



Waqar S. QURESHI

Technology Centre:	CeADAR
Academic Mentor	Dympna O' Sullivan
Company Partner:	PMS
Company Mentor:	David Power

Dr. Waqar S. Qureshi is an electrical engineer by training with over 17 years of experience in research and development in industry and academia. He has a strong passion for automated image analysis and artificial intelligence techniques in signal processing with a focus on solving real-world societal problems. After his graduation from UET Lahore Pakistan he worked at National Engineering and Scientific Commission Pakistan as an electronic testing engineer. He completed his master's in computer engineering in 2007 from UET Taxila Pakistan with a major in digital design and signal processing. During his doctoral studies, he has won several awards including a NUST Faculty Development Fellowship, a Visiting Researcher Scholarship to Japan, a travel grants to present his research at a conference in Portugal in 2014 and later in Italy in 2015 and best poster award in 2014 at Asian Institute of Technology Research Exhibition. He received the Doctor of Engineering degree in Mechatronics at the Asian Institute of Technology Thailand in 2015. After his PhD he joined XYZPrinting Inc. Thailand, where he developed commercially viable products that led to US, Chinese and EU patent. Since 2007, he has taught many undergraduate and graduate courses related to computer programming, digital logic design, electronics, robotics, signal, and image processing at Air University Islamabad, Asian Institute of Technology Thailand, and National University of Sciences and Technology (NUST) Pakistan. In 2016, he returned to academia to fulfil his obligation to work at NUST, Islamabad Pakistan for five years. At NUST, he focussed on applied research in image processing and machine learning for precision agriculture and consumer products. As part of his administrative duties, he was appointed as departmental research head (2016-2021) and a core team member that organized IEEE international conferences (ICRAI 2016, 2019, and 2021), national workshops, national annual robotic competitions (2016-2019), and outcome-based education accreditation for mechatronics engineering program 2019. During his tenure at NUST he supervised eight master students and co-supervised one PhD student. He has a strong publication record (14 international journal articles and 12 conference papers) and has secured four research grants (excluding Career-FIT plus) and many development projects (approx. 284 thousand USD), all of which are successfully completed. These projects enabled collaboration with diverse researchers in Thailand, Australia, Russia, Czechia, France, Japan, Taiwan, Saudi Arabia, and China. His strong interpersonal skills allow him to interact with a wide range of stakeholders, to build effective relationships and manage project partners. He is a co-director of a robotics technology start-up that provides agricultural drones and services in Pakistan.

Dr. Dympna O' Sullivan

Is a senior lecturer in the School of Computer Science at Technological University Dublin. She is currently PI of two large research projects – an SFI Frontiers for the Future Project on Smart Dementia Care in the Community and an EU Erasmus+ grant, Ethics4EU that aims to create educational curriculum and materials for the teaching of Digital Ethics. She is a member of the SFI-funded ADAPT research centre. Her research focus is smart systems, and applied machine learning which has a direct overlap with Waqar's work on automated pavement condition assessment. Dr. O'Sullivan is co-supervising on PhD funded schemes with UCD, TCD, DCU and DkIT.

David Power

Is the Chief Technology Officer (CTO) at PMS. David holds a B.E. in Civil Engineering and an MSc in Computer Science from NUI Galway. He leads PMS' technology function and team and is a key influencer in the direction and future vision of the company. As part of this role, he manages and mentors the business and software development staff who are working on their initiatives in this domain. He also leads PMS software development activities. David is currently coordinating ongoing research projects that PMS have underway with Maynooth University/LERO and TU Dublin. He is also leading a significant inhouse R&D team that are working with our US JV partner to update and improve the data acquisition, processing and storage capabilities for our US data collection and processing activities.

CeDAR

The CeADAR team at TU Dublin have been onsite for 8 years and are now in Phase II of their operation. The CeADAR group provides the ideal hosting arrangement for collaborative industry work. They are already hosting Marie Curie research fellows, their core "business" is collaborative research with industry, and they have full support of technology transfer processes. They provide an in-built dissemination and knowledge exchange environment.

PMS

PMS specializes in testing, evaluation and management of roads, airports, and ports. Most of PMS's work to date has been carried out in Ireland, however PMS has also carried out international projects in the UK, Europe, and the US. Annually PMS would survey over 10000 km of Irish roads and have years of previous data stored and analysed on our server and in cloud services. PMS is a member of the RIMES Research Consortium, funded under the EU Commission, to develop European standards for pavement and bridge maintenance management systems. PMS is one of the founder members of the UK & Ireland FWD User's Group, UK Sideways-Force Skid Resistance Consultation Group and has membership of the UK County Surveyor's Society and Surface Characteristics group. PMS is a member of the UKPMS Forum. The company employs state-of-the-art equipment and currently has an inventory of over 80 Terabytes of pavement imagery. PMS has a long history of R&D engagement with third level institutions and understands that complex problems require collaboration between commercial and academic institutions. Dr. Kieran Feighan, founder and Managing Director of PMS holds master's and PhD degrees from Purdue University in the US and all other key management personnel hold master's degrees. Kieran is recognized through his work, professional activities, and publications as a leading international expert in pavement management. He has published over forty papers and is a former president of Engineer's Ireland. PMS has been collaborating with Maynooth University for over 12 years focused on developing innovative route corridor surveying technologies. These research partnerships have been funded in the main by SFI through the Industry Fellowship programme and joint-funded through the STRATAG research cluster where PMS were the lead industrial partner. One benefit of this Industry-University research partnership has been that PMS is developing its own Irish designed AI cloud platform to automatically process tens of thousands of images. This is being developed through a LERO-led SFI-funded spoke on driverless autonomous vehicles. PMS is also actively working with TU Dublin via the ML-Labs SFI program with Dr Dympna O'Sullivan and Dr Susan McKeever.

Host Institution

Technological University Dublin is the largest producer of computer science graduates in Ireland. The School of Computer Science in Technological University Dublin hosts its own research Centre for excellence in machine learning: Applied Intelligence Research Centre (AIRC). There over 60 PhD students and 8 postdocs working at AIRC and the School's research capacity is growing rapidly with their involvement in three fully funded PhD schemes under the SFI Centres for Research Training.

Waqar's project

Automated road pavement condition assessment – a deep Learning approach

This project aims to deliver quicker and more accurate results using image processing and machine learning techniques. We intend to apply the different decision-based rules and deep learning techniques to the captured images to develop an artificial intelligence-based system that can rate pavement surfaces based on the type of distress on the surface. The results could potentially cut costs and reduce the time it takes to identify and repair road damage that could cause an accident if left unattended. The system will be developed and tested on a range of image data and be deployed on Irish and US roads.

A survey carried out by the Automobile Association in Ireland in 2020 revealed that more than 60% of respondents had experienced damage to their cars, motorbikes, or bicycles as a result of striking a pothole. This is an inconvenience and potentially costly impact of not repairing roads in a timely manner. The costs involved in maintaining pavements are significant – both to road users and to the State - in 2019, Transport Infrastructure Ireland had a budget of €36 million for road repairs with an additional €100 million for pavement improvements on national roads in Ireland. However, the need to identify problems and repair roads as quickly as possible is also critical to maintaining overall road safety.

Currently, specially adapted vehicles with cameras and video infrastructure are used to survey roads and feed information back to experts who in turn evaluate the extent of damage by manually examining the images and ranking them using an international scale.