this thesis advocates for a sociological perspective on determining urban sustainability transition because domestic decarbonisation is highly dependent on the users' energy consumption behaviour. In other words, the research aims to investigate the impact of smart technologies diffused at the household level on the energy consumption behaviour of its consumers.

It is used to validate the study's urban sustainable exploration in order to facilitate a Smart City's socio-technical transition to a Sustainable Smart City model. The socio-technical in this context being addressed is the interdependence of social (household, energy consumption, behaviour) and technical (technology) aspects of the Smart City system towards sustainable transformation.

John Carr
Year: 3+
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Professor Paul Jones

ARE NEW BUILD HOMES IN THE UK HELPING OLDER PEOPLE TO AGE IN PLACE?

Abstract: The UK population is undergoing a massive age shift; in less than 20 years, one in four people will be over 65 (Centre for Ageing Better, 2021). With this shift in age profile, we must consider the needs of older people as they age. Millions of the older people in the UK live in houses that are no longer suitable for their needs and which compromise their wellbeing and their ability to live safe and fulfilled lives. In the past, houses were not designed with the needs of older people in mind, and an ageing population brings with it many issues that must be addressed with housing design so that homes do not compromise people's lives as they age. The housing market does not respond to the challenges of growing old. Consequently, many people struggle with ageing; a principal concern is their housing environment (Hayes, 2018). There has been increasing pressure on the volume housebuilders to make new homes accessible, adaptable, and spatially flexible, so that homes can be modified to the changing needs of people as they age. This industrial doctorate is a collaboration with an architectural practice, IDPartnership, where I have set out to demonstrate that speculative houses produced by the volume housebuilders can be significantly improved to help people age better. The overarching aim of this project is to develop innovative homes that are accessible, adaptable and technology-enabled to support people to age in place, where they can live safe and fulfilled lives as they grow older.

Mahir Msawil

Year: 3+
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: David Greenwood

CONCEPTUALISING THE ROLE OF BLOCKCHAIN IN ENHANCING CONSTRUCTION CLAIMS MANAGEMENT AND DISPUTE RESOLUTION

Abstract: Contractual claims for time extensions and additional costs result from a variety of events occurring during the course of construction projects. However, claims management is reported to be ineffective and wasteful for contracting parties and their respective agents. This deficiency tends to result in unsettled claims that evolve into legal disputes. Hence, claims management in construction contracts needs to be enhanced to overcome a wide array of challenges. The challenges can be seen through (i) process, (ii) content, and (iii) behaviour lenses.

To enhance construction claims management, an optimal solution that addresses the relevant challenges needs to: (1) enhance visibility of the process, (2) streamline the contents of construction claims, (3) meet the contractual needs of contracting parties, and (4) moderate the behaviour of involved agents. Encapsulating these aspects in a single solution may now be possible with the advent of blockchain technology and its associated smart contracts.

Blockchain-based solutions have been proposed in the construction project management (CPM) research domain with the aim of tackling typical challenges encountered in construction projects. Yet, there remains a paucity of work that conceptualises the potential role that blockchain can play in tackling the particular challenges facing construction claims management.

To assess and conceptualise the applicability of blockchain to the desired need for enhanced construction claims management, the work presented herein sheds light on how blockchain technology can enhance construction claims management by overcoming reported challenges associated with this contractual process.

Shashwat Shashwat

Year: 3+
Department: Architecture & Built Environment (ABE) [PGR Lead - Dr Lesley McIntyre)
Supervisor: Kishor Zingre

ANALYSING THE EFFECT OF BUILDING FAÇADE DESIGN ON URBAN MICROCLIMATE

Abstract: Rapid urbanization has a significant impact on the rise in urban air temperature which consequently leads to outdoor thermal discomfort for pedestrians. The research on usage of façade materials to improve the outdoor conditions are very limited. Therefore, the purpose of this research is to analyses the impact of façade materials on urban microclimate by computational simulations using ENVI-MET tool. ENVI-MET offers liberty to model and simulate urban environment with greenery, building materials, roads, pathways, etc. In this study, a cluster of office buildings located on the city campus of Northumbria University at Newcastle were selected which are 2-5 storied in height connected with network of asphalt roads and concrete pathways and greenery in between. The cell size of 2x2 m2 was chosen for modelling. This research focused on the impact on microclimate by variation of building materials under UK weather condition involving summer and winter seasons. The result data are compared for facade materials with variable reflectance, emittance and specific heat capacity for typical summer and winter days. Weather parameters such as temperature, radiation/cloud, precipitation, wind, and relative humidity were forced into each simulation to obtain the accurate results. It has been observed that the urban air temperature in the first cell near façade can be reduced up-to 2°C on a summer day by implementing the high reflective cool paint. Similarly, the temperature shows a rise of up to 0.6°C in winters with the application of phase change material in the facade, hence improving the outer thermal comfort.

Northumbria University NEWCASTLE

Department of Computing & Information Sciences

Year 1 Students

Abubakar Mairiga

Year: 1
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Naveed Anwar

TINNITUS MANAGEMENT AND SUPPORT- A MIXED METHODS STUDY

Abstract: Tinnitus affects the quality of life and is impacted by psycho-social pressure, which includes negative emotions, anxiety from work or home, and affects the sense of hearing and emotional state. However, numerous studies conducted in the past have suggested using smartphone applications to reduce tinnitus. The current study conducted a SWOT analysis on the tinnitus app. The findings showed that the four tinnitus apps in the study have one major strength which is good stress and anxiety management. Beltone tinnitus calmer, Sanvello, and white noise tinnitus applications. The dataset used in the study were app reviews (Beltone tinnitus calmer, ReSound tinnitus relief, Sanvello, and White noise tinnitus app) by users which were harnessed using Appbot a webs crapper tool.

Alaa Elnabawy

Year: 1
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Ossama AlShabrawy

BIOMARKERS IDENTIFICATION FOR BIPOLAR DISORDER LITHIUM TREATMENT THROUGH INTEGRATIVE DISCRIMINATIVE ANALYSIS

Abstract: Psychiatric diseases diagnosis is commonly performed by clinicals after tracking number of symptoms over time, which proved to be impacting daily life functioning. Bipolar disorder is a mental disease that affects more than 1% of the population globally, it shares symptoms with other psychiatric diseases like Major depression and Schizophrenia. Bipolar has mainly two subtypes bipolar I and bipolar II and Lithium is the main treatment prescribed for bipolar patients. It is considered as a gold standard since 1966 in UK since it minimizes the manic episodes which accordingly declines the suicidal behaviour among patients. The responsiveness to lithium treatment is 40%-50% but it's still under investigation. Biomarkers identification for bipolar lithium treatment is a challenging task, there are two approaches for identifying biomarkers; statistical approach and machine learning approach, both approaches try to find the best features that contributes to the phenotypes provided, the statistical approach relies on the significance of differential expression of either genes or proteins through statistical methods, and the computational approach relies on trained algorithms through applying machine learning feature selection techniques to figure out effective genes' subset. This study proposes an integrative biomarkers identification analysis framework that benefit from the power of both machine learning and statistical approaches. The proposed framework relies on six stages that lead to effective biomarkers analysis: Discriminant Analysis, Feature Ranking, Statistical Biomarkers Identification, Machine Learning Classification, Causal Interference and Integrative Feature set Analysis.

Anas Althobaiti

Year: 1
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Dr. Ossama Alshabrawy

DEEP LEARNING BASED ANALYSIS OF DIGITAL PHENOTYPES AND RESPONSE EVALUATION FOR BIPOLAR DISORDER

Abstract: This research focuses on the application of deep learning techniques in the analysis of digital phenotypes for the diagnosis and treatment evaluation of bipolar disorder. The study identifies the potential of a research gap in the need to investigate accurate and novel digital biomarkers and evaluate bipolar disorder patients after treatment. The main aim of the research is to develop a deep learning-based approach that can discriminate bipolar disorder and predict response to long-term treatment by identifying digital markers derived from the integration of clinical and neuroimaging variables. The research objectives include the development of a deep learning-based approach for the detection of bipolar disorder, exploration of novel and diverse biomarkers, formulation of algorithms for computing the effectiveness of individual biomarkers, and the evaluation of different treatments given to bipolar disorder patients. The study aims to probe different deep learning models and devise an ensemble of deep learning approaches for proficiently predicting bipolar disorder onset. The research questions aim to address the development of a deep learning-based analysis for the proactive detection of bipolar disorder, the identification of crucial digital markers involved in the classification of bipolar disorder, and the analysis of the effectiveness of selected biomarkers. The results of this study could provide valuable insights into the development of accurate and efficient tools for the diagnosis and treatment evaluation of bipolar disorder using deep learning-based approaches.

Conor Wall

Year: 1
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Dr Alan Godfrey

MULTIMODALITY IN HEALTHCARE: THE ROLE OF AI AND DIGITAL BIOMARKERS (MULTI-BIO)

Abstract: This presentation demonstrates the work being undertaken on my PhD, which is on the utilisation of AI and digital biomarkers to address the challenges faced by individuals with Parkinson's disease, particularly high rates of falls and gait abnormalities. While the current state-of-the-art approach for addressing such issues involves using a metronome or generic music cues to improve gait, literature indicates a shortage of personalised approaches. The proposed methodology involves utilising embedded sensors to collect triaxial sensor data, creating a smartphone application to track gait characteristics in near real-time, and generating personalised music cues that match the patient's gait characteristics. This low-cost, adaptive, and widely available approach offers a more effective and personalised method of music cueing. Its contribution to knowledge would be the development of a modern approach that

employs accurate sensing to dynamically adapt music cueing to fit the patient's physiological condition and characteristics.

Luis Carvalho

Year: 1
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Dr Kyle Montague

THE EPIDEMIOLOGY OF WEB ACCESSIBILITY: LARGE-SCALE ACCESSIBILITY EVALUATION

Abstract: A 2022 audit found that 96.8% of 1 million websites contained at least one Web Content Accessibility Guidelines (WCAG) 2 failure. Previous work has shown that third-party frameworks and services do not make accessibility a central concern, potentially contributing to the spread of accessibility barriers. To explore this issue, we adopt Ross et al.'s conceptual framework based on epidemiology, which looks at the accessibility of a webpage as the product of its continued interaction with its surrounding environment.

As a first step in the research, we will conduct a large-scale automated accessibility evaluation of the web, collecting both accessibility and technology reports from 1 million web pages. By analysing the data, we aim to understand better how accessibility barriers propagate in the web ecosystem and the relationship between the technologies used and the accessibility of a webpage. This study will provide a foundation for identifying potential solutions to prevent and mitigate the propagation of accessibility barriers in the web development ecosystem.

Zoe Moorton

Year: 1
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Zeyneb Kurt

EXPLAINABLE DEEP LEARNING MODEL FOR MARINE DEBRIS DETECTION.

Abstract: Marine debris has been significantly affecting ocean life due to debris becoming entangled, consumed or leaching toxic substances. Therefore, scientists face a major predicament, as we find ways to deal with the consequences of plastic breaking down to smaller fragments and becoming increasingly difficult to separate from the marine ecosystem as well as our own food chain. To address this issue, AI could be used to detect debris in marine environments.

Therefore, the aim of this research is to develop an explainable 3DCNN with causal learning, to accurately detect marine objects within video and image data.

This study assesses whether or not we can produce trustworthy machine learning models that distinguish between synthetic debris and marine biodiversity accurately, providing support to preserving and protecting marine environments.

Our research objectives include collective a large-scale database of underwater footage as well as producing an explainable hybrid 3DCNN model that incorporates causal learning for specifically targeting objects that are small or overshadowed in selection from another subject within the frame.

Year 2 Students

Alpana Kumari

Year: 2
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Prof Yifeng Zeng

ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS TO IMPROVE PATIENT-CARE OUTCOMES IN PEOPLE WITH COPD

Abstract: This study aims to predict acute exacerbations of COPD (AECOPD) using respiratory sounds, mobility parameters and symptoms.

--Identify criteria to detect Symptoms, those gets manifested during an AECOPD like coughing, wheezing, shortness of breath, physical inactivity, phlegm (mucus) in chest, sleep disorder.

--Developing machine learning algorithms to detect variations in coughing and wheezing.

--Development of 3 mobile based applications,

:Collection of audio samples to detect AECOPD and storing it in cloud database for better security and extensibility.

:Collection of data that accesses steps/day, walking time etc., to detect restrained mobility.

:A questionnaires-based data collection on patient's perception about various symptoms: breathlessness, fatigue, changes in the colour, thickness, or amount of mucus, swelling of the legs or ankles, trouble sleeping than usual, feeling the need to increase your oxygen if you are on oxygen.

--Patient study and clinical tests & validations.

Jason Moore

Year: 2
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Alan Godfrey

A DEEP LEARNING APPROACH TO AUTOMATED ENVIRONMENTAL CONTEXT

Abstract: Falls are a common occurrence in individuals with neurological conditions such as Parkinson's disease and stroke, with gait asymmetry being a strong indicator of fall risk. Inertial measurement units (IMUs) have become a popular and accessible tool for measuring gait parameters, but they lack environmental context. Recent studies have incorporated body-worn cameras to capture the environmental context and supplement IMU data. However, manual

review of video data is time-consuming and ethically challenging. This paper proposes a deep learning-based object detection algorithm to automatically label video data captured in a clinical gait lab. The dataset consists of two walking tracks with intentionally placed obstacles and distractors, and participants wearing eye tracking glasses. The proposed algorithm uses the FasterRCNN network with a ResNet50 backbone, trained on full-resolution images (1920×1080px) and applied non-maximum suppression to reduce noise. The approach shows promise in improving the efficiency and accuracy of gait analysis in a controlled clinical setting.

Jeffrey RedondoSarmiento

Year: 2
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Zhenhui Yuan

LOW LATENCY HIGH-DEFINITION MAP SYSTEMS IN WIRELESS AD-HOC NETWORKS FOR VEHICLES

Abstract: High-Definition (HD) Map is one of the main vehicular applications to achieve a fully autonomous driving without assistance. Nevertheless, the HD Map application faces challenge due to the huge data that is collected by the sensor that requires processing to later render the map. For this, the raw data is offloaded to the cloud and edge servers to alleviate the vehicle unit on board. The generate HD Map is transferred to all the vehicles on the road. Additionally, to have a real-time HD Map updates the latency must be lower and equal to 100ms. To achieve this threshold, the wireless communication standard IEEE802.11p must guarantee the delivery of data. Therefore, it was necessary to evaluate the current standard under data saturation. Results showed that a new access category (AC) was necessary to improve quality of service for HD Map. The implementation of the new AC has an improvement on the average delay and throughput of HD map traffic improved by 80%.

Lauren Scott

Year: 2
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Dr Marta Cecchinato

EXPLORING THE POTENTIAL ROLE OF DIGITAL TECHNOLOGIES TO SUPPORT FAMILY NETWORKS WITH MISINFORMATION CORRECTION

Abstract: As we navigate into a more digital world, information gets easier to produce and share, and the credibility of information comes into question. Individuals are exposed to misinformation on a regular basis, from multiple sources, and this misinformation can cause changes to behaviour and identity and can have detrimental effects on individuals' health and well-being. As misinformation spreads online, current research has focused on platform-based interventions to address these beliefs and to have a positive change on misinformed individuals' behaviours. My thesis explores how technology can support trusted individuals such as family members in their efforts challenging misinformed belief. Through this work my aim is to build a better understanding of how family members currently address misinformed beliefs, and where the limitations with current digital interventions lie, to create a tool to assist

these conversations within families, and ultimately reduce the impact misinformation has on our society.

Victor Ayodele

Year: 2
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Prof. Rebecca Strachan

WORKING WITH STUDENTS TO CO-DESIGN TECHNOLOGICAL SOLUTIONS TO SUPPORT THEIR LEARNING

Abstract: Over the past few years, the impact of technology in education has been far reaching, giving cause to new modes of learning such as remote learning, flipped classrooms, blended learning etc., increasing the need to explore newer ways in which technology can be used to support students' ability to get the best learning experience possible. Fields such as learning analytics exist with similar goals, but evidence in research has shown that students are the least consulted in designing and are hardly the focal point of such systems. Before designing solutions to support student learnings, it's important to work with students to identify their needs. My research focuses on conversion master's students studying computer science at Northumbria university.

From my earliest research, it was observed that students need to be willing to use the tools designed for them, for it to have any traction, and it was better to design tools or processes that will (1) support and enable them to improve their learning through metacognition (2) support "staying motivated" and (3) facilitate peer-to-peer support. Based on this premise, I conducted 2 focus group sessions. Each group consists of 5 students. The session featured a co-creation activity called "Design the box".

Some of the findings from the research reveal (1) conversion student struggle learning new concepts and need a buffer for foundational learning (2) there's a need to monitor progress based by capturing student's learning pulse. These two areas will be explored further as my research progresses.

Year 3 (+) Students

Anthony Ashwin Chazhoor

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Professor Wai Lok Woo

DEFECT DETECTION USING USING ACTIVE LEARNING

Abstract: Defect identification is an important responsibility in many sectors, including manufacturing and quality control. Active learning, a subset of machine learning, has been proven to reduce the quantity of labelled data needed for training defect detection models. Demonstrate an active learning method to defect detection that includes iteratively picking the most informative samples to label and adding them to the training set. We compare our technique to a baseline model trained on a random sample of labelled data on two datasets. Our experimental results show that our method beats the baseline model in terms of accuracy while using far fewer labelled samples. This demonstrates the value of active learning in increasing the efficiency and efficacy of fault identification.

Buxin Zeng

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Yifeng Zeng

PLAN LEGIBILITY OF INTELLIGENT AGENTS

Abstract: Legibility is a property of the intelligent agent that can provide some valuable information to humans to understand agents' intentions. It can improve human-agent interaction. Legibility makes humans better recognize the agent whose goal it wants to achieve. When we know an agent’s behaviours are legible, we may want to find its legibility function, like a reward function in the RL environment. Then we can apply it to other agents. This study focuses on extracting the legibility function from the agent’s legible behaviours. In this study, we developed methods to extract legibility functions from legible actions. We use inverse reinforcement learning (IRL) to obtain the legibility function.

Cynthia Oguna

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Rebecca Strachan

DIGITAL LITERACY FRAMEWORK

Abstract: To participate effectively in today’s society it is becoming critical that everyone is digitally literate. This can be viewed as the baseline level of computer science education. There have been several frameworks developed over the years relating to digital literacy and what

this should encompass. But much less attention has been given to how to embed this within a specific community. Simultaneously many governments in developing countries have digital technologies as a core part of their strategy, with an accompanying plan to upskill their citizens. However, many of these initiatives still rely on a centralized organisation delivering digital literacy to the community, with little involvement or understanding of that community in the design and roll out of these initiatives. As a result, many of these initiatives are not as effective as they could be. The aim of this study is to explore how to change this approach to provide a framework that puts the community at the centre of a digital literacy development programme. The researchers have developed this framework based on their experience of working with a rural community in Kenya. The paper outlines the issues with current practice, the background information that has informed the design and approach of the framework and then the framework itself. It is anticipated that this framework will be a useful tool for guiding those looking to develop digital literacy within different types of communities.

Eaby KollonoorBabu

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Kamlesh Mistry

AI IN EMOTION RECOGNITION

Abstract: Emotion recognition is the process of identifying the emotions of individuals, a task that can be challenging due to the varying accuracy with which people recognize the feelings of others. With the advent of machine learning, there has been a recent surge of interest in using this technology to improve emotion recognition.

While the recognition of emotions has been a topic of research for a long time, contemporary methods include the identification of facial expressions in videos, the analysis of speeches in audio content, and the examination of social media content. Additionally, physiological signal measures, such as EEG, ECG, body temperature, and AI techniques, are emerging as viable methods for recognizing emotions.

The applications of emotion recognition are numerous and varied, with industries such as retail, education, healthcare, and security all using it in different ways. For instance, marketing and advertising firms can analyse customers' emotions to assess their reactions to ads, designs, and products. In education, emotion recognition can measure students' responses and engagement levels, allowing for personalized content development. Security experts can use real-time emotion recognition to identify individuals exhibiting suspicious behaviour in crowds.

My Talk for today aims to highlight recent advancements in emotion recognition techniques using machine learning, for the benefit of the broader scientific community.

Fraser Young

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Alan Godfrey

ASSESSMENT BEYOND THE LAB: IOT-ENABLED MULTI-MODAL GAIT ASSESSMENT

Abstract: Gait is an important biomarker in a range of physiological applications. For example, understanding an athlete's running gait can lead to performance optimisation, as well as minimising their risk to injury. Conversely, gait monitoring has significant impact within neurological conditions such as Parkinson's disease (PD). Within such conditions, patients generally exhibit degenerating gait over the progression of their disease. As such, gait can be used to monitor the severity and onset of neurological diseases. Providing a means of low cost, habitual gait assessment can enable new opportunities within the field. For example, a low-cost, IoT-enabled wearable device such as an inertial measurement unit (IMU) could begin to understand a patient's gait within their habitual environment, providing clinicians a more accurate understanding of how a patient walks day-to-day. Alternatively, computer vision could provide a markerless assessment through use of low-powered pose estimation and object detection. However, there are currently shortcomings within habitual gait assessment that limit their uptake in daily life. For example, there is a need to develop and validate robust algorithms to power remote gait assessment. In particular, gait patterns are vastly different between conditions and applications. For example, Parkinsonian gait will exhibit differences to e.g., Alzheimer's disease. Conversely, running gait may differ at varying speeds. As such, although one algorithm may accurately assess PD gait, it cannot necessarily scale between conditions, warranting wide scale development and validation.

Jialou Wang

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Honglei Li

AN INTEGRATED COMPUTER VISION BASED OOH AUDIENCE MEASUREMENT SYSTEM

Abstract: This research presents a deep learning-based approach for Out of Home (OOH) advertising models, incorporating appearance features such as gender, age, and other pertinent factors. A more comprehensive model would entail fine-tuned information derived from the audience. We propose a first impression recognition model aimed at augmenting the existing audience measurement techniques for OOH advertising. In our study, we investigate the causal relationships between diverse features and their influence on first impressions. By bolstering the system's interpretability and enhancing its accuracy, we enable OOH companies and businesses to better comprehend audience measurement through digital advertising panels.

Lida Ketsbaia

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Biju Issac

A MULTI-STAGE MACHINE LEARNING AND FUZZY APPROACH TO CYBER-HATE DETECTION

Abstract: The advent of social media has profoundly transformed the manner in which individuals establish connections and disseminate information on a global scale. Nevertheless, the proliferation of these platforms has precipitated an increase in cyber-hate, a pressing concern that has attracted considerable scholarly attention. In response to this issue, numerous strategies have been proposed, which employ Machine Learning and Deep Learning techniques such as Naive Bayes, Logistic Regression, Convolutional Neural Networks, and Recurrent Neural Networks. These methods utilize mathematical approaches to differentiate between distinct classes. However, when analysing sentiment-oriented data, a more refined "critical thinking" perspective is essential for precise classification, as it more accurately reflects the way individuals interpret online messages.

In this study, we implement two machine learning classifiers, Multinomial Naive Bayes and Logistic Regression, on four hate speech datasets. The performance of these classifiers is optimized through the integration of bio-inspired optimization techniques, including Particle Swarm Optimization and Genetic Algorithms, in conjunction with Fuzzy Logic. This combination facilitates a more comprehensive understanding of the textual content within the datasets.

Luca Crosato

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Yifeng Zeng

HUMAN-CENTRIC AUTONOMOUS DRIVING FOR VEHICLE PEDESTRIAN COORDINATION

Abstract: The advancement of automated driving technology presents new challenges for the interaction between automated vehicles and human road users, especially pedestrians. There is a need to investigate pedestrian behaviour and identify the specific motion cues or signals that have the most significant impact on pedestrian behaviour to ensure smooth traffic flow and minimize the risk of accidents. Previous research has suggested that distance or time to collision (TTC) between vehicles and pedestrians is the primary kinematic cue that influences pedestrian behaviour, but recent studies have shown that pedestrians use multiple sources of information from vehicle kinematics. This research aims to analyse pedestrian behaviour to enhance the development of Autonomous Driving Assistance Systems using virtual reality technology and deep learning algorithms. This study collects data in a virtual reality environment to study interactions between a car and a pedestrian and applies deep learning techniques to capture long-term dependencies. The research also aims to develop Autonomous Driving Assistance Systems to avoid collisions with a single pedestrian using a deep learning-based approach with Reinforcement Learning. We demonstrate how the

addition of a social term in the reward function design using the Social Value Orientation concept from Psychology can help train the vehicle agent to behave in a human-like manner towards pedestrians. The study aims to extend previous work that focuses on pedestrian crowd modelling and designing efficient motion control algorithms for autonomous vehicles.

Manli Zhu

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Longzhi Yang

OBJECT KEYPOINTS REPRESENTATION FOR HUMAN-OBJECT INTERACTION

Abstract: Detecting human-object interactions is essential for comprehensive understanding of visual scenes. In particular, spatial connections between humans and objects are important cues for reasoning interactions. Unlike humans that often have fixed skeleton structure, different kinds of objects usually have different structures, thus it is difficult to apply a unified algorithm for representing them. The dominant method for representing objects in object detection and HOI detection is object bounding box, which is too coarse to represent an object's structure. In this research, we propose a unified framework to extract key points of different kinds of objects which preserve object structural information, and such geometric features are fused with visual features to facilitate human-object interaction detection. We demonstrate the effectiveness of our proposed model by conducting experiments in public HOI detection benchmark datasets.

Neeranjan Chitare

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Dr. James Nicholson

TOWARDS LATERAL PHISHING DETECTION: EMPLOYEES' RELIANCE ON UNRELIABLE MARKERS

Abstract: Lateral phishing attacks can be problematic for organisations as these originate from legitimate, but compromised, email accounts that benefit from the implicit trust between sender and recipients. In this paper, we investigate how 17 employees from the UK and India evaluate emails from colleagues. In order to explore how real messages are evaluated, we conducted semi-structured interviews where participants talked through their real emails over two tasks. For the Sender Identification Task, we obscured key information (e.g., email addresses, signatures, etc.) and provided only the content. We found that participants were able to accurately identify the sender but relied exclusively on markers which were either obscured or could be easily spoofed. For the Message Integrity Task, we lightly edited one message without obscuring any information. We found that participants were poor at detecting slight changes in the message. We discuss the results of both tasks and its implication in the context of lateral phishing.

Olalekan Ogundipe

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Prof. Wai Lok Woo

EXPLAINABLE COLON CANCER STAGES PREDICTION WITH MULTIMODAL BIODATA THROUGH ATTENTION-BASED TRANSFORMER FRAMEWORK

Abstract: Abstract

Cancer is an heterogenous disease and accurately predicting the tumour stage is a complex process requiring high level medical expertise. A major factor limiting the adoption of deep neural network of artificial intelligence in real scenario cancer stages prediction and other medical related diagnostic, or prognostic task is its purportedly black-box or non-transparency decision-making approaches. Inspired by recent breakthrough of attention model in computer vision particularly in medical pathology research such as the analysis of biological genomes in identifying functional roles in cancer diseases pathogenesis and other disorder, we proposed state-of-the-art attention-based classifier based on extracted and fused features from genomics and histopathological images to improve colon cancer stages prediction performance and survival risk stratification. Results show the attention-based predictive model capturing existing correlations between samples and measured long range dependency within the input set. In addition, we explored interpretability tools within the model to reveal its cancer stages prediction process and identified order of relevance or importance of the component features within the fused input dataset. The 96% auc predictive accuracy achieved using convolutional base classifier improved to an average of 98% using attention-based transformer model. Also, ranking the input features indicates that the first 6 most relevance or importance features are genomics related features.

Rahul Yumlembam

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Dr. Biju Issac

INSIDER ANOMALY DETECTION BASED ON HETEROGENEOUS GRAPH NODE EMBEDDING GENERATED USING UNSUPERVISED LINK PREDICTION

Abstract: Existing insider detection systems try to model user behaviour by extracting intrinsic features from log entries. However, a single log entry from an insider may not exhibit any attack behaviour. Relationships among log entries may reveal anomalous behaviour in the overall scheme. In this paper, we propose an approach based on the link prediction task of user activity graph and monitoring two rules, specifically the removable device activity count of each day and the content of HTTP and email activity for the suspicious topic. A heterogeneous graph from each user's logs was constructed to capture the relationship between different logs. Second, a relational graph convolutional network was trained to predict links between each node in the heterogeneous graph. The node embedding generated after the link prediction task

captures the relationship among different nodes. To capture the causal relationship between each log entry, an LSTM (Long Short-Term Memory) autoencoder was trained using the temporally arranged node embedding sequences based on timestamps from log entries. Finally, to improve the result generated using LSTM auto encoder, the number of removable devices an individual use within a day is monitored. it is then compared with historical usage patterns to detect any significant deviations. In addition, we monitor HTTP and email activity for a suspicious topic using word embedding cosine similarity. Additionally, experiments are performed by replacing LSTM autoencoder with Isolation Forrest and DBSCAN and results show that LSTM autoencoder outperforms both algorithms, demonstrating the importance of capturing causal relationships.

Raphael Ehiaze Eichie

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Prof. Rebecca Strachan

THE USE OF INTERACTIVE SCREENCASTS TO PROMOTE ACTIVE AND ENGAGED LEARNING IN THE FURTHER EDUCATION MATHEMATICS CLASSROOM: A DESCRIPTIVE CASE STUDY FROM NORTH-EAST ENGLAND

Abstract: The lifelong learning sector is an essential but often challenging area of education. It can be subject to low and inconsistent levels of funding and can attract students who find certain areas of the curriculum particularly challenging. This can lead to a lack of engagement and disruptive behaviour in the classroom. For over a decade, the UK government have been keen to ensure that all adults have a minimum level of 'functional skills', including mathematics. In England's Further Education Colleges, this means many students have to study mathematics alongside their main subject programme, even though they may not be motivated to do so.

This research study investigates whether technology, specifically interactive screencasts, can motivate and engage these students in their mathematics classrooms. This research adopts a case study action research approach working with a group of learners and their teacher and classroom assistants in a college in North East England. The preliminary results indicate that these learners struggle with motivation and engagement. Adopting technology in the form of interactive screencasts could benefit these types of learners by providing a more active and individualized learning experience addressing their motivation and engagement issues and accommodating a range of learning styles.

Shaun Lillie

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Kamlesh Mistry

AN INTERACTIVE SENSORY GAME IN VR ENVIRONMENT TO SUPPORT AUTISTIC STUDENTS IN HE.

Abstract: This research project is to evaluate the use of VR and how we can use it to support autistic students' emotional regulation and learning experience by creating a Virtual Reality interactive simulation game environment essential for the use of autistic students studying in HE.

Using action research breaks up the research project into 3 phases of this research project which involve:

Phase 1: captured autistic students' requirements for a VR sensory study room that they would find support during their Higher Education experience. Through a semi-structured interview to interview ten autistic students here at Northumbria University.

Phase 2: consists of developing a prototype of the VR sensory study room interactive simulation game based on the requirement capture conducted in Phase 1 and evaluating autistic students' perspectives of the prototype. Students' feedback on the prototype will support the continued development of the VR game. Four evaluation sessions will do this: sessions 1 and 3, the test run and semi-structured interview, and sessions 2 and 4, which go more in-depth into the development/co-design. With this phase, we invite ten autistic and ten non-autistic participants to compare similarities or differences when playing the VR video game.

Phase 3: is to modify and move into a new direction to use the finding from phase 2 to create a new version of the video game and then send it off to a gaming company to do a final evaluation before writing up the thesis.

Yunus Celik

Year: 3+
Department: Computing & Information Sciences (CIS) [PGR Lead - Dr Fouad Khelifi]
Supervisor: Alan Godfrey

INSTRUMENTING GAIT IN NEUROLOGICAL DISORDERS: MULTI-MODAL APPROACH USING WEARABLES

Abstract: The presentation will be about my Ph.D. project that investigates gait in people with neurological conditions using wearable sensors.

Why mobility/gait assessment is important?

In Europe, people over the age of 65 make up more than 19% of the population, a figure projected to rise significantly. Increasing life expectancy, coupled with the number of people living with chronic health conditions, means that more people are coping with mobility loss.

Why wearables in gait assessment?

Several limitations such as high cost, low accessibility, and snapshot assessment (limited data capture duration), were reported for laboratory-based systems (e.g., motion capture, instrumented walkways). Wearables such as inertial measurement units, and pressure sensors, on the other hand, have opened data capture opportunities that overcome the limitations listed above. Low-cost wearable sensors are easily attached to the body, and capable of data collection over extended periods (weeks) regardless of environment. Wearables are comfortably used during the day without causing any security or privity concerns.

Aims and objectives

The aim of my Ph.D. is to evaluate gait in those with neurological disorders e.g., Stroke, Parkinson's Disease (PD), and Multiple Sclerosis (MS) using wearable sensors. The Ph.D. project outcome will provide clinically useful quantitative gait characteristics and in return, assist physiotherapists/clinicians with targeted physical (e.g., rehabilitation programs) and/or pharmaceutical interventions. My hypothesis is that using novel algorithms linked to wearables embedded with IMU and electromyography (EMG) sensing, more informative digital biomarkers, and conceptual gait models can better inform rehabilitation programs for people with neurological conditions.

Northumbria University NEWCASTLE

Department of Geography & Environmental Sciences

Year 1 Students

Aaditya Kapil

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Joseph Graly

METEORIC 10BE AS A TRACER OF CHEMICAL WEATHERING IN GLACIER SEDIMENTS

Abstract: The study aims to understand the extent of chemical weathering occurring in subglacial environments and its relation to CO2 sequestration. Chemical weathering of silicate minerals produces alkalinity, removes carbon from the atmosphere, thereby generating positive feedback to glaciation. However, determining the extent of chemical weathering in glacial environments has been a challenge due to difficulty in assessing and differentiating products of pre-glacial and glacier-induced weathering. This study uses a cosmogenic radioisotope, 10Be to quantify the products of chemical weathering and identify the global carbon cycling in subglacial conditions. Meteoric 10Be provides site-specific long-term average depositional flux to track the formation of authigenic minerals. The authigenic minerals lock in the 10Be and 9Be in a certain ratio at the time of formation and is a complex function of lithology and climate. The weathering flux can be inferred by measuring the mass of the authigenic minerals formed such as clays, oxides, oxyhydroxides and comparing it to the mass of primary mineral loss and decipher geochemical mass balance. The advances made in cosmogenic nuclide measurements and understanding of the complex pathways of soil weathering has fuelled in questions which can only be answered by quantify the rate at which these processes occur. New data and methodological improvements can help to define and refine the interlink between climatic, geologic, and biotic controls on the process of soil evolution. The outcomes of the study will hence add to our knowledge of global geochemical cycles.

Chloe Snowling

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Vasile Ersek

PAST CLIMATE IN VIETNAM, INSIGHTS FROM CAVE STALAGMITES.

Abstract: The agricultural practices and water resources of human societies in Vietnam are largely dependent on the seasonal monsoon rainfall. However, this same monsoon rainfall can also give rise to natural disasters such as flooding, landslides, and extreme weather events. As a result, Vietnam has been recognized as a region that is particularly vulnerable to the effects of climate change. Due to the diverse topography and complex climatology, the monsoon season significantly varies across the different sub-regions of Vietnam. The SW summer monsoon is responsible for most of the rainfall across Vietnam. However, regions such as the Central coastline receive rainfall from the NE winter monsoon. Rainfall from the NE winter monsoon is comparably understudied in contrast to its counterpart, the SW summer monsoon. Published paleoclimate studies have been inconclusive in delineating the

relationship between the summer and winter monsoon over longer, pre-anthropogenic timescales.

This study aims to fill the gap in knowledge concerning the spatial-temporal variability of monsoon rainfall in different sub-regions of Vietnam, over the last glacial-interglacial cycle. To achieve this, stalagmite-based climate reconstructions from the Northeast, Northwest, Mekong Delta, and Central coastline will be utilised to place the NE winter monsoon into a broader context. Using stable isotope analysis, this project will extend instrumental rainfall records, creating the first north-to-south paleo-monsoon transect for Vietnam. This will contribute to the understanding of wide-scale monsoon circulation patterns and tropical climate dynamics as well as further constrain climate models, aid in policy making concerning agricultural practices and assist in geohazard preparation.

Ebenezer Amoah

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Peter Forman

TRANSBOUNDARY CIRCULATION OF E-WASTE, POLICY, AND THE OPPORTUNITIES FOR VALUE CREATION

Abstract: Waste electronics imported from developed countries continue to flood developing countries, including Ghana. On one hand, dealing in used electronics and e-waste has employed about 200,000 informal workers in Agbogbloshie, Ghana, who either reclaim materials from waste goods or sell used electronic devices. On the other hand, the informal e-waste sector is coupled with environmental and human health risks due to the toxicity of e-waste and the rudimentary methods adopted by e-waste scrappers to extract valuable metals. The recent demolition of the Agbogbloshie e-waste scrapyard has impacted the e-waste scrappers and other actors within the e-waste network, disrupting the e-waste value chain in Ghana. This study aims to analyse the regulatory interventions of e-waste operations, provide insight into the coping strategies of e-scrappers affected by the Agbogbloshie scrapyard demolition, and create opportunities to develop innovation within the e-waste sector. The study seeks to achieve this by juxtaposing successful waste management case studies in Switzerland, Japan, and Germany and streamlining their applicability in Ghana. In addition, primary data would be gathered from the main actors of the e-waste network in Ghana through questionnaires, interviews, and focus-group discussions. Secondary sources will include data from Statista, UN Comtrade, the Global E-waste Monitor(2014–2022), Ghana's e-waste policy, and the Basel Convention (COP.1-16). The data would be analysed using SPSS and NVivo. The final intent of this research is to enhance the achievement of SDG targets 8.3, 12.4 and 12.5 on enhancing decent employment opportunities, innovation within the informal sector, and improving waste management practices.

Harley McCourt

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Matt Westoby

THE STATE AND FATE OF MOUNTAIN PERMAFROST AND IMPLICATIONS FOR DEBRIS SUPPLY IN GLACIERISED CATCHMENTS.

Abstract: Climatic warming is pronounced within the mountainous regions the globe, causing rapid permafrost thaw in areas high elevation. This reduces slope stability, impacting the debris delivery to glacierised catchments which plays a key role in landscape evolution and can result in severe socioeconomic consequences for local communities. Rock avalanche frequency and magnitude have been observed to increase in recent decades but there is a lack of a comparative global permafrost dataset. Here, I endeavour to update and improve an existing global permafrost zonation model and simulate how permafrost has spatially evolved 1960-2020. In addition, rock avalanche inventories for catchments across the globe will be produced via the GERALDINE toolkit to analyse the spatiotemporal interrelationship between permafrost extent and large-scale episodic debris delivery events, >0.05 km^2. Furthermore, fieldwork will be conducted at the catchment scale to assess the impact of permafrost degradation on small-scale continuous debris delivery, <0.05 km^2.

Holly Bartlett

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Prof John Woodward

SEDIMENT EXPORT FROM THE GREENLAND ICE SHEET

Abstract: Greenland Ice Sheet (GrIS) is a hotspot for sediment delivery where glaciers and their meltwaters transport sediments and associated nutrients across proglacial outwash plains and into oceans. This outflux can initiate highly productive ecosystems across glacier marine outlets and significantly alter primary production and resultant carbon feedback loops. Despite this, the complex relationship between glacial sediment and geochemical cycling is hindered by our distinct lack of knowledge regarding how much glacially derived sediment is delivered to the world's oceans and where this sediment delivery is taking place. This is primarily due to the difficulties traditionally associated with site access, the upscaling of discrete sampling sites and limited periods of data collection. Given that projections for future climatic warming are anticipated to accelerate the freshwater flux from GrIS and drive the transition from more marine-terminating to land-terminating glaciers, a better understanding of pro-glacial sediment dynamics is vital. This PhD research will directly address this current state of uncertainty by investigating the dynamics, potential implications and future evolution of water and sediment export from the GrIS. This will be achieved by employing three distinct research components: 1) Google Earth Engine analysis of suspended sediment concentrations in glacial outflow areas, 2) Geochemical analysis of field samples and 3) Generate conceptual models to explore sediment export under various projections for future climatic warming conditions. This research will improve our current understanding of sediment outflow and help to forecast how Greenlandic sediment export systems might evolve as we transition into a progressively warming climate.

Lindsay Bewick

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Matt Baillie-Smith

WOMEN'S LIVED EXPERIENCES OF ENTREPRENEURSHIP IN URBAN AREAS IN UGANDA: NAVIGATING LIVELIHOODS, SOLIDARITIES AND SPACES

Abstract: My research seeks to critically explore the ways in which entrepreneurial activities enable urban women refugees to create livelihoods opportunities, focusing on three key inter-related lenses – livelihoods, solidarities, and space. Taking the emphasis away from current policy and programming which has a narrow focus on how entrepreneurship leads to local economic contributions, the broader everyday experiences and interactions of urban women refugees will be investigated using visual and participatory methods. The research will take place in Kampala, Uganda.

Purnima Acharya

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Ed Rollason

CITIZENS AS SENSORS? INTEGRATING THE ROLE OF PEOPLE IN MODELLING AND MONITORING OF FLOOD RISK.

Abstract: Surface water flooding is a frequently occurring hazard in many regions around the world. Adequate flood risk management activities which integrate at-risk communities into knowledge sharing and management are imperative to prevent future loss and damage. This requires both large and comprehensive datasets, to inform flood modelling and risk assessment, and an active role for community participants. The aim of this study is to explore the role of citizen science in the management of surface water flooding, and how knowledge developed and held by different individuals, communities and organisations can contribute to more effective flood management and help communities to be more resilient. The study will develop an innovative approach for collaborative working between communities and risk managers to explore (i)how citizen science can fill data gaps in existing risk management approaches and (ii)contribute to building more informed and engaged at-risk communities with greater resilience to floods. To test both of these components, research will be undertaken in two locations. The UK represents a data rich environment in which there are few data gaps but significant disconnect between flood managers and communities. Nepal is a data poor environment in which local people may play a significant role in generating local data for flood management. In both situations the impact of citizen science on participant engagement with flood risk and resilience will be evaluated. The research will be delivered through three different but connected phases and adopts a mixed methods approach including both qualitative and quantitative research methodologies.

Richard Parsons

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Dr Sainan Sun

GLACIER CALVING: OBSERVATIONS AND MODELLING

Abstract: Glacier calving is the process of ice loss through the breaking of ice from the edge of a glacier. Ice-flow models describe calving in a number of different ways but there is still no consensus on the best approach. Recent work suggests that calving can be caused by exceeding a critical threshold of cliff height at the glacier terminus, giving rise to an unstable run-away process. Some of the higher-end predictions of near-future global sea level rely on models implementing such an unstable frontal retreat, a process termed 'Marine Ice Cliff Instability' (MICI). In this project, both observational and numerical methods are used to better understand calving process and how best to implement calving numerically. The aim is to arrive at a description that results in good agreement with observations, while at the same time being numerically robust and flexible enough to fit into an existing modelling framework used in large-scale ice-sheet modelling today. Of particular interest is Crane Glacier (located on the Antarctic Peninsula) where, following the breakup of the Larsen-B ice shelf in 2002, tall ice-cliffs were exposed at the terminus. This is the only such event to have occurred within the timeframe of abundant, high-resolution remote sensing datasets, providing a unique opportunity to validate and constrain the MICI hypothesis.

Sarah Woods

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Andrew Suggitt

LEPS IN THE CITY: HOW URBANISATION AFFECTS NOCTURNAL POLLINATION NETWORKS

Abstract: Across the UK, insect species are in decline (Sánchez-Bayo and Wyckhuys, 2019) . It has been difficult to attribute these declines to any one factor, but urbanisation is leading to increased anthropogenic pressures on the environment (Suggitt et al., 2015) and with them, a concomitant loss of semi-natural habitats (Fox, 2013). Lepidopteran species are excellent study organisms for investigating increased anthropogenic pressures due to their short generational cycles, ectothermic qualities and presence of historical datasets (Roe et al., 2009). Identifying and disentangling the effects of urbanisation, light pollution, microclimates and climate change on moths will be vital for future efforts to understand and mitigate population declines (Fox et al., 2021).

This research project aims to identify the links between environmental change and moth range shifts, traits, morphology, ontogeny and their role in pollination networks.

Tunde Okeowo

Year: 1
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Dr Michael Deary

THE UK'S CLEAN AIR HOSPITAL FRAMEWORK: THE ROLE OF HOSPITALS AS ANCHOR INSTITUTIONS IN ACHIEVING IMPROVED AIR QUALITY WITHIN THE COMMUNITIES THEY SERVE

Abstract: Air pollution has been associated with health effects such as asthma, stroke, cardiovascular diseases, lung cancer, and others (Kampa and Castanas 2008, Great Ormond Street Hospital and Plan 2021). It is the largest environmental risk to public health with an estimated minimum economic impact of £8 billion in the UK in 2010 (Brunekreef and Holgate 2002, House of Commons Environmental Audit Committee 2010). Over 2000 healthcare centres are in areas with average fine particulate matter (PM2.5) levels above the World Health Organisation recommended annual average of 10ug/m3 (British Lung Foundation 2018). Consequently, the NHS has seen a need to look inwards to reduce air pollution and carbon emissions, and in 2019 Newcastle upon Tyne Hospitals NHS Foundation Trust (NuTH) declared a Climate Emergency becoming the first healthcare institution in the world to make such commitment. This declaration commits the NuTH to actively reducing their carbon footprint and improving on air quality towards a sustainable healthcare system. This project is studying, for the first time, how an integrated net-zero carbon, and clean air strategy, based on the UK's Clean Air Hospital Framework (CAHF), can improve indoor and ambient air quality at major urban hospital sites, whilst also contributing to achievement of the hospitals' net-zero carbon targets. Further, it will investigate the role of hospitals as anchor institutions in improving air quality within the communities that they serve, and the health benefits this will bring by drawing on analysis of data from activities that are informed by the CAHF guideline.

Year 2 Students

Bina Limbu

Year: 2
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Sarah Hughes

UNPACKING THE HOUSEHOLD BLACKBOX: HOW RURAL HOUSEHOLDS MAKE DECISIONS IN RELATION TO MOUNTAIN HAZARDS AND RISKS IN NEPAL

Abstract: Disaster risk reduction (DRR) is recognised as a major development agenda under the Sendai Framework 2015-2030, which is committed to 'build back better' through 'owner-driven' approaches to post-disaster reconstruction. However, much ambiguity exists regarding how to effectively integrate community participation and local knowledge into DRR practices to make them more bottom-up and suitable to a community's socio-cultural context (Mercer et al., 2010). On one hand, disaster-affected people are portrayed as 'suffering subjects' or 'victims' (Robbins, 2013) whose voices are unheard in the top-down execution of DDR policies (Dhungana, 2021). On the other hand, they are considered to be drivers of their own change (Delica-Willison & Willison, 2013), possessing indigenous knowledge (Kelman et al., 2012), social capital (Nakagawa & Shaw, 2004) for effective DRR. However, the ground reality is often more complex and messier, as householders constantly negotiate with the state and non-state bodies to rebuild their lives and livelihoods, but do not necessarily end up any more resilient than before (Shneiderman et al., 2021). This research aims to carry out ethnographic study of people living in geo-hazardous locations in Dhading district of Nepal, in order to understand how they perceive, experience and cope with disasters at household level, and what decisions they end up making to safeguard themselves and their families. In doing so, this study will explore what kind of socio-cultural, economic, political, and environmental factors or processes interplay in their everyday household lives and how these factors or processes shape their agency and decisions-making in short- and long-run.

Georgina Woolley

Year: 2
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Nick Rutter

ENSEMBLE MODELLING OF ARCTIC TUNDRA SNOWPACK PROPERTIES

Abstract: State-of-the-art modelling systems are required to provide estimates of the seasonal evolution and vertical layering of Arctic snowpack microstructure properties e.g., depth, density, snow water equivalent (SWE), specific surface area (SSA). Accurate simulation of snowpack properties is necessary within hydrological forecasting (flood prediction, hydropower, water resource management), numerical weather prediction, climate modelling and remote sensing. Uncertainties in the simulation of snowpack layering and snow properties are caused by the representation of key Arctic snow processes, such as wind-induced compaction, the effect of low vegetation, snowpack thermal conductivity, associated metamorphism, and water vapour flux transport. In this study, measurements of snowpack properties collected at Trail Valley Creek, NWT, Canada over a 32-year period (1991-2023)

are used to evaluate the ability of the detailed snowpack model Crocus, to simulate snow depth, SWE, density and SSA. Using an ensemble of process representations and parameterisations, Crocus can simulate the correct magnitude of snow depth and SWE at Trail Valley Creek. However, further evaluation shows Crocus incorrectly simulates vertical profiles of snow density, highlighting the model's sensitivity to missing Arctic physical processes (high wind speeds and upward water vapour fluxes). A new ensemble of simulations accounting for missing physical processes has been created to correct errors in simulations of snow density profiles. The evaluation of Crocus using the new ensemble will identify preferential parameters and process representations for remote sensing, hydrological and permafrost modelling applications.

Jade Robinson

Year: 2
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Sebastian Breitenbach

RECONSTRUCTING INTERGLACIAL WILDFIRES IN SOUTHERN SIBERIA

Abstract: Recent accelerating global temperature rise increases the likelihood and susceptibility of the Siberian taiga to more frequent and extreme wildfires. This leads to enhanced permafrost thaw and subsequent greenhouse gases emissions, in a positive feedback loop. Various studies have examined these paleofires in Siberia on limited, modern timescales, but long-term reconstructions of wildfire occurrences are scarce. This study reconstructs wildfire occurrence during the Holocene using stalagmites from southern Siberia. We provide a new means for assessing Siberian wildfires during interglacial periods and the first southern Siberian Holocene wildfire record.

Three stalagmites from Botovskaya Cave (55˚17'59"N, 105˚19'46"E) have been U/Th-dated at the Oxford geochronology laboratory. These speleothem samples were collected deep inside the poorly ventilated cave, which is overlain by 40-130 m of sandstone covered by a thin soil and boreal taiga forest. Drip sites are active year-round, and cave air temperature is stable at ca. 1.3±0.5°C. Wildfires sporadically occur above the cave.

We use novel speleothem biomarkers, levoglucosan and lignin, as tracers for wildfire activity and vegetation composition above the cave, respectively. Levoglucosan is an anhydrous monosaccharide solely produced by the combustion of cellulose, and thus an ideal proxy for wildfires. Lignin is a biopolymer with three monomers. The monomer ratio can inform on relative changes between gymnosperm vs. angiosperm plant communities. Using both proxies we can decipher not only wildfire recurrence, but also changes in vegetation (e.g., from pine forest to peatbogs or grassland).

Leeza Pickering

Year: 2
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]

Supervisor: Emma Hocking

INVESTIGATING AND MODELLING LAKE MIXING REGIMES IN SOUTHERN FINLAND

Abstract: By 2100AD, it is predicted that approximately 16% of lakes worldwide will experience less frequent mixing and become permanently stratified (meromictic) as a result of climate change. Within the Arctic and subarctic, it is anticipated that increases in global air temperature will be magnified leading to strong feedback effects on the climate system, drastic changes in ecologically sensitive aquatic systems and increasing carbon emissions from lakes. Finland contains a dense network of lakes of differing mixing regimes including meromictic lakes that contain high resolution biogeophysical and biogeochemical data, enabling the opportunity to understand their response to warming temperatures. Hydroclimatic reconstructions have been undertaken, however they have not been focused on mixing regime changes and they have not been combined with modelling efforts to fully visualise changes across past, present, and future timescales. Here, we present preliminary results from reconstructions of lake mixing regimes from sediment cores and initial modelling results from some of the study lakes within Finland.

Loretta-Ann Jilks

Year: 2
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Professor Bronwen Whitney

PALEOECOLOGICAL EVIDENCE FOR THE DOMESTICATION OF THE WETLANDS OF THE BOLIVIAN AMAZON.

Abstract: Recent palaeoenvironmental reconstructions of Amazonia have shifted our understanding of past human manipulation, or 'domestication', of the landscape. Evidence includes extensive earthworks, ancient field systems, and alteration of forests for economically useful taxa. Most studies have focused on terrestrial landscapes, with few investigating the impact on aquatic ecosystems.

The Llanos de Mojos is a 135,000 km2 sub-basin of the Bolivian Amazon, characterised by a strong annual flood cycle and a forest/savannah/wetland mosaic. Pre-Columbian earthworks have been identified throughout the Mojos and are hypothesised to have controlled the annual flood cycle. Examples include raised fields, forest islands, fish weirs, and causeways.

The Quinato Wetland is a permanent wetland situated within a ca. 320km long palaeoriver channel in the Mojos. Earthworks have also been identified here, namely raised fields, forest islands, and fish weirs. This study aims to characterise domestication of the wetland and the associated ecological impacts through new palaeoecological analysis of existing (QM, ME) and new (LA, MI) sediment records using a multiproxy approach (charcoal, diatoms, pollen, and organic geochemistry). We hypothesise: H1) Past societies of the Mojos domesticated the Quinato Wetland using earthen fish weirs to control floodwaters to create permanent (non-seasonal) wetlands; H2) Past societies purposefully altered fish communities in the Quinato Wetland through domestication; H3) Domestication altered the ecology of the Quinato Wetland, impacting the aquatic food web. The results of this study will highlight the legacy impact of past

domestication on wetlands today, increasing our understanding of water-human-environment interactions in tropical regions.

Louise Mercer

Year: 2
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Paul Mann

DEVELOPING ENVIRONMENTAL CONTAMINANT MONITORING THROUGH COLLABORATIVE RESEARCH AND TWO-WAY CAPACITY SHARING

Abstract: Climate-driven landscape change, legacy waste and ongoing infrastructural investment are leading to concerns around water quality, habitat degradation and contaminant release in Arctic communities. Sustainable development considering threats posed by accelerating environmental change requires immediate and longer-term key strategic decision-making. This has been hindered by mismatches in priorities and timelines between communities and research programs that collect baseline data feeding into decision-making processes. These challenges highlight the importance of advancing collaborative partnerships and capacity sharing to promote resilient and sustainable environmental monitoring approaches. Community-Based Monitoring (CBM) has become increasingly common across Arctic research, however current CBM models have specific limitations that impact program effectiveness and the translation from data collection into decision-making. Here, we highlight key elements of community-based research programs that can both enhance or limit the longevity of programs including data utility, funding structures and roles within community-based research programs. Guided by a new model of community-based research, we outline an evolving community-based research program that focuses on addressing contamination threats posed by the legacy of infrastructure including industry, transportation routes and waste. We will show how different capacities and insights from diverse knowledge systems came together to guide baseline data collection that will inform the next iteration of the program towards monitoring that adheres to quality assurance standards. Important practices we enact to ensure Indigenous sovereignty over CBM collected data will be outlined including sustaining dialogue, addressing community priorities, supporting paid positions and continuously working to enhance community autonomy over time by supporting Indigenous-led CBM efforts.

Robert Egwea

Year: 2
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Matt Baillie-Smith

THE IMPACT OF TREE PROTECTION STRATEGIES ON RURAL LIVELIHOODS IN THE SHEA TREE BELT OF UGANDA

Abstract: This qualitative study investigates the impact of tree protection strategies and their interrelationships on livelihoods in Uganda's shea tree belt, a vital ecosystem supporting the livelihoods of millions of people in a region that has experienced significant deforestation in recent years, leading to soil erosion, loss of biodiversity, reduced water quality, poverty, and food insecurity. The study will contribute to original knowledge on deforestation, climate change mitigation, and livelihood outcomes in the global south by providing insights into the complex interrelationships between various tree protection strategies, challenges, and livelihoods in the shea tree belt. The original contribution to knowledge in this study lies in the synthesis of the concepts of agency, theory of access and sustainable livelihoods approach to understanding these relationships. While previous studies have explored the environmental benefits of tree protection strategies, this study highlights the crucial role of the strategies in supporting the livelihoods of rural communities in the global south, particularly in the shea tree belt.

Year 3 Students

Andrea Cristiano

Year: 3
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Andrew Suggitt

INTERACTIVE EFFECTS OF CLIMATE CHANGE AND LAND USE CHANGE ON MAMMALS RANGE CONTRACTIONS

Abstract: Anthropogenic climate change and land use change are the most prominent threats for the conservation of biodiversity. These drivers are known to interact and drive further biodiversity declines, but the studies that have demonstrated this are relatively rare and contextually restricted. We aim to determine the prevalence of an interaction between climate change and land use change on the spatial responses of species, using mammals as an exemplar taxon. Using datasets of occurrence records, we create occupancy maps for 50 terrestrial mammal species in Great Britain at 10 x 10-kilometre scale resolution between 1960 and 2016. We group occurrences in two time periods ('past', 1960 – 1992 and 'recent', 2000 – 2016, based on atlas recording periods) to calculate species' rates of extirpation and persistence, and then estimate distribution change via occupancy modelling. We found that extirpation rates for mammals of Great Britain averaged 0.27, translating to species losing more than a quarter of their original range extents. We then use Generalized Linear Models to model species' range contractions as a function of land use change, climate change and their interaction, finding that interactions were present in the best models for 34 of 50 of species. Whilst the environmental change variables often added explanatory power to models (between 14% and 26% across species, depending on modelling method), responses to the climate-land use interaction were often individualistic. Understanding the drivers of long-term range contractions under global change will help prioritize efforts for the conservation of exposed species and habitats.

Eleanor Wratten

Year: 3
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Prof. Michael Lim

CONTROLS ON PERMAFROST COASTAL EROSION PROCESSES ACROSS ICE-RICH PERMAFROST COASTLINES IN THE NORTHWEST CANADIAN ARCTIC

Abstract: Since the beginning of the 21st century, Northern communities along Arctic permafrost coasts have been some of the most visibly impacted environments from rapid global climate change. Although attempts have been made, the challenge to accurately document widescale coastal change both spatially and temporally, whilst also retaining high resolution data to better understand permafrost coastal behaviour and influences, has been problematic.

Our study uses multiscale approaches to analyse distinct aspects of terrestrial permafrost coastal behaviour and influences, since the beginning of the 21st century across the Northwest

Canadian Arctic. These vary from widescale spatiotemporal satellite mapping over 22 years, to process-level detail helicopter and drone 3D volumetric change surveys from 2018 - 2022.

Landsat 5, 7 and 8 Top of Atmosphere Collection 2 Level 2 Tier 1 satellite imagery was extracted from Google Earth Engine. One image per year during each ice-free season for 22 years (determined from our recent publication) was then used in ArcGIS Pro to digitise the cliff top, cliff base and shoreline positions annually. Then post-processing analysis was completed to evaluate widescale coastal rates of change across the southern Canadian Beaufort Sea Coastline. Different permafrost coastal type sites, including thaw slumps and cliffs, were then chosen from prior satellite mapping to create process-level detail 3D models from helicopter and drone surveys using Agisoft Metashape and Cloud Compare.

The accuracy of both techniques is analysed using surveys taken with a differential global positioning system during summer 2022, to ground truth the cliff top, cliff base and shoreline positions and create error bounds for each technique. Our focus is on establishing trade-offs between coverage, process-level detail, and accuracy, with the hope of improving the understanding of future permafrost coastal change monitoring and modelling in the future for Northern communities to utilise.

Grace Brown

Year: 3
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]
Supervisor: Benjamin Brock

CARBON CYCLING IN SUPRAGLACIAL DEBRIS COVERS

Abstract: The cryosphere plays an important role in the global carbon cycle, but few studies have examined carbon fluxes specifically on debris-covered glaciers, despite rock debris covering 7% of global mountain glacier area. To address this limitation, this thesis investigates spatial and temporal variations in the surface CO2 flux, and its relationship to environmental variables, at two debris-covered glaciers in the Italian Alps. Near-surface CO2 fluxes were monitored over thick (0.23 m) and thin (0.04 m) debris sites over two ablation seasons, using an eddy covariance system. Additional point CO2 flux measurements were made at the surface and subsurface of supraglacial debris at six sites using a portable Li-Cor gas analyser to examine CO2 flux variations across the glacier. These measurements were supplemented by water and atmospheric samples, providing the first assessment of CO2 flux origin considering d13C, as previous studies have relied on bulk chemistry alone. Third, existing glacier, geological and climate inventories are used to extrapolate field measurements to estimate the global CO2 flux attributable to debris-covered glaciers.

Lucy Carruthers

Year: 3
Department: Geography & Environmental Sciences (GES) [PGR Lead - Dr Holly East]

Supervisor: Vasile Ersek

IS SEA LEVEL RISE DRIVING MANGROVE DIEBACK IN THE MALDIVES? INSIGHTS FROM REMOTE SENSING AND DENDROGEOCHEMISTRY.

Abstract: During 2020, mangrove die-back occurred on at least 11 islands in the Maldives which is the lowest elevated nation on Earth and where mangroves provide crucial shoreline protection. The loss of mangroves in the region can decrease these low-lying islands resilience to climate change and reduces vital resources. Here, we use remote sensing and data from wood and sediment cores from dead and living mangrove areas to test the hypothesis that sea level rise is driving mangrove loss. Mangrove health and areal cover were examined from 2014 – 2022 using NDVI and Landsat satellite images (30m resolution). The relationship between mangrove health, sea level and precipitation were assessed by linear regression, which showed that mangrove dieback corresponds to an increase in SLR. Results from NDVI analysis show that mangrove health has decreased significantly since 2020 on all islands, causing complete loss of mangroves in some islands over two years. Affected areas are low-lying within the intertidal zone and dominated by the species Bruguiera cylindrica, which has a low tolerance to salinity and waterlogging. Wood cores were sampled for 14C dating and δ13C to calculate temporal changes in water use efficiency, combined with ITRAX elemental scanning to identify changes in water source and availability. Sediment cores were analysed using 210Pb dating and δ13C to identify changes in sediment redox conditions. This research is crucial to the understanding of tipping points for mangrove ecosystems on low-lying islands under climate change and is essential to guide conservation and rehabilitation strategies.

Northumbria University NEWCASTLE

Department of Mathematics, Physics & Electrical Engineering

Year 1 Students

Adnan Shamaoon

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Daniel Ratliff

HYDRODYNAMIC CHAINS IN INTEGRABLE SYSTEMS.

Abstract: I will go over reductions of the Benney moment equations to systems of finitely many partial differential equations, as well as how to build the Hamiltonian structures of any Benney chain reduction. The reduced equations should be diagonalisable and semi-Hamiltonian, and they all need to meet a compatibility requirement. The approach proposed by Ferapontov (2007) is followed in the construction, which leads to nonlocal Hamiltonian structures in general and these will be reduced to local structures in particular situations. This, with the aid of Poisson bracket formalisms, allow us to cast the infinite system in a finite way.

Bethany Willis

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Neil Beattie

THE MANUFACTURING AND LIFE CYCLE ASSESSMENT OF NOVEL PHOTOVOLTAIC DEVICES

Abstract: Solar energy is a rapidly developing section of the energy sector meaning the sustainability of the equipment required needs to be considered. By 2050, it is expected to be capable of providing 25% of the world's energy demand but to scale up facilities to be able to meet this expectation would require more than 10% of our remaining CO2 budget set in order to meet the terms of the Paris Agreement. This is why the Life Cycle of such "sustainable" products needs to be evaluated more critically.
A life cycle assessment (LCA) is a relatively new approach to investigating the sustainability of products - with the first LCA being carried out by Coca Cola in 1969. The LCA of PV devices includes the mining of the raw materials, the manufacturing stage, the use stage and the disposal /recycling stage. It is uncommon for studies to complete an entire LCA of a PV module - known as Cradle-to-Cradle - due to insufficient data. Instead, the majority of studies investigate the mining and manufacturing stage - known as Cradle-to-Gate. The aims of this project are to carry out a Cradle-to-Cradle LCA and investigate the most sustainable materials, manufacturing processes and disposal scenarios required to guide the future of solar energy from an even more sustainable perspective.

David Martin

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Remy Dubertrand

SEMICLASSICAL STUDY OF THERMALISATION IN QUANTUM MANY-BODY MODELS

Abstract: The central idea of the project is to study the thermalisation for classical and quantum models. Throughout this project, the thermalisation is studied for an isolated system consisting of many interacting particles. Here thermalisation means route to an equilibrium. The PhD project aims to study the thermalisation for several models, using mathematical techniques which make explicit the correspondence between quantum and classical systems.

David Roughton-Reay

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Prashant Agrawal

BIO-INSPIRED ELECTRODES FOR ENERGY TRANSPORT APPLICATIONS IN RENEWABLE ENERGY DEVICES

Abstract: Electrodes are an integral part of solar cells for energy capture and transmission, allowing excited electrons to flow from the surface of a solar cell to be stored or used as energy. Charge transport efficiency is determined by the surface area coverage of the electrodes: large coverage reduces charge flow resistance but limits light transmission. Nature has evolved its transport structures over millions of years to have minimal energy wastage, optimising fluid transport using convection and diffusion gradients, as seen in tree branches, human veins or river networks. In this work, we explore such bio-inspired designs for enhanced charge transport. We fabricate multi-scale fractal like bio-inspired designs using a simple and scalable method employing fluid interfacial instabilities. We will characterise the physical and electrical properties of the different features fabricated using this method to identify an optimum design balancing surface coverage and electron extraction. While replicating bio-inspired designs can have advantage in optimising the surface coverage problem for solar cell contacts, integration of bio-inspired designs also enhances product aesthetics, which has benefits in encouraging the uptake of such products.

Harry Birch

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Stephane Regnier

THE PHYSICS OF SOLAR PROMINENCES: AN AI/ML APPROACH

Abstract: Solar prominences are features consisting of cold dense plasma suspended within the solar atmosphere and display a wide variety of shapes. Using image data from the Atmospheric Imaging Assembly instrument onboard NASA's Solar Dynamics Observatory, these solar features can be identified along with their dynamics and evolution. Machine learning algorithms can be constructed to exploit these data, training models to identify

prominences through deep learning and subsequently to classify them based on properties such as their structure and morphology. These models are expected to lead to a greater understanding of physical questions surrounding prominence physics, including their formation, dynamics, eruption, and relation to the solar activity cycle.

Jake Forsyth-Hughes

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Devendra Tiwari

EXPLORING BISMUTH CHALCOHALIDES FOR PHOTOVOLTAICS

Abstract: There is a need of a suitable material for flexible low-cost and semi-transparent solar cells for incorporation into consumer products and buildings. Established photovoltaic technologies based on silicon, CdTe (cadmium telluride) or CIGS (copper-indium-gallium diselenide) either have low absorption or contain elements that are toxic or rare. Bismuth chalcohalides have gained interest as suitable materials for integrated photovoltaics, offering a wide range of optoelectronic properties favourable for single junction and multijunction devices. However, it has proven difficult to synthesize pure materials due to the vast phase space consisting of 15 different phases which may be present during synthesis. These phases will contribute to recombination of photogenerated carriers. Bismuth chalcohalides also have anisotropic carrier transport due to crystalizing as 1D ribbons or 2D sheets requiring careful control of the crystal growth for high performing devices. Intrinsic defects within these materials as well as band offsets between the absorber and the hole/electron collecting layers can further degrade device performance. Bismuth chalcohalide cells have so far not surpassed 2% efficiency with the highest being 1.8% from a BiOI cell. This project will attempt to improve the performance of bismuth chalcohalide cells by optimizing different fabrication conditions. These cells will be manufactured by physical vapour deposition, reactive annealing and solution proceeding techniques. The quality of each layer that makes up the cell will be studied by a range of characterisation techniques such as XRD (x ray diffraction) and SEM (scanning electron microscopy); cell performance will be tested using a solar simulator.

Katie Knowles

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Tom Stallard

TRACES OF MAGNETIC FIELD IN JUPITER'S EQUATORIAL IONOSPHERE

Abstract: Despite extended periods of observation, the interplay between Jupiter’s ionosphere and magnetic fields away from the poles remains enigmatic. The Juno spacecraft has revealed great complexities in the Jovian magnetic field, with significant small-scale anomalies in sub-auroral regions, which appear to coincide with complex structures identified in near-infrared ionospheric emissions. Here, we directly compare existing ground-based measurements of Jupiter’s ionosphere with the latest magnetic field models, born from NASA’s Juno spacecraft. Unexpectedly, ionospheric emissions are strongly correlated with the magnetic dip angle, as well as both enhanced and reduced emission where the surface field is weakest, suggesting

localised inhomogeneities in particle precipitation. Unlike the Earth, Solar System planets, from Mars to Uranus, exhibit a wide range of equatorial dip angles. Therefore, this analysis opens a discussion into how these poorly understood magnetic field configurations link with the Jovian system and reveal aspects of global ionosphere-magnetosphere coupling not previously explored.

Kendra Gilmore

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Sarah Bentley

CHARACTERISING EARTH'S MAGNETIC FIELD WITH GRAPH NEURAL NETWORKS

Abstract: Graph neural networks are a type of machine learning algorithm that are well suited to graph like structures where the relationships between points are important. To establish them in space physics, we use them to predict the location of the aurora using magnetic field data, solar wind and auroral boundary data to train the neural network. I will give an overview over how this goal will be achieved, including the sub-goals are planned.

Luke McMullan

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Patrick Antolin

MACHINE LEARNING USE IN THE DETECTION OF SOLAR PHENOMENA

Abstract: The Sun's atmosphere is too hot. By this I am referring to the unexpected rise in temperature between the Chromosome and the Corona, broadly called the Coronal Heating Problem. To explain this influx of heat it is crucial that we can track the many energetic events that happen in this region. However, the number of events happening, and that there is now data for, is now much too large for manual identification and tracking. Therefore, in order to increase our understanding of the Physics within this area we must develop Machine Learning Algorithms to carry out this task for us. In this brief presentation I will discuss the steps needed to develop such a tool for specific Solar Phenomena, namely Coronal Rain and Nano-jets.

Nikita Balodhi

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Richard Morton

ADDING UNCERTAINTY TO DEEP LEARNING IN SOLAR PHYSICS

Abstract: While deep learning neural networks are extensively used for machine learning problems across various fields, there are several limitations with their black box approach of learning. Along with little to no transparency and intuition in their training methods, they tend to be overconfident in their predictions and prone to overfitting. We aim to overcome this

problem by incorporating uncertainty in machine learning applications in Solar Physics using Bayesian methods. We will work with imaging data from the Atmospheric Imaging Assembly onboard the Solar Dynamics Observatory for studying the temperature of the Sun and use deep learning methods for de-noising of the image data.

Oghenerekefe Agwae

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Mousa Marzband

LONG TERM FORECASTING OF EV CHARGING STATION INTERACTIONS USING MACHINE LEARNING

Abstract: This body of research proposes using machine learning (ML) techniques that also consider statistical models like ARIMA etc. in conjunction with the ML models in the long-term forecasting of EV charging behaviour considering EV ownership as well. ML approaches have rarely been applied to long term EV charging behaviour forecasting; this body of research aims to contribute to the sparsely considered field. Also, by using datasets with almost a decade's worth of EV data for training and validation, the accuracy of the model can truly be measured against real-world data.

Sophia Long

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Juna Sathian

RESONATOR DESIGN FOR HIGH-BRIGHTNESS LUMINESCENT CONCENTRATOR PUMPED MASERS

Abstract: The MASER, the microwave analogue of a laser, is a device which produces electromagnetic waves through the amplification of stimulated emission. The maser has had limited widespread technological impact due to the high vacuum, magnetic field and absolute zero temperatures needed to function [1]. With little prospect of cost reduction, mass production, and miniaturisation, the future of room-temperature solid-state maser technology seemed a little bleak until recently, where recent breakthroughs in optically pumping masers have led to significant progress [2]. This advanced technology demonstrates the potential of high-brightness solid-state masers that have unparalleled performance as low-noise amplifiers, with applications in medicine, radio astronomy, and data communication [3].

This work presents the design, construction, and experimental testing of scalable LED-LC (Light-emitting diode-Luminiscent Concentrator) pumped microwave resonators to establish new efficient high-brightness technology for a miniaturised room-temperature maser. In this work, a range of antennae are optically pumped via LED-LC and investigated using the Finite-difference time-domain (FDTD) method in Computer Simulation Technology microwave studio® (CST). We will analyse the optical pumping dynamics of the LED-LC maser resonators using Monte Carlo raytracing of luminescent light guides using LightTools® Illumination design software to achieve the most efficient and compact resonator-LC combination. Current analysis shows all three resonators successfully resonating at 1.45 GHz with sufficient Quality (Q)

factors ranging 480-871.6. On average, the resonators are 5.1 times smaller than the first continuous room temperature maser [3], with the prospect of further miniaturising.

Utsav Panchal

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Robert Wicks

HELICITY BARRIER EFFECT IN SOLAR WIND TURBULENCE

Abstract: The fundamental mechanisms that heat the solar corona and accelerate the solar wind are yet unknown. A good theory must explain why does the solar wind not cool down as fast as we expect it and what are the origin of the waves we see. So, there is a large-scale driver which makes the turbulence happen and the turbulence transports the energy to kinetic scales and we don't understand actually how the dissipation happens. Is it collision-less distribution happening near to the sun that are evolving and making waves or is it turbulence prompt energy which makes process like the helicity barrier? Helicity barrier is a newly proposed theory, and it is fascinating because it's an organized process around these waves rather than just talking about wave-particle interactions. Proving the presence of helicity barrier will help us to understand the early evolution of solar wind as it leaves the sun and how does it evolve in the heliosphere also, how does the development of turbulence leads to heating and acceleration.

Will Tetlow

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Giulia Longo

NEW SYNTHETIC ROUTES FOR THE PREPARATION OF CHALCOGENIDE PEROVSKITE MATERIALS

Abstract: The objective of this PhD project is to develop new synthetic routes for the preparation of chalcogenide perovskite materials, specifically focusing on barium zirconium sulphide (BaZrS3). The current methods for synthesizing this material are very difficult, mostly due to the high temperatures required, greatly limiting its availability in solar cell structures. The proposed method for synthesis involves the use of a photonic curer to prepare the material, while keeping the remaining structure and layers at much lower temperatures. Chemical bath deposition and sputtering will also be utilized in this project to investigate alternative, low temperature methods for fabricating the material, and the synthesized barium zirconium sulphide will be fully characterized for its structural, optical and electrical properties. The potential of this material as a much more stable alternative to organic-inorganic perovskite materials in single-layer solar cells will be thoroughly explored. This research will contribute to the development of a more efficient, cost-effective, and stable solar cell technology with lower environmental impact.

Yash Saneshwar

Year: 1
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Eamon Scullion

EXPLORING FUNDAMENTAL MAGNETOHYDRODYNAMIC (MHD) PROPERTIES OF SOLAR CHROMOSPHERIC MAGNETIC FIELDS

Abstract: In this project, we will be studying an observation taken from the ground based Swedish 1-m Solar Telescope (SST). This observation of interest is a giant spiral structure in the solar chromosphere in the vicinity of a magnetic null point. Understanding how magnetic fields evolve through the layers of the solar atmosphere will help with the understanding of energy transport (through waves and magnetic reconnection) throughout the Sun and may lead to answers to many unanswered questions. The focus of this project is to study the nature of highly twisted magnetic fields, and in this project, we focus on the giant spiral. The goal of the project is to understand how giant spirals contribute to the transfer of heat and energy from the lower to the upper levels of the sun.

Year 2 Students

Dovile Rasinskaite

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Clare Watt

A NUMBER DENSITY/TEMPERATURE DESCRIPTION OF THE EARTH'S OUTER RADIATION BELT

Abstract: Substorms can inject electrons of energies ranging from 10s to 100s keV (often called source and seed populations) into the magnetosphere which can be accelerated to relativistic energies and be harmful to space-based infrastructure. Here we present a number density/temperature description of the Earths outer radiation belt obtained by using omni-directional flux and energy measurements from the HOPE and MagEIS instruments from the Van Allen Probe mission. This dataset provides a comprehensive statistical study of the whole Van Allen probe era. Values of number density and temperature are extracted by fitting energy and phase space density in log space to find the distribution function. Zeroth and second moments are taken respectively of the distribution function to find the number density and temperature. A number density/ temperature description is advantageous over an energy/flux description as it allows to differentiate between the transport and heating of electrons. The shape and variation of plasma distributions is also discussed, and general statistical properties presented. The relative importance of transport and heating is also discussed. We will explore the classification of substorm injections (i.e., is the injection a heating or transport of electrons, or a combination of both) and this technique can be extended across more energy ranges.

Efe Egbra

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Mousa Marzband

A BI-LEVEL GAME THEORY APPROACH CONSIDERING THE CONSUMER AND RETAILER PREFERENCES USING A MILP APPROACH

Abstract: Based on studies in the traditional electricity market with respect to economic and environmental incentives, most of the research has covered two players, and minimisation of cost as main objectives. However, considering behaviour and equipment costs related to constraints for the home-microgrid user has not been extensively studied. This paper presents an electricity retail market with stages and levels which will consider the users preferences and lifestyle changes to affect the consumers quest to reduce electricity cost. The upper level of the framework is for the retailer to maximize profits while the lower level is for the consumer to reduce cost based on users' behaviour for shifting appliances for the system. Furthermore, our model assumes a bi-level PSO approach which computes necessary optimal conditions differentiating it from other traditional methods. The particle swarm optimization (PSO)is a computational intelligence (CI) method that is related to the AI industry and is famously known for resource scheduling due its low complex nature and computing requirements which enables

near-optimal solutions in short periods. The competitive retail market proposed in this paper maximises the retailer's objective function for profit as well as minimizes the consumers objective function for cost. Analysis show that an equal equilibrium outcome can be achieved for this system and improvement can be compared to other optimisation methods for future purposes.

Hui Ling Ong

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Richard Fu

ZNO/GLASS SURFACE ACOUSTIC WAVES FOR EFFICIENT DIGITAL ACOUSTOFLUIDICS AND ACTIVE SURFACE CLEANING

Abstract: Transparent microfluidic devices based on ZnO thin film/glass surface acoustic waves (SAWs) were explored for active surface cleaning based on its acoustofluidic performance. Acoustic waves generated from ZnO films on glass substrate were investigated and their acoustofluidic performance including transportation, jetting and nebulization were evaluated. Ash particles and starch solutions were used as model contaminants on the surface of the ZnO/glass SAW devices, and the mass loading of the contaminants on the device's surface was monitored using the SAW device with a high sensitivity of 280.0 ± 9.0 Hz/(μg/mm2). Active surface cleaning of the contaminants was demonstrated based on the transportation of water droplets, and optimized SAW powers were identified which caused strong interactions between water droplet and contaminants, thus effectively cleaning the surfaces. Studies of surface heating effects induced by SAWs showed that the cleaning efficiency was also influenced by the substrate temperature induced by SAW agitations.

Jikai Zhang

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Richard Fu

DEFORMATION AND TRANSPORTATION BEHAVIORS OF NON-NEWTONIAN FLUID DRIVEN BY PROPAGATING SURFACE ACOUSTIC WAVES

Abstract: Acoustofluidics, with its multiple functionalities, portability, miniaturization, non-contact operation and high biocompatibility, is of great interest in the fields of drug delivery, microscale sample separation, and cell biology in many medical, chemical and biological fields (1,2). However, most of the studies in acoustofluidics are based on the Newtonian liquid (e.g., water solutions, either in sessile droplet or liquid flowing in the microchannel). Non-Newtonian fluids, including those of blood samples, are widely found in various industrial applications ranging from biomedical devices to food industry. They refer to fluids that do not satisfy the Newton's experimental law of viscosity and show a non-linear relationship between shear stress and shear strain rates (3). The viscosity of a non-Newtonian fluid is a function of the shear strain rate and varies according to the pressure to which it is subjected. With the applying of acoustic wave pressure, these non-Newtonian liquids often show significantly different behaviours as a function of interaction time between waves and liquid (4). However, this is a

rather less investigated area, and there are a lot of issues that are not well-understood. In this study, different concentrations of non-Newtonian fluid droplets (Xanthan solutions with a shear-thinning behaviour) were selected to be actuated using propagating surface acoustic waves (SAWs). Deformation and transportation behaviours of these non-Newtonian fluids were evaluated by measuring their deformation angles and transportation speeds.

Manthila Wijesooriya Mudiyanselage

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Mousa Marzband

MULTI-AGENT DATA-DRIVEN APPROACH FOR ELECTRICAL VEHICLES SCHEDULING TO ENHANCE THE GRID STABILITY

Abstract: In recent years, significant attention has been gained on the electrification of the transport sector integrated with renewable energy sources (RES) and energy storage systems (ESS) due to the limited availability and high cost of fossil fuel, and the reduction of greenhouse gas emission. As the energy requirement accelerate with EVs charging demand unnecessary stress and instability on the power grid could be occurred. Hence, the properly planned EV charging infrastructure with EV control strategies (forecasting and scheduling) is important to investigate the charging behaviour, allocate the required power demand for EVs, and balance the load demand. It is important to consider all the relevant technical, environmental, and social characteristics (e.g.: peak hours, traffic conditions, weather, EV battery specifications, EV driver's behaviours etc) that influence the EV charging demand when implementing an optimal charging infrastructure. This Project proposes the approach to EV charging forecasting and optimal EV charging scheduling using machine learning (ML) approaches. LSTM (Long Short term memory) is used for EV forecasting and reinforcement ML method have been applied for EV load scheduling.

Nadira Meethale Palakkool

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Daniel Ho

FABRICATION OF NOBLE METAL-FREE 3D PRINTED ELECTRODE FOR ELECTROCHEMICAL WATER SPLITTING APPLICATION

Abstract: Considering its clean and fully recyclable nature, hydrogen generated through water electrolysis is a potential alternative to fossil fuels. However, the ability of hydrogen to hold the next-generation fuel capability is largely affected by the unaffordability of the water electrolyser systems and unachievable practical-level electrochemical performance. Moreover, the oxygen evolution reaction remains enigmatic in the overall water splitting reaction. Currently the large overpotential accompanied with the overall reaction is compensated by noble metals such as Pt, Ir and Ru due to their high intrinsic catalytic activity. Recently 3D printing (additive manufacturing) technology has been explored for the fabrication of high surface area electrode for the electrochemical water splitting application. Additive manufacturing involves the rapid prototyping of complex and novel geometries which are pre-designed using computer aided

design (CAD) software offering low-cost manufacturing methods with low fabrication waste. This work involves fabrication of polymer template-based electrode using stereolithography (SLA). The main novelty of the work lies in using a Rod-Connected Diamond-based geometry, i.e., whose topology is like that of an atomic diamond crystal, where bonds between atoms are represented by cylinders. Hence printable 3D polymer structures with different filling fractions can be designed and subsequently analysed for material and electrochemical performance. The 3D printed polymer structures are subjected to a sequence of post-processing treatments involving carbonizing the polymer template through thermal decomposition followed by nickel electroplating and thermal condensation of carbon nitride with the purpose of obtaining nitrogen-carbon-nickel hybrid electrode and functionalizing the electrode surface with emerging two-dimensional layer materials.

Prakriti Kayastha

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Lucy D Whalley

FOLLOWING THE REACTION OF CHALCOGENIDE PEROVSKITE BAZRS3

Abstract: The perovskite ABX3 class of materials show great promise as photovoltaic materials, with low production costs, high efficiencies and a wide range tunability through structural and compositional variation. The most successful of these perovskites are lead-based halide perovskites. However, there are several outstanding questions around their toxicity and stability of these materials. Chalcogenide-based perovskites, with a less toxic transition metal on the B-site, have been proposed to address both of these issues. In particular, BaZrS3 has been recently fabricated in the lab but there are relatively few computational studies to support this experimental work. Here we present results from calculations using Density Functional Theory and finite displacement methods. In particular, we will analyse the electronic structure of BaZrS3 and evaluate the dynamical properties (phonon band structure) of this system. We will also discuss how our predictions will be used to support synthesis of the material via ball-milling. With this work, we hope to highlight how electronic structure methods can support experimental work and accelerate materials design.

Ruth Pollard

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Marc Etherington

TUNING INTO BLUE TADF: HOW METHYLATION AND NITROGEN POSITION EFFECT THE SINGLET TRIPLET GAP

Abstract: Control of light-emission from organic compounds is crucial in the development of new organic light-emitting diodes for uses in lighting, sensing, and fluorescence microscopy.

By understanding the interplay between room-temperature phosphorescence (RTP) and thermally activated delayed fluorescence (TADF) we can create criteria for obtaining delayed fluorescence. Recently Klimash et al.1, showed that quaternising sp2-hybridised heterocyclic

nitrogen in a carbazole – quinoline system can imbue TADF. In this work we seek to obtain TADF in the blue region of the spectrum by using N-quaternisation on 3 carbazole – pyridine isomers. By measuring the photophysical properties of the neutral compounds and the N-quaternised salts we can understand the effects that the sp2-hybridised nitrogen position has on key properties such as emission colour, photoluminescence quantum yield (PLQY) and the formation of charge transfer species useful for TADF.

In preliminary work so far, we see a red shift in the absorption spectrum consistent with previous work1, 2 and a possible appearance of a charge transfer band in the N-quaternised salts. The emission spectroscopy in solution shows a locally excited band in both the salt and non-salt forms. In 1 wt% poly(methyl) methacrylate (PMMA) films the salts display an increase in intensity of the charge transfer emission at long wavelengths with relatively high PLQYs. These results demonstrate that the salts perform best as films in the PMMA host. Time-resolved data shows that three of the compounds exhibit delayed fluorescence and will be the focus of future measurements.

References

1. A. Klimash, A. Prlj, D. S. Yufit, A. Mallick, B. F. E. Curchod, P. R. McGonigal, P. J. Skabara and M. K. Etherington, Journal of Materials Chemistry C, 2022, 10, 9484-9491.

2. A. T. Turley, A. Danos, A. Prlj, A. P. Monkman, B. F. E. Curchod, P. R. McGonigal and M. K. Etherington, Chemical Science, 2020, 11, 6990-6995

Udari Punchirala Arachchige

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Oliver Hutter

ORIGIN AND ALLEVIATION OF J-V HYSTERESIS IN ANTIMONY SELENIDE SOLAR CELLS

Abstract: Antimony selenide is an attractive light-absorber used in low-cost, non-toxic, earth abundant thin-film solar cells with rapidly rising efficiency values. Current antimony selenide solar cells are fabricated mostly using cadmium sulphide, titanium dioxide, zinc oxide, and tin oxide as buffers. Antimony selenide solar cells' photocurrent density−voltage (J-V) responses demonstrate anomalous dependence on the voltage scan direction/rate/range, voltage conditioning history, defect states, structure of the buffer, and device configuration. The hysteretic J−V behaviour in titanium dioxide-based devices is caused due to charge carrier accumulation which may be because the capacitive charge is quickly discharged through charge separation. In addition, the accumulation of oxygen vacancies at the titanium dioxide/absorber interface can reduce charge extraction, and at the same time, significantly accelerate the charge recombination at the interface, which also leads to unfavourable hysteresis. The electrical properties derived from the dark J–V characteristics of solar cells also provide essential information necessary for the analysis of performance losses and device efficiency. The presence of J–V hysteresis causes overestimation or underestimation of the accurate power conversion efficiency of solar cells. Therefore, challenges associated with

buffers should be resolved to continue the momentum in antimony selenide solar cell development.

Vishal Singh

Year: 2
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Gert Botha

OBSERVATION OF SUBSTRUCTURES OF SOLAR FLARE RIBBONS

Abstract: The driving mechanism behind solar flares is magnetic reconnection. This allows energy to transfer from the magnetic field to the plasma, resulting in accelerated particle beams composed of electrons and ions. In addition to the energy deposited in the coronal plasma locally, energy is also transferred from the electron beams when the electrons impact the chromosphere. This results in Hydrogen 656.3nm (Hα) emission extending across the surface of the Sun in a “ribbon” formation. Recent access to high-resolution Swedish 1-m Solar Telescope (SST) CRISP data has allowed us to examine the ribbons and their substructures, which we refer to as “riblets”, in unique detail, sampling 43 km per pixel at 0.2 s cadence. Here we outline our definition of riblets and a detailed statistical and kinematic analysis of their formation for an X-class solar flare observed on 10 June 2014. This approach gives us unique insight into how energy becomes deposited in the chromosphere by electron beams, both locally and globally. The analysis can be used to test 1D radiation hydrodynamic models of electron beam physics, such as HYDRO2GEN and RADYN, for understanding the impact of electron beams in chromospheres.

Year 3 (+) Students

Ewan Matheson

Year: 3+
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Neil Beattie

COMPARING SLOT DIE DEPOSITION AND PHYSICAL VAPOUR DEPOSITION OF AL: ZNO (AZO).

Abstract: Aluminium-doped zinc oxide (AZO) is a potential low-cost alternative to indium tin oxide (ITO) for application in optoelectronic devices as a transparent conducting thin film. Typically, AZO thin films are deposited using expensive, high vacuum equipment with high energy cost and materials wastage. In this study, slot-die coating was used as an inexpensive alternative to vacuum deposition to form AZO nanoparticle thin films under ambient laboratory conditions. The films were characterised structurally, optically and electrically and compared with a commercially obtained AZO film fabricated using physical vapour deposition (PVD). Structural characterisation of the nanoparticle film shows uniform coverage across the substrate with increased crystal quality following annealing in Ar up to 500 C. The optical properties of the nanoparticle film exhibit a wider band gap than the PVD film, while the high density of grain boundary defects between the nanoparticles inhibits sheet conductivity.

Henry Carr

Year: 3+
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Gennady El

THE SOLITON GAS TUNNELLING PROBLEM: A NUMERICAL AND ANALYTICAL STUDY

Abstract: Solitons arise as fundamental solutions to a broad family of partial differential equations (PDEs)--they play a crucial role in many physical systems owing to their core properties which include: (i) elastic i.e., pairwise interactions leading to well-defined phase/position shifts and (ii) the fact that its shape remains unchanged even after colliding with other solitons. This particle-like behaviour motivated the introduction of the soliton gas: a statistical ensemble of interacting solitons in which their phases (positions) and spectral parameters (i.e., amplitudes) are randomly distributed. The study of the soliton gas encompasses many elements from statistical physics such as the determination of power spectra, probability distribution function etc.
The interaction of a particle with a potential barrier is a defining problem in the field of quantum mechanics. It was found that the particle may either transmit (tunnel) through the potential or become embedded (trapped) within it. This phenomenon can be extended to the nonlinear case of solitons and—more importantly—the soliton gas: such problems fall within a class of dynamics termed soliton mean-flow interactions. We compare our numerical realisations directly to existing theoretical predictions and offer a qualitative extension of the soliton mean flow problem—the so-called solition gas mean flow interaction.

Hossein Abdolnezhad

Year: 3+
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Ciro Semprebon

GROWING AND STEADY LUBRICANT RIDGES FOR DROPS ON SLIPPERY LIQUID INFUSED POROUS SURFACES (SLIPS)

Abstract: Slippery liquid-infused porous surfaces (SLIPS), inspired by the slippery properties of the Nepenthes pitcher plant, have been introduced to increase the mobility of liquids by minimizing the liquid–solid contact. The SLIPS are composed of lubricating liquid film that is impregnated with micro-nano-porous matrix. The low frictional force of the SLIPS enables them to exhibit anti-biofouling, anti-icing, and self-cleaning properties as well as corrosion prevention and drag-reduction with broad implication for industry including biomedical devices, fuel transportation and food packaging.

When a droplet is placed on such slippery surfaces a lubricant ridge is formed. When a drop is fixed in space the lubricant ridge grows slowly over time, as the lubricant is driven from the surrounding by a pressure imbalance. The growth rate depends both on the lubricant viscosity and the thickness of the lubricant layer and continues until either the ridge reaches a size comparable to the drop size, or the lubricant available is gathered. When the drop is moving, however, the growth dynamics is deeply altered by drop motion, leading to a symmetry breaking front / rear, a different growth law, and velocity dependent steady states with smaller ridge sizes. In this experimental work we systematically describe these phenomena at varying of lubricant thickness, viscosity and drop velocity. Furthermore, we evaluate how the relative size of the lubricant ridge impacts the drop motion.

Sonal Fernando

Year: 3+
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Apel Mahmud

ROBUST ADAPTIVE NONLINEAR MODEL PREDICTIVE CONTROLLER FOR RAPID EARTH FAULT CURRENT LIMITERS IN COMPENSATED DISTRIBUTION NETWORKS TO MITIGATE POWERLINE BUSHFIRES

Abstract: Powerline faults are responsible for major bushfires around the world where arcs provoked by ground faults are common causes for igniting such fires. The grounding in distribution networks, in particular, the resonant grounding is utilized to extinguish bushfires caused due to powerline faults. Resonant grounding utilizes passive compensation devices (e.g., arc suppression coil) to negate the effect of the capacitive fault current created during a single line-to-ground (SLG) fault. However, the active portion of the fault current present due to the ground conductance is large enough to create electrical arcs that can ignite bushfires. The active fault current is compensated using devices known as the Rapid Earth Fault Current Limiter (REFCLs) which consist of residual current compensator inverters. This work focuses on designing a robust adaptive nonlinear model predictive controller to control the REFCL to inject a certain compensation to the distribution network that can eliminate the effect of the fault current during an SLG fault. The endeavour is to make a robust controller that can achieve

its control objective while being able to handle the variation in parameters in the dynamic model of the distribution network (e.g., variation in the ground conductance and capacitance due to environmental conditions) and external disturbances that can perturb the successful operation of REFCL.

Susheel Kumar Pirmani

Year: 3+
Department: Maths, Physics, & Electrical Engineering (MPEE)
Supervisor: Apel Mahmud

FAULT DETECTION AND PERFORMANCE ANALYSIS OF POWER DISTRIBUTION NETWORKS WITH RAPID EARTH FAULT CURRENT LIMITERS TO MITIGATE POWERLINE BUSHFIRES

Abstract: Bushfires are catastrophic events which cause scathing impacts globally on human lives and economies of different countries around the world. Powerline faults are considered as a key reason for several devastating bushfires where single line-to-ground faults are generally responsible for such events. A powerline safety technology called; the rapid earth fault current limiter that works based on the resonant grounding technique is currently being utilized to reduce the fault current so that bushfire risks can be prevented. The resonant grounding technique poses challenges to detect faults (i.e., feeder, phases, and locations) with existing protection relays and circuit breakers. Moreover, the sampling frequency of field devices play a key role for developing advanced fault detection schemes using different techniques. In recent years, there have been significant progresses to develop new techniques. An exhaustive analysis of existing literature clearly shows that attentions have been paid mostly for the faulty feeder detection and then for identifying faulty phases while there are only few approaches for locating SLG faults in resonant grounded distribution network which require high sampling rate (at least 5 kHz) and can detect moderate fault impedance. Moreover, none of these approaches is developed by considering the high impedance faults (i.e., 25.4 kΩ) on power networks in bushfire prone areas and the sampling frequency (2 kHz) of field devices used for measurements. This research aims to provides a comprehensive technique for the fault detection in resonant grounded networks from the perspective of the faulty feeders, faulty phases, and Location, as well as zero-sequence resistance estimation and secondary earth fault detection.

Northumbria University NEWCASTLE

Department of Mechanical & Construction Engineering

Year 1 Students

Anwar MoumenJamai

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Mohammad Rahmati

AERODYNAMIC PERFORMANCE AND AEROELASTIC DESIGN DEVELOPMENT METHODS FOR VERTICAL AXIS WIND TURBINES BOTH INDIVIDUALLY AND IN ARRAY CONFIGURATIONS *Abstract*: The global demand for clean and renewable energy sources is continuously growing to mitigate the environmental impact of fossil fuels. Wind energy is considered a clean and affordable alternative that can significantly reduce carbon emissions. Although horizontal axis wind turbines (HAWTs) dominate the market, vertical axis wind turbines (VAWTs) offer several advantages, particularly in peri-urban areas with unstable misaligned flows.

In this study, we will focus on optimising the aerodynamic and aeroelasticity of the H-Darrieus wind turbine using a computational fluid dynamic (CFD) approach under fluid-structure interaction (FSI). The H-Darrieus turbine is cheaper to produce and maintain than HAWTs but is less efficient due to its aerodynamic drag and inability to self-start at low tip speed ratios.

To improve the performance and efficiency of the H-Darrieus turbine, we will implement an aero-servo-elastic approach that includes external auxiliary devices, variable pitch angle and angle of attack (AOA), and an ideal airfoil with high lift-to-drag ratio and solidity. Additionally, we will examine the aeroelasticity of the H-Darrieus turbine under FSI to reduce wind-induced vibration and flutter.

Experimental and simulation analyses will be conducted to validate the proposed method. The results will help us comprehend the airfoil conditions under turbulent flow, and the design modifications will be tested to determine their effectiveness in increasing the efficiency of H-Darrieus wind turbines. We will also explore the performance of individual and array wind turbines. The findings of this study will contribute to the development of more reliable, efficient, and cost-effective VAWTs.

Drew Gray

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr keerthan poolaganathan

STRUCTURAL PERFORMANCE OF INNOVATIVE COMPOSITE STEEL-TIMBER BEAMS
Abstract: CComposite steel-timber beams have many advantages of steel/timber beams including increase in shear and flexural capacity whilst reducing creep and increasing sustainability when compare to composite steel-timber beams. Although there are many advantages to using composite steel-timber beam as previously mentioned and many applications such as prefabrication and modular buildings. Composite steel-timber beams are

rarely used in the construction industry due to a lack of standardised design equations. As unlike Eurocode 4 for composite steel-concrete beams there are no standards for such composite steel-timber sections which limits the use in the UK construction industry. The research project will look into developing composite steel-timber sections with design equations for use in the UK construction industry. This will be completed by developing innovative steel sections and combining them with manufactured timbers such as glulam. Then detailed parametric studies into the bending and shear behaviour of the steel-timber sections using numerical modelling, to provide numerical data which can be used to develop design equations for composite steel-timber sections which will allow for wider use of composite steel-timber section in the UK to increase sustainability in construction as well as decrease carbon dioxide emissions and embodied carbon.

Job Wambua

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Prof. Esther Akinlabi

DEVELOPMENT OF OPTIMALLY ENGINEERED MAGNETRON SPUTTERED THIN COATINGS FOR CUTTING TOOLS

Abstract: The basic requirement for the machining industry is a cutting tool, which is principally used to remove some materials from the stock material through shear deformation to achieve a specific shape of a functional component. In a machining process, the cutting tool is exposed to extreme conditions of wear, deformation, corrosion, and localized temperature. The design of a cutting tool should therefore take into consideration these conditions. Although several cutting tools' materials have been developed and available in the market, cutting tools remain a major cost in the machining industry. The current focus by the research industry is on the reduction of the use of bulk materials rather application of thin film coatings on inferior bulk substrates while producing superior performance of the cutting tools. This study will involve the simulation of the sputtering process and use of artificial intelligence (AI) to identify the range of optimum sputtering parameters to adopt. A selection of potential thin film coating materials for use in selected common cutting tools (substrates) will then be conducted. These coatings will be deposited on the substrates using magnetron sputtering (Teer coating) under varying conditions. The coated substrates will then be characterized using different characterization methods. Deposition will then be conducted on commonly selected cutting tools, annealed, and used to conduct different dry machining processes. These tools will be analyzed for wear, strength, and general performance. A model will then be produced to guide the production and application of durable and reliable self-lubricating thin film coated cutting tools.

Joseph Thomas

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Lu Xing

MODELLING ELECTROLYTES AND HIGH TEMPERATURE WATER ELECTROYLSERS FOR GREEN HYDROGEN PRODUCTION

Abstract: I will discuss the current issues facing water electroylsers and the electrolytes used within and how my work will seek to solve these issues by modelling new materials to be used and the benefits of operating at high temperatures.

Kajaharan Thirunavukkarasu

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Keerthan Poologanathan

WEB CRIPPLING BEHAVIOUR OF STAINLESS STEEL SIGMA SECTIONS - ETF LOAD CASE

Abstract: Construction industry is seeking for alternative materials to replace the conventional materials such as steel and concrete based on sustainability concerns. On that note, stainless-steel sections have come to limelight considering sustainability aspects as well as to attain specific advantages such as high strength, corrosion resistance, aesthetic appeal, and toughness in elevated temperatures. Many section profiles have been introduced to the conventional steel industry. Such sections can be applicable to stainless steel as well and the merits of the section profiles can be amplified. Sigma section is one of the innovative section profiles which offers numerous benefits including higher torsional resistance and high cross-sectional resistance. However, the existence of longitudinal stiffeners in sigma sections might cause web crippling failure under concentrated loads. Web crippling failures can be categorized as End-Two-Flange (ETF), End-One-Flange (EOF), Interior-Two-Flange (ITF) and Interior-One-Flange (IOF) based on the loading patterns. Hence, this paper intends to study the web crippling behaviour of stainless-steel sigma sections under ETF load case. Comprehensive numerical investigation on stainless-steel sigma sections under ETF load case was carried out utilizing Finite Element Analysis (FEA) software package, ABAQUS CAE 2017. The numerical model was successfully validated against experimental results and parametric plan was developed to analyse the web crippling behaviour of stainless-steel sigma sections under ETF load case. Various critical parameters were included in the parametric plan and the results were obtained from numerical analysis. The results were analysed with each critical parameter and suggestions were made.

Leila Pasandi

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr.Zi Qian

DEVELOPING A METHODOLOGY TO MEASURE AND OPTIMISE THE IMPACTS OF CLIMATE CHANGE ON URBAN BUILDING ENVIRONMENT

Abstract: Following the Government heating and energy target guidelines to improved building performance it is important to consider building design and human activities when examining

the impact of changing microclimate due to climate change. The urban microclimate impacts on urban building environment issues such as energy consumption, thermal comfort and air quality of occupants and their activities. Current concern over building and system design and urban infrastructure under future climate and microclimate change will place increasing requirements for improved accuracy and simulation of microclimate. This research will assess building performance and the improved design of new urban construction and infrastructure to minimise these impacts. This is particularly important in the design of sustainable buildings where lower HVAC systems are utilised and where there is an increasing need of passive design and low carbon systems to simultaneously minimise energy consumption whilst maximising thermal comfort. There is an increasing need of localised and explicit uncertainty weather files to provide the boundary conditions for energy, passive design, environmental analysis to establish the interaction between the urban microclimate and building infrastructure in future sustainable design. An additional complication and uncertainty arises from the fact that the urban microclimate is highly variable in both space and time and is dependent on location and situation regarding the building's position, facade, the material within a complex urban landscape.

This project aims to develop a novel mathematical model to measure and evaluate the urban microclimate interactions under climate change, future urban built environment and human activities. This will provide assessment and decision-making tools to inform urban layout, building design, simulation and sustainable energy system options for both new and existing urban buildings and infrastructure. This will be achieved under a range of different climate scenarios and in different climate regimes to meet the challenge of future heating energy technology by 2050 over the impacts of climate change.

Tesfay Gebreegziabher

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Yolanda Sanchez Vicente

CARBON-BASED HYDROGEN STORAGE MATERIALS

Abstract: These days due to the worsening climate change and increasingly growing energy crisis, the need for alternative energy sources is vital. Hydrogen is regarded as one of the clean energy alternatives due to its ability to produce clean energy without emitting any detrimental gases to the environment. In this study, different biomass precursors such as ground coffee waste, nutshells, corncob, and rice husk will be used as raw materials to synthesize a porous carbon for the adsorption of hydrogen via the spillover effect. Hence, this project aspires to store hydrogen on a biomass-based porous carbon via the spillover process at ambient conditions to ultimately meet the market standards.

Year 2 Students

Yuan Wang

Year: 1
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Prof. Ben Xu

DESIGN AND DEVELOPMENT OF RELIABLE ELECTRODE FOR HIGH-PERFORMANCE HYDROGEN PRODUCTION UNDER FLUCTUATING POWER SUPPLY

Abstract: Electrolytic hydrogen production is a promising approach for generating clean energy, and using fluctuating renewable energy sources, such as wind energy, is an effective way to power this process. However, the use of fluctuating power sources can have an impact on the performance and lifetime of the electrodes used in electrolytic hydrogen production. In this study, the effects of fluctuating voltage on the performance and durability of electrodes will be investigated. The mechanisms that lead to electrode failure will be analysed and strategies will be proposed to mitigate the impact of fluctuating power on electrolytic hydrogen production. The results will provide valuable insights into the optimisation of electrolytic hydrogen production systems powered by fluctuating renewable energy sources and can contribute to the development of a more sustainable hydrogen economy.

Matin AtaeiKachouei

Year: 2
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr Maryam Bayati

A SOLUTION TO GLOBAL WARMING AND ENERGY CRISIS; DIRECT AMMONIA FUEL CELLS

Abstract: The extensive use of fossil fuels in various areas, such as industrial and transportation, etc. have arisen some issues for the environment and human health. Renewable energies like fuel cells paly a vital role to address the these environmental challenges.

Ammonia, an indirect hydrogen storage media containing a high content of hydrogen (17.8 wt. %), could be an ideal carbon-free fuel for fuel cells.

Direct ammonia fuel cells (DAFCs), are an important emerging technology that can be used to extract the chemical energy within ammonia and convert such into electricity at high efficiency. Different types of ammonia fuel cells have been developed, and among them direct ammonia fuel cells attracted more attention. These can be divided into alkaline anion exchange membranes (AEMs), referring to the low temperature AEM-DAFCs, not only have merits of the high energy efficiency, but are compatible with non-precious catalysts without ammonia decomposition process, which means a lower cost compared to proton exchange membrane fuel cells.

In this study our focus was on developing a low-cost, highly active, and stable electrocatalyst of the direct ammonia fuel cell that can also use as the electrocatalyst for oxygen reduction reaction (ORR) in the anodic cell of the fuel cell.

Qiumei Jing

Year: 2
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Ben Xu

A ENERGY STORAGE ANALYSIS FROM MARKET PERSPECTIVE FOR ENGLAND NET ZERO PATH

Abstract: Renewable energy is the most attractive science area nowadays. Wind, solar, hydro, and other renewable resources have developed into mature industries and already provide solutions to transfer these resources into useful forms and apply them to everyone's daily life. However, there is a challenge that how to store and distribute this renewable energy at low cost and efficient ways, and the challenges are highly dependent on the region.

In this work, general renewable energy marketing is investigated, including the energy storage science and technology service, especially in electrochemical storage and hydrogen storage, and its data analysis in the marketing-related fields. Currently, the electrochemical storage pathway includes lithium-ion battery, sodium-sulphur battery, lead accumulator, flow battery, and the lithium-ion battery accounts for 90 % of them. Different from the new-energy vehicles that have the priority demand on battery capacity density, energy storage is more focused on battery cycle life, security, and cost. Therefore, the lithium-ion battery is the answer and development trend for electrochemical energy storage.

The demand for energy storage is getting bigger and urgent along with more installation of wind and solar power capacity. To understand that, the regional distribution of energy requirements needs to be studied on both the electric generating side and customer side, since to provide project management service in the international transfer and cross-border transaction on energy storage field.

Sareh Akbarpoor

Year: 2
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr Mohammadali Rezazadeh

AN ARTIFICIAL NEURAL NETWORKS MODEL FOR THE PREDICTION OF THE BOND PERFORMANCE OF NSM FRP SYSTEMS USING CEMENT-BASED ADHESIVES

Abstract: Near-surface mounted (NSM) techniques have become a well-known method for strengthening existing concrete structures with FRP composites. The adhesive plays a significant role in ensuring the efficiency of the NSM FRP system by transferring shear stress

between FRP reinforcement and concrete. Although epoxy adhesives have been utilized most commonly for the NSM FRP system, some drawbacks like poor high-temperature resistance and moisture-durability problems have caused concerns over their performance. Consequently, cement-based adhesives have been developed recently as alternative adhesives.

In the NSM FRP strengthening system, the bond between FRP reinforcement and concrete is of critical importance to its performance. However, few studies have investigated the bond performance of the NSM FRP system using cement-based adhesives analytically. In this regard, this paper aims to present an analytical model for predicting the bond performance of this system, which is based on Artificial Neural Networks. The proposed model includes analytical relationships, as an innovation, that consider several important parameters that deserve more attention using collecting an extensive experimental database. The accuracy of the model is accessed using the predictions of experiments and international design codes as well as of proposed models for the NSM FRP system using epoxy adhesives.

Tida Moyo

Year: 2
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr Yifan Li

COPLANAR REVERSE-ELECTROWETTING FOR ENEGY HARVESTING AND FORCE AND VIBRATION SENSING

Abstract: In recent years, reverse-electrowetting on dielectric (REWOD) technology has gained appeal as a rapidly developing technique for energy harvesting.The method successfully uses liquid droplet dynamics to convert low-frequency excitations into usable electrical energy, which has been used to power wearable sensors that can operate independently. REWOD technology hasn't been widely employed for sensing, despite its success in energy harvesting.A "two-plate" REWOD design, where the top and bottom structures both contain conductive electrodes with bias, has been the subject of earlier research.This work suggests a different system architecture in which the device's bottom structure has electrodes for both sensing and biassing voltage.More material and design options for the top structure are made available by this method, potentially greatly expanding the range of sensing applications.Examples of applications for flexible/stretchable top structures include soft robotic motion sensing and tactile sensing.

Year 3 (+) Students

Armin Jamali

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr. Joao Mendes

STUDYING THE EFFECT CURING TIMES, SHRINKAGE REDUCING ADMIXTURE AND GROUND GRANULATED BLAST FURNACE SLAG ON THE CAPILLARY PRESSURE EVOLUTION OF CONCRETE

Abstract: Volume reduction of concrete at an early-age due to moisture loss, called shrinkage, has been known as the main cause of cracking and deterioration in planar concrete structures including pavements, bridge decks, and slabs on the grades. Determination of the capillary pressure value and its behavior, identified as the main contributor to shrinkage in concrete, provides a better understanding of the durability of concrete and effective factors in this regard. However, due to the low capacity of the existent sensors, less than 100 kPa, capillary pressure could just be recorded for a short period, around 5 hours after casting, leading to missing a significant part of capillary pressure evolution in concrete at an early age. In this study, the High-Capacity Tensiometers (HCTs), were used for the first time to record the capillary pressure in the concrete for a longer period and values up to 2000 kPa, 20 folds higher than the previous sensors. Through this novel technique, the effect of different parameters including curing times, shrinkage-reducing admixtures (SRA), and Ground Granulated Blast Furnace Slag (GGBS) on the capillary pressure evolution of concrete has been investigated, providing a depth insight to achieve more durable, and sustainable infrastructures with less carbon footprint.

Elilarasi Kanthasamy

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Keerthan Poologanathan

APPLICATION OF INNOVATIVE COLD-FORMED STEEL BUILT-UP SECTIONS IN THE MODULAR BUILDING APPLICATION

Abstract: Modular Building System (MBS) offers numerous benefits in terms of productivity, sustainability and safety. Therefore, MBS is considered as a viable option to sort out housing crisis in Britain as well as to drive Britain towards sustainable construction. Recent advancements in steel manufacturing including Cold-Formed Steel (CFS) has showed potential benefits in structural performance compared to concrete and timber. However, structural performance of built-up sections in modular constructions is still unknown. The aim of this project is to investigate the structural behaviour of innovative cold-formed steel section and back to back built-up sections made up of innovative sections with various screw arrangements. Finite element analysis will be performed to evaluate the structural performance of the innovative cold-formed steel built-up sections with different screw arrangements and then a conceptual design of the modular building will be developed using them. The outcome of utilizing novel built-up sections in MBS will address the modular construction needs in terms

of sustainable performance as well as structural performance. The finite element models will be developed and validated by comparing the results with experimental data, and subsequently will be used in parametric studies. By investigating the experimental data and parametric studies, structural performance of the innovative cold-formed steel built-up sections with different screw arrangements will be addressed and shortcomings of the current design rules and appropriate design rules within the framework of European and International Standards and the direct strength method (DSM) will be developed based on the FEA results.

Getachew Mamo

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Davide Motta

QUANTITATIVE METHODOLOGY FOR DOWNSTREAM IMPACT EVALUATION AND DAM OPERATION OPTIMIZATION: THE CASE OF THE TAMS HYDROPOWER PROJECT IN ETHIOPIA

Abstract: Abstract: Although undoubtedly providing benefits, hydropower dam projects may also cause negative hydrological, social, environmental and ecological impacts upon their downstream areas. Studies on this are often qualitative, which may give way to manipulation and bias; they also focus mainly on the hydrological impact (i.e. the modification of magnitude and duration of “natural” flooding due to the presence of the dam), neglecting for instance social impacts (e.g. on human activities in the communities downstream of dams such as fishing and recession based agriculture) and environmental impacts (e.g. on wetlands and their natural recharge). When quantitative approaches are adopted, they typically do not identify exhaustively where, for how long, and at what magnitude downstream impact occurs, which makes it difficult to devise feasible dam operation scenarios that may achieve a balance between maximisation of energy production and minimisation of downstream impact.

A spatially-based quantitative method is developed by integrating the results of a calibrated hydraulic model for flooding with mapping of impact, which allows quantification and insightful visualisation of various types of impact at different spatial and temporal scales. This also provides the basis for the comparison of different dam operation scenarios and for the possible development of optimised protocols. The proposed approach can facilitate the decision-making process regarding dam project feasibility.

Heshachanaa Rajanayagam

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: A/Prof Brabha Nagaratnam

DEVELOPMENT OF INNOVATIVE MODULAR BUILDING SYSTEM WITH ENHANCED FIRE, ENVIRONMENTAL, STRUCTURAL AND THERMAL PERFORMANCE (MOD-FEST)

Abstract: Modular Building System (MBS) is an emerging offsite construction technique, which uses prefabricated units, transported, and assembled onsite. In the MBS construction process, the designing stage is considered the most significant stage. One of the critical concerns in designing MBSs is to maintain and ensure the structural integrity of the assembly against critical loading conditions. Connections in the MBSs as a crucial part of the off-site construction, play a prominent role in providing the essential performance and integrity for the assembled MBS. Hence, it is indispensable to analyse the existing connections used in industry and to investigate the benefits and limitations of their application in MBS construction. A thorough study of connection types will evaluate their capabilities in addressing functional requirements and will exhibit their potential to serve as a benchmark for a range of future modular construction techniques. Thus, this study primariliy focuses on reviewing various forms of connection systems used in the contemporary construction industry. It covers the role of connections in the automation of assembly and disassembly of modular units; architectural, structural, and constructional challenges faced by the industry in using them; and their performance under different loading conditions. In addition to connections, this study further targets a combined approach to analyse the overall (Fire, Environmental, Structural and Thermal (FEST)) performance enhancement of MBSs to develop an innovative, sustainable MBS which can support overcoming the difficulties in the design and construction of MBSs. Finally, based on the review and analysis, suggestions to address modern construction obstacles by adding new information to the literature and then overcoming challenges in the wide adoption of the MBS in the construction industry are evaluated. The outcome of this research study will assist in overcoming the obstacles and encourages the potential growth of MBS and/or off-site construction techniques in the building construction industry.

Ian Brewis

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Shahid Rasul

DISCOVERY AND DESIGN OF TRI-METALLIC STRUCTURE ELECTROCATALYSIS FOR PROMPTING C-C BOND FORMATION IN THE ELECTROCHEMICAL REDUCTION OF CO2

Abstract: The lack of availability of efficient, selective, and stable electrocatalysts is a major hindrance to the scalability of CO2 reduction processes. Alloying Cu with Indium (In) and Tin (Sn) has been shown, from our pioneering work [1-3], to greatly improve selectivity of CO2 reduction through changes in morphology and electronic structure.

Herein, we report a pioneering study into the key role of tri-metallic electrocatalysts in improving the selectivity of the CO2 reduction reaction (CO2RR) toward multi-carbon compounds. Through tailored deposition of sub-surface platinum (Pt), it has been observed that the selectivity of previously cutting-edge bimetallic electrocatalysts such as Cu-In and Cu-Sn can be tuned to a specific product range, stabilising carbonaceous intermediates to promote the formation of C2+ hydrocarbons. Experimental results, supported by Density functional theory

(DFT) studies, demonstrate how the incorporation of small quantities of Pt can improve the adsorption strength of multi-carbon intermediates beyond that of Cu-In and Cu-Sn, overcoming key limitations in their instrumentation. Such changes are likely due to the strong binding energy of Pt, diluted to such a degree by neighbouring Cu and In so as to prevent over-binding of CO, preventing poisoning of active sites whilst opening an effective pathway to higher order reduction products. Through improved stabilisation of intermediates such as CO*, OCCOH* and CH3CHO, all shown to be key in proposed C3 pathways [4, 5], Cu-In-Pt and Cu-Sn-Pt electrocatalysts may even pose a core role in the formation of energy dense products such as n-propanol (C3H8O) and allyl alcohol (C3H6O) through the promotion of C-C bonds.

Islam Ali

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Ahmed Elmarakbi

GRAPHENE MEDIATED EROSION RESISTANT PROTECTION FOR WIND TURBINE BLADES

Abstract: Leading edge erosion is a serious issue for wind turbine blades. It decreases the performance and the annual energy production of wind turbines by more than 25%. It could be explained as the degradation and the fracture failure of wind turbine blades materials by the effect of raindroplet impingements, UV- radiation, and many other environmental particles and weathering effect. Rain erosion of leading edge through raindroplet impact with the surface of the coating layers or the substrate of the wind turbine blades is considered as the main detrimental factor for leading edge erosion of the blades. A turbine blade is simply explained as fiberglass, epoxy resin and hardener. Any erosion and degradation of the material on the blade's surface would lead to decreased performance, increased maintenance, and health risk. Barrier protective coating provide wind turbine blades with the required protection to minimise the leading-edge erosion. Graphene nanoplatelets is known for its incredible barrier performance which when added as a filler for polymer nanocomposites, will increase the pathways the water could take to infiltrate the coating system and reach the substrate, a prosperity called tortuosity that form a barrier for water. In addition, as epoxy resins are considered rigid and stiff, adding tougheners such as thermoplastics or polysulphides, would increase the flexibility and impact resistance, to decreasing the effect of leading-edge erosion. Hence, in this project, we aim to formulate a graphene-based nanocomposite to protect wind turbine blades from leading edge erosion.

Jeffri Ramli

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr Brabha Nagaratnam

EXPERIMENTAL INVESTIGATION OF FIBRE REINFORCED SELF-COMPACTING CONCRETE FOR PRECAST SLAB APPLICATIONS

Abstract: The concrete precast industry has often to cope with the difficulties concerning the production of structural elements having complex or atypical shapes. That is the case of flat concrete slabs, whose thin geometry involves difficulties in the placement of reinforcement, resulting in a large cost and time consumption during the construction process. In the recent years, fibre reinforced self-compacting (FRSCC) has been widely used in several applications in construction such as bridges, tunnels, industrial flooring, high-rise buildings, precast concrete and repair and retrofitting. FRSCC can result in cost savings and improved construction efficiency, as it eliminates the need for external vibration and reduces the amount of rework required. This PhD research consists of experimental investigation on the fresh and mechanical properties of self-compacting concrete incorporating different types of fibres, i.e. hooked end steel fibres, three-dimensional (3D) steel fibres and polypropylene fibres, at varying fibre contents. Furthermore, two series of experimental studies have been conducted to investigate the flexural behaviour of heavily and minimally reinforced precast concrete slabs incorporating SCC with steel and hybrid fibres at varying fibre volume fractions and comparing them to those with plain SCC.

Muhammad Ahmad

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Muhammad Wakil Shahzad

AN INNOVATIVE INDIRECT EVAPORATIVE COOLING SOLUTION FOR FUTURE SUSTAINABILITY

Abstract: Energy consumed by the air conditioners and their direct and indirect emissions is the major concerns due to economic development, improved lifestyles, and rising demand for thermal comfort. This is mainly because of the low efficiency of the existing chillers and utilization of chemical-based refrigerants having high global warming as well as ozone depletion potential. Even though indirect evaporative coolers (IEC) have emerged as an alternative solution because of their low energy demand and green refrigerant utilization but they were unable to commercialize at a large scale due to several challenges in design, operation, and maintenance. We have redesigned the IEC and introduced working air humidification outside the main system to make it a simple, most robust, and energy-efficient solution for large-scale applications. A prototype was designed, fabricated, and tested under assorted outdoor air conditions to map the full-scale performance and provide guidelines for commercial system design. The experimentation showed that the proposed system achieved over 20oC temperature drop at 48oC outdoor air and produced 130Watt cooling. The measured coefficient of performance was 32 (only for cooling), one of the highest values reported for IEC systems so far in the literature. We also demonstrated that advanced IEC has a stable operation at various outdoor air temperatures from 30-48 oC and maintained supply air temperature within ASHRAE-55 and ISO7730 comfortable zone.

Pakinam Eltouby

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]

Supervisor: Jibran Khaliq

SYNTHESIS AND CHARACTERISATION OF PIEZOELECTRIC COMPOSITES FOR SENSING AND ACTUATION APPLICATIONS

Abstract: This study aims to develop and optimise a comprehensive mathematical model for the molten salt synthesis technique, specifically for synthesising BNT ceramic powders as a case study. The developed mathematical models take into account the effect of various molten salt synthesis parameters and their combined interaction effect on the characteristics of the synthesised powder, such as size and shape. By considering the complex interactions between these parameters, the models can accurately predict the characteristics of the output powder, allowing for the optimisation of the synthesis process to produce powders with desired properties. The models have been validated and can be used to predict and control the size and shape of BNT-molten salt synthesised particles for specific applications. These results can serve as a basis to produce textured ceramics which find applications in electronic, aerospace and 5G. Furthermore, this study aims to utilise the optimally synthesised BNT ceramic powder to fabricate quasi 1-3 lead-free dielectric ceramic-polymer composites using a novel mechanical alignment technique. This technique offers ease of piezoelectric composite fabrication unlike other techniques such as dielectrophoresis, allowing the BNT ceramic powder to be aligned mechanically within the polymer matrix in a preferred directionality to enhance the composite's dielectric properties. The resulting composite exhibits enhanced dielectric properties compared to state-of-the-art materials.

Raja Muhamad Hafiz Raja Adzhar

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Prof Martin Birkett

THE EFFECT OF SURFACE TEXTURING ON THE MECHANICAL PROPERTIES OF ALUMINIUM-CARBON FIBRE REINFORCED PLASTICS (AL-CFRP) COMPOSITES JOINTS

Abstract: It is often desirable to join dissimilar materials, where a combination of light weight, stiffness and controlled deformation can be achieved in certain manufacturing practice like automotive, aerospace, structural, and many more. This research will focus on designing and manufacturing several Aluminium-Carbon Fibre Reinforced Plastic (Al-CFRP) joints with various surface designs and textures to investigate their effects on the mechanical properties. This data will be used to design a new surface condition that will improve the characteristics such as stress and strains.

Mechanical tests must be performed to clarify and describe the mechanical behaviour of the joint. These joints will be characterised to determine their mechanical properties and corresponding failure modes in Mode I and Mode II tests. Therefore, double cantilever beam (DCB) test will be used for mode I and lap shear test will be used for mode II.

As we go on through the tests, the strength of the Al-CFRP joint improved every time the surface interaction area was increased. The surface texturing improves the strength of the joint from 180% to 340% from the standard/control sample. Surface preparation such as etching,

crystallisation, pins, and the combination of the all-surface preparation have improved the joint strength either chemically or mechanically.

For now, the maximum percentage of strength increase was shown in the micro blasted with pins samples in the lap shear test with an increase of 340% (4.21552 MPa to 18.53136 MPa). Micro blasted surface improved the joint strength with its increased interactions between roughened aluminium and CFRP. The increased roughness improved its resistance to peel off effect hence increase the overall stress and strain.

Rana Faisal Shahzad

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr Shahid Rasul

MULTI-LAYERED SN AND HARD CARBON ARCHITECTURES FOR LONG-TERM STABILITY AND HIGH-CAPACITY LITHIUM-ION BATTERY ANODES

Abstract: Tin (Sn) is a promising candidate for lithium-ion batteries (LIBs) because of its high theoretical capacity, abundance, and low cost. However, Sn suffers from large volumetric expansion during charging and discharging, causing cracking and degradation. Thus, the development of new Sn-based interfaces and architectures is crucial that can accommodate the volume changes and improve cyclic performance. In this study, we present the development of a novel Sn and hard carbon (h-carbon) architectures for LIB anodes, focusing on improving their long-term stability and high capacity. The composite architectures are achieved through the nano Physical Deposition (nano-PVD) technique by depositing Sn and hard carbon on the copper substrate at room temperature and a high temperature (470 °C). Our results show that the Sn and h-carbon architectures exhibit long-term cycling stability (> 79% capacity retention after 50 cycles) and higher capacities reaching up to 1570 mAh g-1 at 2nd cycle after SEI formation. The resultant microstructures, especially at 400 °C, created a multi-layer interface with Cu-Sn and h-carbon. The newly developed, so-called soft (Cu-C-Sn) and hard interface (h-Carbon) provide a cushion against the volumetric expansion of Sn microstructures. These findings demonstrate the potential of Sn and hard carbon as promising anode materials for advancing the performance of LIBs.

Saeid Mehvari

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr. Yolanda Sanchez Vicente

ELECTRICAL PROPERTIES OF MICRO SILVER AND COPPER POLYURETHANE COMPOSITES (EXPERIMENTAL AND NUMERICAL STUDIES)

Abstract: Today, there is a growing demand for flexible, lightweight and inexpensive conductive materials in the electronic industry. Many studies have focused on conductive polymer composites because they are ideal materials for electronic applications such as wearable sensors, smart fabrics, flip-chips and switching devices. This research investigates the

electrical properties of silver- polyurethane (Ag-PU) and copper-polyurethane (Cu-PU) composite films with different degrees of agglomeration. Regarding that, various composite films were prepared by adding silver or copper particles into the thermoplastic PU matrix using a solution mixing method, followed by spin-coating or casting techniques. To achieve a uniform dispersion of filler into the polymer matrix, the filler solution was shear mixed in an ultrasonic bath then it was added to the PU solution. Different characterization techniques have been used to know a comprehensive understanding of fabricated composites such as SEM, DMA, optical microscopy. The electrical conductivity of composites were measured using an developed set-up equipped with multimeter. Simultaneously the electrical performance of the fabricated composites was numerically simulated using finite element method based on the representative volume element model (FE-RVE, MSC-Digimat software).

Sebastian Tamayo Vegas

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Khalid Lafdi

ADVANCED STRUCTURAL HEALTH MONITORING FOR POLYMER-BASED MATERIALS: FREE SPACE MEASUREMENTS WITH VNA AND NANOVNA, MICROSTRIP RESONATORS, AND PYTHON POST-PROCESSING OF S PARAMETERS AND RCS

Abstract: This presentation will discuss the design and development of a prototype for structural health monitoring (SHM) technology using free space measurements and microstrip resonators to monitor the health of polymer-based materials. The prototype was designed to be more compact than traditional monitoring solutions by using nanoVNA techniques. Python post-processing was employed to analyze S parameters and radar cross section (RCS) data collected from the prototype, resulting in increased efficiency and accuracy in data processing. The findings of this research will contribute to the advancement of SHM technology for polymer-based materials and have potential applications in aerospace, automotive, and other industries. This presentation will provide insights into the process of designing and developing a prototype for SHM technology and highlight the benefits of using Python post-processing for data analysis

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Shivdarshan Sherugar

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Dr. Matthew Blacklock

CHARACTERISATION AND STATISTICAL RE-GENERATION OF CONTINUOUS CARBON FIBRE PATHS IN ADDITIVE MANUFACTURING

Abstract: Additive manufacturing (AM) is one of the recent advances in manufacturing sector. With its capability to produce complex parts within shorter time, it is gaining a lot of popularity. Using such technique to manufacture Continous cabon fibre (CCF) reinforced composite offers several benefits but one major benefit is low cost optimised composite structure i.e., placement of CCF in required region only. However, to achieve this, a AM composite has to be accurately analysed by Finite Element Analysis (FEA) which is currently not possible due to limited

research in this context. Therefore, this study proposes a methodology that characterises the microstructure of the AM composite and regenerates the same for building an accurate virtual model for FEA.

Sifan MuhamadIbrahim

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Brabha Nagaratnam

DEVELOPMENT AND APPLICATIONS OF LIGHTWEIGHT HIGH STRENGTH CONCRETE

Abstract: The popularity of lightweight high strength concrete (LWHSC) is rising, as it provides better mechanical properties while being lighter to handle, therefore beneficial in terms of constructibility and economy. However, LWHSC possesses distinctive qualities to employ in actual practise than conventional concrete, and hitherto the applications of LWHSC are limited because of its sensitivity to its material constituents and lack of appropriate mix design guidelines. The overall aim of this project is to develop eco-friendly, flowable LWHSC by using locally available materials, and to evaluate the structural performance of LWHSC filled cold-formed steel beams. The findings of the study indicate that it is feasible to develop lightweight high strength concrete (LWHSC) by completely substituting normal weight aggregates with appropriate lightweight aggregates within ultra high performance concrete (UHPC). Moreover, the use of concrete inside cold-formed steel beams led to a significant improvement in their flexural and shear capacities, with enhancements of up to 55% and 8%, respectively. The resulting UHPC and LWHSC possess favourable properties that make them suitable for practical applications.

Sohrab Jafarpour

Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Hamed Farokhi

THEORETICAL STUDY OF ATHEROSCLEROSIS IN CORONARY ARTERIES

Abstract: In the current study, a nonlinear fluid-structure interaction (FSI) biomechanical model of atherosclerosis in the left anterior descending (LAD) coronary artery is developed to perform a detailed sensitivity analysis of the geometrical features of an atheroma plaque. In the development of the numerical model, first, a 3D geometry of the diseased artery is developed based on patient-specific dimensions obtained from the experimental studies. The geometry includes four influential geometric characteristics: stenosis ratio, plaque shoulder-length, fibrous cap thickness, and eccentricity intensity. Then, a suitable strain energy density function (SEDF) is proposed based on the detailed material stability analysis to accurately model the hyperelasticity of the arterial walls. The time-varying inlet velocity and outlet pressure profiles are adopted from experimental measurements to incorporate the pulsatile nature of the blood flow. In addition, a computationally efficient type of structural boundary condition is imposed on the arterial walls. Finally, a non-Newtonian viscosity model is implemented to model the shear-thinning behaviour of the blood flow. According to the results, the structural responses

in terms of the maximum principal stress (MPS) are affected more compared to the fluid responses in terms of wall shear stress (WSS) as the geometrical characteristics are varying. The extent of these changes is critical in the vulnerability assessment of an atheroma plaque.

Zhuofan Qin
Year: 3+
Department: Mechanical & Construction Engineering (MCE) [PGR Lead - Dr Craig Warren]
Supervisor: Ben Xu

ELASTIC INSTABILITIES OF MICROPATTERNED SURFACE

Abstract: By manually planting micropatterns on the surface of an elastic bilayer system or swelling induced multilayer mechanism, the surface topology of elastic instabilities is obviously influenced by the localization of stress with specific structure. The buckles occurred and are gradually transformed into crease and folds and observed in experiment. Furthermore, we utilized the Neo-Hookean hyperelastic model and finite element method to demonstrate the morphogenesis under uniaxial compression for elastic bilayer structure.

Eaby Kollonoor Babu

Year: 3+
Department: ReNU CDT - Newcastle University
Supervisor: Kamlesh Mistry

ARTIFICIAL INTELLIGENCE FOR EMOTION RECOGNITION

Abstract: Emotion recognition refers to the process of identifying the emotions of individuals, a task that can be challenging due to the varying accuracy with which people recognize the feelings of others. With the advent of machine learning and artificial intelligence, however, there has been a recent surge of interest in using these technologies to improve emotion recognition.

While the recognition of emotions has been a topic of research since ancient times, contemporary methods include the identification of facial expressions in videos, the analysis of speeches in audio content, and the examination of social media content. Additionally, physiological signal measures, such as EEG, ECG, body temperature, and AI techniques, are emerging as viable methods for recognizing emotions.

The applications of emotion recognition are numerous and varied, with industries such as retail, education, healthcare, and security all using it in different ways. For instance, marketing and advertising firms can analyze customers' emotions to assess their reactions to ads, designs, and products. In education, emotion recognition can measure students' responses and engagement levels, allowing for personalized content development. Security experts can use real-time emotion recognition to identify individuals exhibiting suspicious behavior in crowds.

In general my talk today aims to highlight recent advancements in emotion recognition techniques across a range of fields, including artificial intelligence, machine learning, and medical science, for the benefit of the broader scientific community.
