Positioning Solutions for Cooperative Intelligent Transportation Systems

Session 1: 10:30 – 12:00

Chair: Guenther Retscher

Mark Hedley and Shenghong Li, CSIRO, Australia:
Cooperative Localisation – Challenges and Opportunities

Mark Hedley received a PhD degree from the University of Sydney, working in the field of medical imaging. After graduation he remained a member of the academic staff for several years, and was part of a start-up company, Dilithium Networks, developing video coding solutions for the commercial market. He then joined CSIRO, where he has led projects in video coding, acoustic imaging, wireless communications and tracking, and he currently leads a wireless research group based in in Marsfield, Sydney. Mark is the recipient of multiple awards, including four engineering excellence awards from Engineers Australia, and a national award from the Australian Innovation Challenge. He is also the author of eight patents, over one hundred international publications, and numerous reports for commercial clients.

Shenghong Li received the B.S. degree in communication engineering from Nanjing University, Nanjing, Jiangsu, China, in 2008, and the Ph.D. degree in electronic and computer engineering from Hong Kong University of Science and Technology (HKUST), Hong Kong, in 2013, respectively. He is currently with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia. His research interests include indoor positioning system, cooperative localization, sensor fusion, and SLAM.

Local positioning systems (LPS) for GNSS denied or degraded environments are often challenged by the requirements for installed infrastructure sufficient to achieve the accuracy and availability required for the application. A solution to this problem is to use cooperative localisation, whereby the mobile and fixed devices form a mesh network, which is represented as a graph that is to be embedded in a two or three dimensional space to track device locations. This approach is particularly valuable where dense network connections are formed, which can occur in applications such as cooperative intelligent transportation systems (C-ITS), retail, and industrial safety. This talk will address some of the challenges faced implementing practical cooperating localisation systems, and progress that we have made in these areas.

Lilian S. C. Pun-Cheng and Charles M. S. Wong, Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Hong Kong, Hong Kong SAR, China:
Positioning for Public Transportation Enquiry Service and Classroom Management

Dr. Lilian Pun is Associate Professor and Associate Head in the Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University. She obtained the BA degree from the University of Hong Kong (1984), MPhil from the Chinese University of Hong Kong (1994) and PhD from the University of Newcastle upon Tyne, U.K. (1999). She has also been Fellow of British Cartographic Society and executive member of the Hong Kong GIS Association. Her teachings, research and consultancy interests and publications are in the areas of Cartography, GIS data modeling and application, especially in GIS-T and spatial data standards. Currently, she is engaged in collaborating with the Transport Department of the HKSAR Government in the development of a mobile and internet-based public transport enquiry service.

Location Based Technology has been increasingly deployed to civilian uses in recent decades. This paper presents the application and possible issues of an outdoor and an indoor service. The
HKeTransport is a multi-modal public transport query system, computing optimal routes upon a user-selected pair of origin-destination. The mobile positioning of the user’s origin is also taken into account, and its accuracy may alter the solutions significantly in a dense network of streets and public transport stops. On the other hand, an indoor location based service called iClassPolyU is developed for classroom teaching and management. It enables attendance recording, dynamic information sharing, “hands up”, forum, e-activities, as well as recording students’ preferences via iBeacon iLBS with students’ locations up to 2-3 metres accuracy.

Hakim Ghazzai, Hamid Menouar and Abdullah Kadri, Qatar Mobility Innovation Center, Doha, Qatar:
On the Placement of UAV Docking Stations for Future Intelligent Transportation Systems

Hakim Ghazzai (S’12, M’15) was born in Tunisia. He is currently working as a research scientist at Qatar Mobility Innovations Center (QMIC), Doha, Qatar. He received his Ph.D degree in Electrical Engineering from King Abdullah University of Science and Technology (KAUST), Saudi Arabia in 2015. He received his Diplome d’Ingenieur and Master of Science degree in telecommunication engineering with highest distinction from the Ecole Superiere des Communications de Tunis (SUP’COM), Tunisia, in 2010 and 2011, respectively. He is a recipient of appreciation for an exemplary reviewer for IEEE Wireless Communications Letters (WCL) in 2016. His general research interests include mobile and wireless networks, green communications, internet of things, and UAV-based communications.

Hamid Menouar (SM’16) received the Engineer degree in Computer Science from the University of Sciences and Technology Houari Boumediene, Algiers, Algeria, in 2003, the DEA (MS) degree in Systems and Information Technologies from the University of Technology of Compiègne, Compiègne, France, in 2004, and the Ph.D. degree in Computer Science from Télécom ParisTech, called at that time Ecole Nationale Supérieure des Télécommunications, Paris, France, in 2008. From 2005 to 2010 he worked at Hitachi Europe in France as a researcher then as lead of the Cooperative Systems team. In late 2010 he moved to Qatar and joined Qatar Mobility Innovations Center (QMIC) R&D Expert and product manager, leading different initiatives in the areas of Connected & Automated Vehicles, Intelligent Transport Systems, Internet of Things, Smart Mobility, etc.

Abdullah Kadri (SM’16) received the M.E.Sc. and Ph.D. degrees in electrical engineering from the University of Western Ontario (UWO), London, ON, Canada, in 2005 and 2009, respectively. Between 2009 and 2012, he worked as a Research Scientist at Qatar Mobility Innovations Center (QMIC), Qatar University. In 2013, he became a Senior R&D Expert and the Technology Lead at QMIC focusing on R&D activities related to intelligent sensing and monitoring using mobility sensing. His research interests include wireless communications, wireless sensor networks for harsh environment applications, indoor localization, internet-of-things, green communication, applications of UAVs, and smart sensing. He is the recipient of the Best Paper Award at the WCNC Conference in 2014.

Unmanned Aerial Vehicles (UAV) have attracted a lot of attention in a variety of fields especially in intelligent transportation systems (ITS). They constitute an innovative mean to support existing technologies to control road traffic and monitor incidents. Due to their energy-limited capacity, UAVs are employed for temporary missions and, during idle periods, they are placed in stations where they can replenish their batteries. In this paper, the problem of UAV docking station placement for ITS is investigated. This constitutes the first step in managing UAV-assisted ITS. The objective is to determine the best locations for a given number of docking stations that the operator aims to install in a large geographical area. Based on average road network statistics, two essential conditions are imposed in making the placement decision: i) the UAV has to reach the incident location in a reasonable time, ii) there is no risk of UAV’s battery failure during the mission. Two algorithms, namely a penalized weighted k-means algorithm and the particle swarm optimization algorithm, are proposed. Results show that both algorithms achieve close coverage efficiency in spite of their different conceptual constructions.
Joon Wayn Cheong, UNSW, Sydney, Australia:
*GNSS Vulnerabilities in Urban Environment for Vehicular Applications*

Joon Wayn Cheong received his PhD in 2012 and BE in 2008 from UNSW Sydney. He has 8 years of experience in developing GPS/GALILEO navigation receivers. He collaborated with Thales Alenia Space France on various aspects of Cooperative Intelligent Transport Systems. He also led the team who developed two of Australia's first 2U Cubesats that was launched into space in April 2017.

Majority of new vehicular technologies rely heavily on Global Navigation Satellite System (GNSS) to provide accurate position, velocity and timing (PVT) information. Furthermore, some of the applications of these technologies are safety-critical and assumes ubiquitous availability of sub-meter positional accuracy.

However, GNSS has many severe shortcomings that are unbeknown to unsuspecting users. Intentional (e.g. signal jamming and spoofing) and unintentional (e.g. multipath and satellite malfunction) disturbances to the received GNSS signal may degrade the quality and availability of PVT solution. Typical references to Real-Time Kinematic (RTK) equipment that are capable of delivering centimeter level accuracies fail in such urban environments. Typical GNSS receivers will exhibit tens of meters of error, making even street level accuracies difficult to achieve. In such environments, intermittent unavailability of navigation solution is the norm due to obstructed view of the sky.

The paper presents an overview of GNSS issues encountered in urban scenarios. Then, a description of the several state-of-the-art solutions to these shortcomings are provided, followed by some emerging methods that are especially applicable to urban vehicular navigation.

Andrew Dempster, UNSW, Sydney, Australia:
*Interference Effects on Vehicle Positioning*

Professor Andrew Dempster is Director of the Australian Centre for Space Engineering Research (ACSER) in the School of Electrical Engineering and Telecommunications at the University of New South Wales (UNSW). He has a BE and MEngSc from UNSW and a PhD from the University of Cambridge in efficient circuits for signal processing arithmetic. He was system engineer and project manager for the first GPS receiver developed in Australia in the late 80s and has been involved in satellite navigation ever since. His current research interests are in satellite navigation receiver design and signal processing, areas where he has six patents, and new location technologies. He is leading the development of space engineering research at ACSER.

This presentation examines the effects of interference on the GNSS positioning of vehicles, especially in a CITS environment. Unintentional and intentional sources are examined, and in particular the role of meaconing and spoofing. These methods are compared with other "hacking" techniques and are found to be more easily dealt with.
Yanming Feng, Queensland University of Technology, Brisbane, Australia: Vehicle Positioning System and Performance Requirements for Different V2X Safety Applications

Yanming Feng is a professor in GNSS and data science at Queensland University of Technology, Brisbane Australia. His active research interests and expertise developed over 25 years have covered several GNSS technology and application areas, and extended to wireless communications and data science. He has managed research and development projects on GNSS and mobile communications crossing the sectors including spatial, road, automotive, Maritime, aviation and space. Professor Feng served as Editor-in-Chief for Journal of Global Positioning Systems from 2008 to 2014. He received degrees including PhD in satellite geodesy from Wuhan University China.

In the road observation environments, a hybrid vehicle positioning system usually consists of GNSS and onboard sensors to offer positioning solutions at varying uncertainties. There are generally four levels of vehicle navigation: road level, lane-level, where-in-lane level, and control-level, which can support different levels of vehicle safety applications. The higher the performance, the more strict V2X safety applications are supported. The presentation will outline six road positioning performance parameters for absolute and relative vehicle positioning, focusing on determination of accuracy and integrity parameters for road safety requirements. In order to establish road navigation integrity parameters similarly to aviation, we adjust the aviation MOPS parameters for different road applications. For each of the accuracy levels, we determine the Horizontal Alert Limit (HAL), continuity, integrity risk. Consequently, the presentation outlines the basic requirements for a hybrid vehicle positioning system in order to support V2X safety applications.

Session 3: 15:30 – 17:00

Chair: Guenther Retscher

Positioning Solutions for Cooperative Intelligent Transportation Systems

Panel Discussion

Panellists:

Allison Kealy, Lilian Pun, Andrew Dempster and Mark Hedley

Workshop Organizers:

Dr Allison Kealy is Associate Professor in The Department of Infrastructure Engineering at The University of Melbourne Australia. She holds an undergraduate degree in Land Surveying from The University of the West Indies, Trinidad, and a PhD in GPS and Geodesy from the University of Newcastle upon Tyne, UK. Allison’s research interests include sensor fusion, Kalman filtering, high precision satellite positioning, GNSS quality control, wireless sensor networks and location based services. Allison is currently the vice president of IAG Commission 4 on Positioning and Applications and the co-chair of the joint IAG Working Group 4.1.1 and FIG Working Group 5.5 on Multi-Sensor Systems.
Dr Guenther Retscher is Associate Professor in the Department of Geodesy and Geoinformation at the TU Wien – Vienna University of Technology, Austria. He holds an undergraduate degree in Surveying, a PhD and a Habilitation (venia docendi) in Applied Geodesy from TU Wien with the focus on Mobile Multi-sensor Systems for Personal Navigation and Location-based Services. Guenther’s research interests include positioning and navigation with GNSS, location based services, indoor and pedestrian navigation, applications of multi-sensor systems and sensor fusion. Guenther is currently the co-chair of IAG Sub-Commission 4.1 on Emerging Positioning Technologies and GNSS Augmentation and the co-chair of the joint IAG Working Group 4.1.1 and FIG Working Group 5.5 on Multi-Sensor Systems.

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