BRITISH COUNCIL | Newton Fund | Middlesex University London | University of Transport and Communications

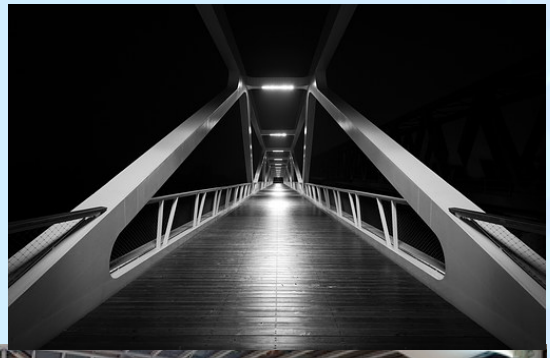
London Digital Twin Research Centre

Middlesex University

Workshop on Digital Twins for Global Digital Transformation

09th March 2020




UKIERI UK-India Education and Research Initiative | Department of Science & Technology, Government of India | Middlesex University London | Indian Institute of Information Technology SRICITY

London Digital Twin Research Centre

The London Digital Twin Research Centre (LDTRC)[1], based in Middlesex University London, focuses on the development of state-of-the-art technology in digital realization of the physical world. The developments in this centre focus on the digital transformation of physical environments, whether it is industry, infrastructure, healthcare or transportation using concepts and technologies from the notion of a "digital twin". The current work in the LDTRC focuses on three core aspects: Industry 4.0 (I4.0), Structure Health Monitoring (SHM) and Enterprise management.

Supported by the Newton Fund under the Institutional Link programme (managed by the British Council)[2], LDTRC is conducting research using DT technology to support early detection of infrastructure damage with University of Transport and Communications in Hanoi (Vietnam). The project[3] focuses on development of Digital Twins for SHM and prediction systems to enable continuous monitoring of bridges and other vital infrastructures. It also aims to develop translational techniques to implement the technology for various infrastructure elements.

A second project[4] funded by the UK India Education and Research Initiative (UKIERI)[5] is fostering research in Digital Twin modelling for automation, monitoring and maintenance in Industry 4.0 smart factory concepts and is in collaboration with the Indian Institute of Information Technology, Sricity (India). The aim of this work is to develop more sophisticated tools to enable high productivity, lower running costs, product quality improvement, minimized maintenance and shutdown to keep up with rapid advancements in manufacturing technologies and industry transformation in the 4th Industrial Revolution.

In collaboration with TCS Research Labs, India and Aston University, UK, a third project is researching the development of agent-based modelling languages and environments as the basis of foundational DT technology.

The Centre also oversees research collaborations in a multi-disciplinary context and is participating in knowledge transfer of DT research capability through the Connected Curriculum[6] project in partnership with Siemens. There are on-going activities in Building Information Modelling (BIM) that is another

[1] https://www.dt.mdx.ac.uk/
[2] https://www.newtonfund.ac.uk/
[3] http://5g-iot.mdx.ac.uk/?page_id=567
[4] http://5g-iot.mdx.ac.uk/?page_id=574
[5] http://www.ukieri.org/
[6] https://new.siemens.com/uk/en/company/education/connected-curriculum.html

research element of the Centre. The LDTRC will also provide a focal point for PhD/MPhil students and final year students conducting their projects, facilitated by our facilities and members of staff.

Workshop Agenda

Venue: Middlesex University, Town Hall Building, Committee Room 2

8:30	**Registration**
09:00 – 09:15	**Welcome and Introduction (Prof Sean Wellington, Reps from British Council and UKIERI)**
09:15 – 09:40	**Digital Twin projects and Opening LDTRC** Prof Mehmet Karamanoglu, Prof Huan Nguyen, Dr Ramona Trestian, Middlesex University
09:40 – 10:20	**Digital Twins in Industry 4.0** Dr Hrishikesh Venkataraman, Dr. Raja Vara Prasad, IIIT, Sricity, India
10:20 – 11:00	**Coffee Break (Networking/Informal discussion)**
11:00 – 11:30	**Translating the Digital Twin into the Clinic** Prof. Steven Niederer, Kings College London, UK
11:30 – 12:00	**Structural Digital Twins** Prof. Guido De Roeck, KU Leuven and Dr Thanh Bui, UTC, Vietnam
12:00 – 12:30	**The 5G Network Digital Twin** Stephen Douglas, Head of 5G Strategy, Spirent Communications
12:30 – 13:30	**Lunch and Poster Presentation**
13:30 – 14:00	**Digital Twin for Structural Health Monitoring and Control** Dr Andrew Parry & Dr Viet Tung Nguyen, Schlumberger, Paris, France
14:00 – 14:30	**Digital Twins in the Heavy Assets Industry** Dr. Veronica Martinez, Digital Built Britain, University of Cambridge (UK)
14:30 – 15:00	**Agent based Modelling Technologies for Realising Digital Twins** Prof Balbir Barn, Middlesex University, and Prof Tony Clark, Aston University
15:00 – 15:15	**Coffee Break (Networking/Informal discussion)**
15:15 – 15:45	**Digital Twin and Connected Curriculum Project** Prof Mehmet Karamanoglu and a Speaker (TBC) from Siemens/Festo
15:45 – 16:30	**Plenary Discussion: Digital Twin and Its Potentials** All speakers
16:30 – 17:00	**Networking/ Funding Opportunities / Closing & Remarks**

- Event hashtag: #MdxDT2020
- How to get to the venue: https://www.mdx.ac.uk/get-in-touch/directions-london
- **How to register for the event (free)**: https://www.eventbrite.com/e/workshop-on-digital-twin-in-london-tickets-95580292227

Speakers' Biographies

Dr. Andrew Parry (Schlumberger, France) received his PhD in Fluid Mechanics from Liverpool John Moore's University. He is a Chartered Engineer (UK) and a Fellow of the Institution of Mechanical Engineers. He joined Schlumberger in 1989 as development engineer in Stretford, Manchester; He is currently Technical Advisor at Schlumberger Riboud Product Center (SRPC), Clamart, France.

Prof. Balbir Barn (Middlesex University, UK) is Professor of Software Engineering in the Computer Science Department at Middlesex University. Balbir has extensive commercial research experience working in research centres at Texas Instruments and JP Morgan Chase as well as leading on academic funded research (Over £2.5 million). Balbir's research is focused on model driven software engineering where the goal is to use models as abstractions and execution environments to support complex decision making. In collaboration with TCS research labs, Balbir is working on model driven approaches for supporting Manufacturing 4.0 contexts through the design and implementation of a simulation environment for Digital Twins that accommodates value sensitive design principles. Balbir has published over 120 peer-reviewed papers in leading international conferences and journals and is currently editing a book on the "Digital Enterprise" with IGI-Global.

Prof. Guido de Roeck (KU Leuven, Belgium) is Professor emeritus of the University of Leuven (KU Leuven), past head of the Structural Mechanics Section and author of more than 500 scientific journal and conference papers. He is a world-famous expert in vibration based damage detection, dynamic system identification and soil structure interaction and vehicle bridge interaction. More specifically, the research of Structural Mechanics Section is notorious for the pioneering work in operational modal analysis, combined deterministic-stochastic subspace identification, fully automated (operational) modal analysis, derivation of uncertainty bounds on modal parameters from stochastic subspace identification, damage assessment by model updating. The Section is also very much engaged in extensive experimental work on buildings and bridges to apply and validate the developed algorithms. In one of the recent projects sub-microstrain FBG data have proven to identify very accurate modal strains which will allow the detection of small local damage. Professor Guido De Roeck was coordinator of EC Brite Euram project "System Identification to Monitor Civil Engineering Structures (SIMCES)", participated to the European projects RFCS "Fatigue damage control and assessment for road and railways bridges (FADLESS)" (2009-2012) and RFCS "DEsign for opTimal life cycle costs (LCC) of high-speed rAILway bridges by enhanced monitoring systems (DETAILS)", and was lecturer in the Marie Curie course SICON TC3 on "Experimental dynamics model identification and damage detection" (2008) and the CISM course on "New trends in vibration based structural health monitoring" (2008). The Structural Mechanics Section is frequently cooperating with (inter)national industrial partners on short and long term research projects. The Section has been and is a key partner in the following EC funded projects and networks: SIMCES (Brite-Euram), ENOVNET, SINOPSYS, EFCT, CONVURT (FP5-Growth), IMAC (FP5-Growth), CONVIB (ESF Scientific Programme), DETAILS (EC RFCS– STEEL), SAMCO, SH3M (ESFEurocores), NERA (FP7).

Dr. Hrishikesh Venkataraman (Indian Institute of Information Technology Cri City, India) did his MTech from IIT Kanpur, from 2002-04 and his MTech thesis from Vodafone Chair for Mobile Communications, TU Dresden, Germany in 2003-04.Subsequently, he did his PhD from Jacobs University Bremen, Germany where he was awarded the best Graduate Student in September 2007. Dr. Venkataraman's area of interest is in wireless communication, connected cars and device-to-device communication. Dr. Venkataraman has more than 13 years of industry and research experience, having worked with Irish national centre–RINCE (Research Institute for Networks and Communication Engineering), CTO Office of Tech Mahindra and Microverse Automation Pvt. Ltd. Dr. Venkataraman is currently an Associate Professor and Faculty-in-Charge for R&D activities at Indian Institute of Information Technology (IIIT) Sri City, AP, India. He has 3 PhD students and several research Honours students working under him. Dr. Venkataraman has more than 60 publications in different international conferences and journals, including in ACM, Elsevier, IEEE, IET and Springer. He has edited 3 books, has one granted US patent, one contribution in European Telecom Standards Institute (ETSI) and has been an Editor of European Transactions of Telecommunications (ETT) for 5 years.

Prof. Huan Nguyen (Middlesex University, UK) is a Professor of Digital Communication Engineering in Design Engineering and Mathematics department. He leads research activities in 5G systems, machine-type communication and machine learning within his department. He has been managing many council/industry funded projects, including the four current/recent relevant research grants on: i) Digital twin modelling for automation, maintenance and monitoring in Industry 4.0 Smart Factory (PI, £200k, UKIERI) which focuses on developing a digital twin model for Festo cyber physical system for the purpose of predictive maintenance and monitoring in manufacturing assembly; ii) Digital twin model for structural health monitoring of lifeline infrastructures (PI, £210k, Newton Fund) which aims to conduct various structural measurements that facilitate the development of a digital twin model in order to implement damage assessment/prediction for structural health monitoring (SHM) of important infrastructures (bridges, ports, roads and/or dams); iii) disaster management & safety warning system (PI, £150k, Newton Fund) where machine learning and latest 5G mobile technologies are employed to facilitate a smart location database to assist recovery in the events of (human/natural) disasters such as disease epidemic, flood, and earthquakes with case study being in Turkey; and iii) public safety and monitoring for transportation (PI, £33k, Newton Fund) with case study/beneficiaries from Vietnam. Prof. Nguyen has published more than 100 peer-reviewed research papers, mainly in the IEEE journals and conferences. He currently serves as an Editor for the KSII Transactions on Internet and Information Systems.

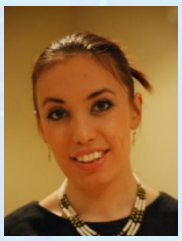
Stephen Douglas (Head of 5G Strategy, Spirent Communications, UK)

Stephen works for Spirent's strategy organization helping to define technical direction, new innovative solutions and market leading disruptive technologies. Currently Stephen leads Spirent's strategic initiatives for 5G and IoT. With over 20 years' experience in telecommunications, Stephen has been at the cutting edge of next generation technologies and has worked across the industry with service providers, start-ups and network equipment manufacturers, helping them drive innovation and transformation. Stephen is an ardent believer in connected technology and strives to challenge, blur and break down the silos which prevent innovation and business success. Follow Stephen: LinkedIn, Twitter, Blog. Spirent Communications offers innovative test, measurement, analytics and assurance solutions for next-generation devices and networks worldwide. The company provides products, services and information for high-speed Ethernet, positioning and mobile network infrastructure markets, with expanding focus on service assurance, cybersecurity and 5G. Spirent is accelerating the

transition of connected devices, network equipment and applications from development labs to the operational network, as it continues to innovate toward fully-automated testing and autonomous service assurance solutions. Spirent is a global business serving customers around the world. For more information visit www.spirent.com

Prof. Mehmet Karamanoglu (Middlesex University, UK) is currently serving as the Head of Department of Design Engineering and Mathematics in the Faculty of Science and Technology at Middlesex University and Professor of Design Engineering. He is a member of several professional bodies and societies, including a Fellowship at Institution of Mechanical Engineers and the Royal Society of Arts. He has spent significant length of time working in collaboration with industry in a variety of sectors and has managed numerous Knowledge Transfer Partnership projects in the field of Manufacturing Engineering and Automation. His research interest includes engineering education, interplay between art, design and engineering, advanced manufacturing including optimisation, mechatronics and robotics. His recent work included mass customisation, developing autonomous systems and he is currently working on mathematical optimisation techniques and cognitive manufacturing. In his wider area of work, he is the UK national expert for Mechatronics and Automation competitions for WorldSkills UK.

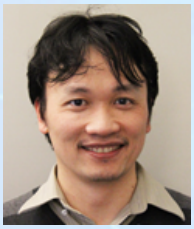
Dr. Raja Vara Prasad (Indian Institute of Information Technology Cri City, India) obtained his Ph.D. degree from Indian Institute of Technology Hyderabad in the year 2016 under the supervision of Dr.P. Rajalakshmi. He is currently working as an Assistant Professor with Indian Institute of Information Technology, Sri City. His research areas are centered on Wireless Sensor Networks, Wireless Sensor and Actuator Networks, Smart Buildings, Net Zero Energy Buildings, Wireless Protocols for IoT applications, Smart Cities automated wireless sensor networks, Green networks, and Internet of Things.



Dr. Ramona Trestian (Middlesex University) is a Senior Lecturer with the Design Engineering and Mathematics Dept., Middlesex Univ., London, UK. She received her Ph.D. degree from Dublin City Univ., Ireland in 2012. She was with Dublin City University as an IBM/IRCSET Exascale Postdoctoral Researcher. She published in prestigious international conferences and journals and has five edited books. Her research interests include mobile and wireless communications, user perceived quality of experience, multimedia streaming, handover and network selection strategies. She has active collaborations with India, Turkey, Ireland and within UK in the area of machine learning and wireless communications. She is Co-PI on UKIERI-DST project on Digital Twin Modelling for Automation, Maintenance and Monitoring in Industry 4.0 Smart Factory (£161K).

Dr. Thanh Bui (UTC, Vietnam) is Vice Dean of the Faculty of Civil Engineering, the University of Transport and Communications, Vietnam. He received the Ph.D. degree from the University of New South Wales, Australia, in 2007, then worked as a post-doctoral fellow at Universite´ de Liege and KU Leuven, Belgium. His research interests include structural health monitoring, digital twin, intelli- gent transportation, machine learning and structural damage diagnosis of bridge.

Dr. Veronica Martinez (Digital Built Britain, University of Cambridge, UK) works in the Cambridge Service Alliance at University of Cambridge. She leads the 'Making and Sustaining the Shift to Services' project with close collaboration with CAT, IBM, BAE Systems, GEA, Zoetis, Pearson, Rolls-Royce and Thales. Veronica is a visiting professor at Karlsruhe Institute of Technology, Germany. Prior to joining Cambridge she worked at the Cranfield and Strathclyde Universities in the UK. Her major research expertise revolves around the fields of Servitization, Digital and Smart Service Business Models, Strategic Value Creation and Performance Measurement and Management Systems. Veronica has led and participated in large European and UK research projects in Integrated Products and Services. Veronica is a member of the Economic and Social Research Council in the UK, a member of the Portuguese Foundation for Science and Technology Research Council, a member of the Italian Ministry of Education, University and Research Council. Veronica is a member of the Higher Education Academy in the UK and a board member of the European Operations Management Association EUROMA. Veronica's current research projects are summarized as: 1) The disruption of Digital Twins in service business models, 2) Digital service business models, 3) Blockchains underpinning economic business models, 4) Digital healthcare wearable services and 5) The transition of services.



Dr. Viet Tung Nguyen (Schlumberger, France) received his PhD in Materials & Structure from the Ecole des Ponts ParisTech (ENPC). He has a master's degree is in Computational Mechanics from University of Liege. He joined Schlumberger in 2010 after 6 years working in the aerospace and automotive industries. He is currently Senior Engineer, Modeling & Simulation Team Leader at Schlumberger Riboud Product Center (SRPC), Clamart, France.

Prof. Steven Niederer (Kings' College London, UK) completed his undergraduate degree in Engineering Science at the University of Auckland and received his DPhil in computer science from the University of Oxford in 2008. Prof Niederer was a UK Engineering and Physical Sciences Research Council (EPSRC) Life Sciences Interface Early Career Fellow at Oxford prior to moving to Kings' College London where he is currently a Professor of Biomedical Engineering in the Division of Imaging Sciences and Biomedical Engineering. Prof Niederer's research aims to combine experimental and clinical data with biophysical computational models to better understand cardiac physiology and pathology to better inform patient selection, treatment and therapy optimisation. This work focuses on understanding the cellular and tissue scale physiology that underpin the short and long term response to pacemakers in patients, developing detailed biophysical models of the rat and mouse heart linking subcellular physiology to whole organ function, developing simulations of atria electrophysiology and mechanics to investigate atrial fibrillation and using models of cardiac myocytes to investigate cardiotoxicity. His group are currently supported by funding from a European Research Council, British Heart Foundation, the EPSRC, MRC and the NIHR. They work closely with cardiologist and industry to apply cardiac digital twins in the development of therapies and in the treatment of patients. The combination of engineering, clinical and industrial research drives the translational focus of the group.