School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:

- Director of Study: Dr Faheem Ahmed Malik (Email: f.malik@napier.ac.uk)
- 2ND SUPERVISOR: tbc

Subject Group: Built Environment

Research Areas: Engineering

Project Title: Developing a hybrid twin cycling safety interaction model in a naturalistic environment

Project description:

Presently there is a need to improve cycling safety, as this will make it a more attractive mode of travel. For this it is paramount to develop an in-depth understanding of interactions between cyclists, motor vehicles, pedestrians, and road infrastructure. Understanding these interactions in a naturalistic environment—where behaviour is observed in real-life, uncontrolled conditions—is crucial for developing effective safety interventions. This will help better understand cyclists behaviour, design the infrastructure, and perform real time mode choice modelling based upon safety criterions. Such work has extra impetus, as we move to a semi-autonomous, and autonomous transportation infrastructure. As we move towards automation, cyclists maybe the only transport mode associated with human vulnerabilities. This research proposal aims to develop a comprehensive interaction model (hybrid twin) for cyclist safety by studying real-world behaviours and interactions in a naturalistic setting. This research will aim to bridge this gap by integrating naturalistic data

with advanced modelling techniques. The primary objectives of this research are:

1. To identify key interaction patterns between cyclists, motor vehicles, pedestrians, and road infrastructure in naturalistic environments (Pervasive control, Time to Conflict, Post encroachment time)
2. Develop a Hybrid twin model, that can predict the interaction between cyclist and a) Infrastructure, and b) Other Road users in real time
3. Construct a base file (Abacus of possible solutions) recommendations for urban planners, engineers, and policymakers to enhance cyclist safety based on model outcomes.
   Methodology : a) Review of Literature, b) Data Collection: Instrumented bicycles equipped with GPS, cameras, and sensors to capture real-time interactions; Surveys and Interviews; Road Congestion Data, Traffic patterns, Weather, and infrastructure data, c) Development of a hybrid twin: Interaction Analysis, Model Development: Machine learning algorithms/ toolkits, Model order reduction toolkits. The model will be trained on the naturalistic data and validated and tested accordingly, and Simulation Analysis.
   Expected Outcomes: a) Cyclist Naturalistic Hybrid Twin model, b) Safety Recommendations, c) Enhanced Safety Protocols

   This research will contribute to the body of knowledge on cyclist safety by providing a detailed understanding of real-world interactions in naturalistic settings. The final hybrid twin will be a valuable tool for cyclists infrastructure design, modelling and developing interaction codes for autonomous vehicles / infrastructure. Such work is essential to achieve sustainability in transportation and is in line with UN SDG's, global climate emergency, and regional as well as national targets. Scotland aims to reduce 20% car travel by 2030.

References:

1. Kovaceva, J., Bärgman, J. and Dozza, M., 2022. On the importance of driver models for the development and assessment of active safety: A new collision warning system to make overtaking cyclists safer. Accident Analysis & Prevention, 165, p.106513.
2. Malik, F.A., Dala, L. and Busawon, K., 2021. Intelligent nanoscopic cyclist crash modelling for variable environmental conditions. IEEE transactions on intelligent transportation systems, 23(8), pp.11178-11189.

Candidate characteristics

Education:

A first degree (a minimum 2:1) in Transportation, Mathematical Modelling, Geography

Subject knowledge:

Transportation Modelling, Mathematical Modelling, AI-based modelling

Essential attributes:

- Good aptitude
- Willingness to learn and apply mathematical/ data driven knowledge in transportation