

## Dr Lawrence Lau

### Personal Details

Assistant Professor in Geodesy and Surveying  
Division of Engineering

MPhil (Hong Kong Polytechnic University), PhD (University College London)  
MRICS (Chartered Surveyor), FCIInstCES, FRIN, FRAS

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### Expertise Summary

Lawrence joined the University of Nottingham, Ningbo, China (UNNC) in October 2011. Before joining UNNC, he worked as an Associate Professor in the Institute of Geomatics in Barcelona from March 2010 to September 2011. In 2004 – 2010, he was a Postdoctoral Research Fellow at University College London (UCL), UK. In his about 6 years at UCL he worked on several research projects, including two UK [EPSRC](#)-funded research project called [SPACE](#), [iNsight](#), two EU FP6 projects called [BEAR](#) and [ANASTASIA](#), and two consultancy projects. [SPACE](#) was undertaken by a consortium of eleven UK university and industrial groups (*the CAA Institute of Satellite Navigation at the University of Leeds, the Department of Civil and Environmental Engineering at Imperial College London, the Department of Geomatic Engineering (CEGE) at UCL, and the Institute of Engineering Surveying and Space Geodesy (IESSG) at University of Nottingham, the UK Civil Aviation Authority, EADS Astrium, Leica Geosystems, Nottingham Scientific Limited (NSL), Ordnance Survey, QinetiQ and Thales Research and Technology*) and [iNsight](#) (an on-going project) is undertaken by a consortium of thirteen UK university and industrial groups (*the Department of Electronic, Communication and Software Engineering at the University of Westminster, the Department of Civil and Environmental Engineering at Imperial College London, the Department of Civil, Environmental and Geomatic Engineering (CEGE) at UCL, and the IESSG at University of Nottingham, Air Semiconductors, Civil Aviation Authority, EADS Astrium, Leica Geosystems, NSL, Ordnance Survey, QinetiQ, ST Microsystems, and Thales Research and Technology*). Before joining UCL, he worked as a technical analyst in NSL (2002 - 2004) in design and development of the [new European GNSS \(Galileo\)](#); he worked on two European Commission (EC) and European Space Agency (ESA) funded Galileo System Test Bed ([GSTB-V1](#) and GSTB-C0) projects. In 1999 – 2002, he worked in the Hong Kong Polytechnic University as a Research Associate for several vehicle navigation projects.

Lawrence helped with the supervision of BSc, MSc and PhD projects, and giving lectures to MSc courses (Positioning module), in Department of CECE at UCL. Moreover, he was a (part-time) lecturer in Engineering Surveying at the Hong Kong Institute of Vocational Education in 1999 – 2002. In 1995 – 1997, he worked as a Junior Land Surveyor in the Hong Kong Mass Transit Railway Corporation for the construction of the new airport railway.

Lawrence has practical and industrial experience in Engineering Surveying and Space Geodesy. Moreover, he has significant research and lecturing experience in Engineering Surveying and Space Geodesy.

Lawrence's current research interests are summarized as follows:

- Integration of GNSS systems (e.g., GPS + Galileo + Compass): Multiple-frequency data processing algorithms
- Sensor integration for positioning (e.g., integration of GNSS and inertial measurements sensors)
- Ambiguity resolution – reliability and efficiency improvements
- Precise Point Positioning (PPP) techniques

- High-precision relative positioning for static and kinematic applications
- Multipath modelling and mitigation techniques
- Attitude determination
- GNSS for geodetic and engineering surveying applications

## Teaching

### Undergraduate:

- Professional Engineering Studies (Module Convenor; 2011-12)
- Engineering Communication (Module Convenor; 2011-12)
- Engineering Surveying 1
- Engineering Surveying 2 (Module Convenor)

### Postgraduate:

- MSc in Engineering Surveying and Geodesy (Course Director):
- Analytical Methods (Module Convenor)
- Fundamentals of Satellite Positioning
- Geodetic Reference Systems (Module Convenor, 2012-2013)
- Advanced Satellite Positioning (Module Convenor)
- Physical Geodesy (Module Convenor, 2012-13)
- Engineering Surveying
- Research Project (Module Convenor)

### PhD supervision

Precise Orbit Determination for Beidou/Compass

Mapping Utilities in Difficult Environments

### Selected Recent Publications

#### Journal Articles:

Lau, L., Cross, P., Steen, M. (2012) Flight Tests of Error-Bounded Heading and Pitch Determination with Two GPS Receivers. *IEEE Transactions on Aerospace and Electronic Systems*, January, 48(1), pp. 388-404. [ISI-SCI Impact Factor: 1.767 (2012)]

Lau, L. (2012) Comparison of Measurement and Position Domain Multipath Filtering Techniques with the Repeatable GPS Orbits for Static Antennas. *Survey Review*, January, 44(324), pp. 9-16. [ISI-SCI Impact Factor: 0.393 (2012)]

Lau, L. and Cross, P. (2007) Phase Multipath Mitigation Techniques for High Precision Positioning in All Conditions and Environments. *Journal of Navigation*, 60(3), pp. 457-482. [ISI-SCI Impact Factor: 0.479 (2006), 0.486 (2007), 0.826 (2012)]

Lau, L. and Cross, P. (2007) Development and Testing of a New Ray-Tracing Approach to GNSS Carrier-Phase Multipath Modelling. *Journal of Geodesy*, 81(11), pp. 713-732. [ISI-SCI Impact Factor: 1.21 (2006), 1.636 (2007), 2.898 (2012)]

Mok, E., Retscher, G., Lau, L. (2002) Development of an Event-Reporting Intelligent Vehicle Navigation System for Areas with Urban Canyons, *Survey Review*, 36(284), pp. 398-409. [ISI-SCI Impact Factor: 0.102 (2002), 0.196 (2003), 0.393 (2012)]

Lau, L. and Mok, E. (1999) Improvement of GPS Relative Positioning Accuracy By Using SNR. *Journal of Surveying Engineering*, 125(4), pp. 185-202. [ISI-SCI Impact Factor: 0.357 (1999), 0.982 (2012)]

#### **Peer-Reviewed Conference Papers/Conference Papers:**

Lau, L. and G. Roberts (2012) GNSS Modernisation and Its Effect on Surveying, Proceedings of FIG Working Week 2012, Rome, Italy, 6-10 May.

Wasle, E., Lau, L., Mongrédien, C., Kalmann, A., Ritter, S. (2011) Development of an Assisted Galileo Receiver Integrated with Inertial Sensors for Automotive Applications. Proceedings of the International Geomatics Week, 15 -17 March 2011, Barcelona, Spain.

Groves, P.D., Hennessy, P., Cross, P.A., Lau, L., Adane, Y., Kale, I. (2010) Novel Multipath Mitigation Methods using a Dual Polarization Antenna. Proceedings of ION GNSS 2010, September 21-24 2010, Portland, Oregon.

Lau, L. (2009) Practical Multivariate Statistical Multipath Detection Methods Using Multiple-Frequency GNSS Phase Data. Invited paper, *Coordinates*, Vol. V, Issue 12.

Cross, P., Ziebart, M., Lau, L., Ochieng, W., Feng, S., Moore, T., Hill, C., Kale, I., Kazazoglu, R. (2009) Extending the Applications and Improving the Efficiency of Positioning Through the Exploitation of New GNSS Signals. Proceedings of ENC-GNSS 2009, May 3-6, 2009, Naples, Italy.

Lau, L. and Cross, P. (2008) Tests with Practical Multivariate Statistical Multipath Detection Methods Using Multiple-Frequency GNSS Phase Data. Proceedings of International Symposium on GPS/GNSS 2008, 11-14 November, Tokyo, Japan, pp. 990-1004.

Moore, T., Hill, C., Hide, C., Ochieng, W., Feng, S., Aguado, E., Ioannides, R., Cross, P., Lau, L. (2007) End-to-End Testing of an Integrated Centimetric Positioning Test-Bed. Proceedings of the ION GNSS 2007, 25-28 Sept. 2007, Fort Worth Convention Center, Fort Worth, Texas.

Lau, L. and Cross, P. (2006) A New Signal-to-Noise-Ratio Based Stochastic Model for GNSS High-Precision Carrier Phase Data Processing Algorithms in the Presence of Multipath Errors. Proceedings of ION GNSS 2006, September 26-29, Fort Worth Convention Center, Fort Worth, Texas.

Lau, L. and Cross, P. (2006) Prospects for Phase Multipath Mitigation Using Antenna Arrays for Very High Precision Real-Time Kinematic Applications in the Presence of New GNSS Signals. Proceedings of The European Navigation Conference 2006, 8-10 May 2006, Manchester, UK.

Moore, T., Hill, C.J., Hide, C.D., Walsh, D.M., Cooper, J., Ioannides, R., Ochieng, W.Y., Feng, S., Cross, P.A., Lau, L. (2005) Seamless Positioning in All Conditions and Environments: SPACE. Proceedings of National Navigation Conference NAV05, The Royal Institute of Navigation, 1-3 November 2005, London.

- Lau, L. and Cross, P. (2005) Use of Signal-To-Noise Ratio for Real-Time GNSS Phase Multipath Mitigation. Proceedings of National Navigation Conference NAV05, The Royal Institute of Navigation, 1-3 November 2005, London.
- Moore, T., Hill, C., Hide, C., Cross, P., Lau, L., Walsh, D., Cooper, J., Ioannides, R., Ochieng, W., Feng, S. (2005) Development of a Test Bed Facility for High Accuracy Positioning in Difficult Environments. Proceedings of ION GNSS 2005, 13-16 September 2005, Long Beach, California.
- Moore, T., Hill, C., Hide, C., Walsh, D., Cooper, J., Ioannides, R., Ochieng, W., Feng, S., Cross, P., Lau, L. (2005) Seamless Positioning in All Conditions and Environments: SPACE. Proceedings of The European Navigation Conference GNSS 2005, 19-22 July 2005, Munich, Germany.
- Lau, L. (2004) Investigations into Multipath Effects on GNSS Multiple-Frequency Single Epoch High Precision Positioning. Proceedings of ION GNSS 2004, Long Beach, California, 21-24 September 2004. (ION Sponsored Student Award)
- Lau, L. and Cross, P. (2003) Impact of GPS Modernization on Precise Carrier Phase-Based Positioning in the Presence of Multipath. Proceedings of ION GPS/GNSS 2003, Portland, Oregon, 9-12 September 2003.
- Lau, L., Pattinson, M., Sheridan, K. (2003) Adapted Precise Point Positioning within Galileo Development and Validation Activities. Proceedings of GNSS 2003 The European Navigation Conference, 22-25 April 2003, Graz, Austria.
- Mok, E. and Lau, L. (2001) GPS vehicle location tracking with the Minimum Range Error Algorithm (MRERA). Proceedings of ION GPS-2001, Salt Lake City, Utah, 11-14 September 2001.
- Mok, E., Rizos, C., Shea, G., Lau, L. (2001) A Low-Cost Automated GPS-Based Deformation Monitoring System, Proceedings of IAG Workshop on Monitoring of Construction and Local Geodynamic Processes, Wuhan, China, 22-24 May 2001.
- Mok, E., Rizos, C., Lau, L. (2001) Accuracy Assessment of a Low-Cost GPS Receiver Suitable for Deformation Monitoring Systems. Proceedings of IAG Workshop on Monitoring of Construction and Local Geodynamic Processes, Wuhan, China, 22-24 May 2001.
- Mok, E. and Lau, L. (2000) A Prototype of Event Reporting Intelligent Vehicle Navigation. Proceedings of the 5th Conference of the Hong Kong Society for Transportation Studies (HKSTS), 2nd December 2000, Sheraton Hotel, Kowloon, Hong Kong.
- Chao, C. H. and Lau, L. (1999) Transformation between PZ-90 and HK-80. Proceedings of The First Hong Kong Symposium on Satellite Positioning System Application, The Hong Kong Polytechnic University, 11th, December, 1999.
- Lau, L. and Mok, E. (1999) Precise GPS Processing Algorithm for Short Observation Time-span in Urban Area. Proceedings of the 55th Annual Meeting: Navigational Technology for the 21st Century, jointly sponsored by the Institute of Navigation and Draper Laboratory, June 28-30, 1999, Royal Sonesta Hotel, Cambridge, MA, USA., pp. 533-540.
- Lau, L. and Mok, E. (1999) Improvement of GPS Relative Carrier Phase Positioning Accuracy by SNR Weighted Ambiguity Function Technique. Proceedings of the 55th Annual Meeting: Navigational Technology for the 21st Century, jointly sponsored by the Institute of Navigation and Draper Laboratory, June 28-30, 1999, Royal Sonesta Hotel, Cambridge, MA, USA., pp. 323-332.

### **Research Awards, Grants and Consultancies**

- ION Sponsored Student Award, 2004 (US\$2000).

- EPSRC Large Grant for a project called “Extending the Applications and Improving the Efficiency of Positioning Through the Exploitation of New GNSS Signals” or iNstight in short – Lawrence was a Researcher Co-investigator of the project and he contributed in writing the proposal that was led by UCL in collaboration with colleagues from Imperial College and the universities of Nottingham and Westminster, and in collaboration with nine commercial companies and government agencies, 2008 (£706k).
- 2011 - Co-Investigator (co-author of the proposal), Galileo for Gravity (GAL), funded by the European Commission (grant 287193) as part of the 7th Framework Programme for Research and Development (FP7). GAL belongs to the FP7-GALILEO-2011-GSA-1-a call and to the Work Programme Topic GALILEO.2011.1.3.1 "Use of Galileo and EGNOS for Scientific Applications and Innovative Applications in New Domains", FP7-GALILEO-2011-GSA-1 (Ref: 287193), (€253.6k for IG; total: €864k).

### **On-going Research Project:**

EQUATOR - Exploiting the use of QZSS and Multi-GNSS for navigational and high precision positioning applications and their performance assessment, JAXA's Multi-GNSS Joint Experiment 2011

### **Service, Including Administration**

#### **External Service**

- Member of the International Association of Geodesy (IAG) Working Group 4.5.4: Data Processing of Multiple GNSS Signals, 2010-present.
- FIG Commission 6 Vice Chairman
- RICS Student Chapter

#### **External Examining**

- PhD External Examiner, School of Surveying and Spatial Information Systems, University of New South Wales, March 2010.
- PhD External Examiner, Department of Infrastructure Engineering, University of Melbourne, March 2013.

#### **University Committee Responsibilities**

- Examinations Officer ((BEng in Civil Engineering, 2011-12; and MSc in Engineering Surveying and Geodesy, 2012-13)

#### **Invited Lectures/Seminars**

- “GPS: Biases, Errors and Limitations”, Continuing Professional Development, invited by The Hong Kong Institution of Engineering Surveyors – 24/09/1998.
- “Control of Multipath” in Scottish Geomatics 2007, University of Glasgow, invited by the Institute of Civil Engineering Surveyors and the Department of Geographical and Earth Sciences at the University of Glasgow – 23/02/2007.
- Lau, L, G. Roberts, C. Hancock (2012) Technical Impact of Multiple GNSS on Applications, Reference Frame in Practice, IAG/FIG Commission 5/ICG Technical Seminar, Rome, Italy, 4-5 May.

#### **Reviewer for Journals**

ASCE Journal of Surveying Engineering, IEEE Transactions on Aerospace and Electronic Systems, IET (IEE) Radar, Sonar & Navigation, International Journal of Navigation and Observation, Journal of Civil Engineering - Korean Society of Civil Engineers (KSCE), Journal of Geodesy, Sensors

#### **Professional Associations**

- Fellow of The Royal Institute of Navigation

- Fellow of The Royal Astronomical Society
- Fellow of The Chartered Institution of Civil Engineering Surveyors
- Member of The Royal Institution of Chartered Surveyors
- Member of International Association of Geodesy