

PhD Studentship

Evaluating the use of Unmanned Aerial Vehicles (UAVs) for river flood flow measurement

A University of Worcester funded PhD studentship in collaboration with the Environment Agency

Closing date: Wednesday 5th April 2017

Interview date: Tuesday 9th May 2017

Supervisory team

Director of Studies:

Professor Ian Maddock, Professor of River Science, Department of Geography, Institute of Science and the Environment (ISE), University of Worcester

Additional Supervisors:

Dr Mark Corbett, Lead Technician, Institute of Sport and Exercise Science (ISES) (Motion and Performance Centre), University of Worcester

Nick Everard, Hydro-Acoustics Technical Advisor, Environment Agency (EA)

Context

Monitoring river flows (discharge) is essential for water resource management and flood forecasting. However, uncertainties in flow measurement are at their greatest when the river exceeds the banktop and water inundates the floodplain. In extreme flood flows, access to measurement sites can become difficult or impossible, and current meters and Acoustic Doppler Current Profilers sometimes cannot be used, as unsteady surface conditions and high levels of floating debris can endanger both measuring equipment and operators. The use of video imagery from drones or Unmanned Aerial Vehicles (UAVs) provides the opportunity to obtain data on surface flow velocity without requiring contact with the water surface. When combined with data on channel and floodplain morphology, this technique could potentially be used to estimate flood discharges.

Particle Imaging Velocimetry (PIV) is a measurement technique that uses digital video acquisition outside the flow current to track particles and measure turbulent flows. In recent years, several studies have assessed the viability of applying derivatives of PIV in natural water bodies to measure surface velocities over larger surface areas than small laboratory flumes, known as large-scale particle image velocimetry (LSPIV) (e.g. Muste *et al.*, 2008; Le Coz *et al.*, 2010; Detert and Weitbrecht, 2015) and Space-Time Image Velocimetry (STIV) (Fujita *et al.*, 2015). Video imagery can be collected by attaching digital video cameras to fixed mounts on bridges or mobile tripods, or by using video footage collected by UAVs. This PhD project aims to assess the viability of using video footage for flood flow measurement by comparing data obtained from a fixed-mount and UAV across a range of flow conditions including both in-channel and overbank flows. Significant investment has been made recently in UAV equipment at the University of Worcester, including the purchase in 2016 of a DJI

Matrice 600 rotary-winged UAV dedicated to this research, with a 4K video camera and flight times of upto 35 minutes, and a c-Astral Bramor rtk fixed wing with a 24MP sensor for still images and flight times of upto 2.5 hours.

Training in piloting an UAV will be provided by a UK Civil Aviation Authority (CAA) approved National Qualified Entity and supplemented with in-house training. The work will be carried out in collaboration with and supported by the Environment Agency (EA) via provision of supervisory expertise and access to data and information collected by the EA. Where appropriate, collaborative field work with EA staff and ADCP flow sensors may also be possible.

Further Reading

- Detert, M. and Weitbrecht, V., (2015). A low-cost airborne velocimetry system: proof of concept. *Journal of Hydraulic Research*, 53(4), pp.532-539.
- Fujita, I., Notoya, I. and Shimono, (2015). Development of UAV-Based River Surface Velocity Measurements by STIV based on High-Accurate Image Stabilization Techniques. *E-proceedings of the 36th IAHR World Congress, 28 June – 3 July, 2015, The Hague, the Netherlands*.
- Le Coz, J., Hauet, A., Pierrefeu, G., Dramais, G., & Camenen, B. (2010). Performance of image-based velocimetry (LSPIV) applied to flash-flood discharge measurements in Mediterranean rivers. *Journal of Hydrology*, 394(1), 42-52.
- Muste, M., I. Fujita, and A. Hauet (2008). Large-scale particle image velocimetry for measurements in riverine environments, *Water Resources Research*, 44, doi: 10.1029/2008WR006950.

The University of Worcester

Research at the University of Worcester has grown significantly over the last 10 years. This growth is most clearly shown in the outcomes of the Research Excellence Framework (REF 2014). Worcester was the most improved University in the UK based on Research Fortnight's "Research Power" measure, reflecting a more than four-fold increase in the number of staff submitted compared to RAE 2008 and a commensurate increase in the quality of the research. As a consequence of its REF 2014 submission, Worcester's QR income for 2015-16 is up by 341% from 2014-15.

The University is committed to further developing its research profile in the coming period, through a strategic approach to its support for and investment in research. As part of this investment it is funding a number of full-time PhD studentships in its areas of particular research strength.

The Institute of Science and the Environment

The successful candidate will join the Institute of Science and the Environment (ISE), a dynamic, multi-professional Institute that has experienced significant growth in recent years, particularly in staffing and research output. Staff in the Institute contribute to the development of knowledge and practice by engaging in a wide range of research and consultancy activities. Working in collaboration with different disciplines and with other universities, private industry and the public sector, research is always grounded in the aim of achieving real-life benefits.

Professor Ian Maddock is the Director of Studies and is leader of the [River Science Research Group](#) and has research expertise in River Science: Fluvial Geomorphology; Hydroecology; Ecohydraulics; River Monitoring & Assessment; Habitat Modelling; and Remote Sensing with Unmanned Aerial Systems (UAS). Dr Mark Corbett has a background in electro-optic sensing with research expertise in 3d motion capture, data acquisition and

signal processing. Nick Everard has almost 30 years' experience of river level and flow monitoring and leads the Environment Agency's Acoustic Doppler Current Profiler (ADCP) programme. Nick is also leading Environment Agency research into innovative solutions for river flow monitoring solutions.

The River Science Research Group consists of four academic staff, three postdoctoral research fellows, two PhD students and four MRes in River Science students. In addition to the investment in the DJI Matrice 600 and c-Astral Bramor rtk UAVs described above, ISE has a DJI Inspire 1 PRO for use in learning and teaching and a Draganflyer X6. The group are well equipped, with access to flow measurement equipment including a Teledyne StreamPro Acoustic Doppler Current Profiler (ADCP), a 2D Flow Tracker, six Valeport Electromagnetic current meters and several Solinst water level data loggers. Two hydrological monitoring sites on local streams (Leigh Brook and Bow Brook) carry out continuous monitoring of water level and various water quality parameters (pH, temperature, specific conductance, dissolved oxygen, turbidity) with data logged every 15 minutes and accessible online via telemetry in real-time. Survey equipment includes Trimble mapping and survey grade GPS, a Leica Terrestrial Laser Scanner, three total stations, six quickset levels and three laser distance measurers. We have a number of Panasonic Toughbook field ruggedised laptop and tablet PCs for field use for data collection, input and running software to operate equipment.

ISE also has a fully-equipped GIS, Mapping and Visualization Suite, which provides access to high-end computers, industry-standard GIS (ArcGIS) and statistical analysis software (e.g. Primer-E, Matlab, SPSS) and other mapping and remote sensing software (e.g. Photoscan Pro (Agisoft LLC)).

Research School

The Research School is a focal point for all our research students. It provides:

- day-to-day support for our students, both administrative and practical, through our dedicated team
- a Research Student Study Space with both PCs and laptop docking station
- a comprehensive Researcher Development Programme for students and their supervisors
- a programme of student-led conferences and seminars

Details of the studentship

During the period of your studentship you will receive the following:

- a tax free bursary of £13,863 for a period of 3 years
- a fee-waiver for 4 year
- a laptop
- use of the Research Student Study Space in Research School
- access to the Research Student Support Scheme

Qualifications needed

Essential:

Applicants should have or be able to evidence:

- A First or Upper Second (2.1) Honours Degree in Geography, Environmental Science, Natural Sciences, Engineering or other relevant discipline, or expect to receive one by October 2017;
- A sound understanding of quantitative research methods,
- An interest in river science and remote sensing;
- The ability to undertake fieldwork on river systems in an organised and safe manner and to learn how to fly a UAV;
- Proficiency in oral and written English;
- Computer literacy;
- Ability to organise and meet deadlines;
- Good interpersonal skills;
- Ability to work independently and contribute to a team;
- Commitment and an enthusiastic approach to completing a higher research degree.

Desirable:

- Education to Masters Degree level in Geography, Environmental Science, Natural Sciences, Engineering or other relevant discipline;
- Experience of appropriate research methods, fieldwork and data analysis skills;
- Full UK Driving Licence.

As part of its mission statement the University is committed to widening participation for its higher degrees. Although most candidates will have an undergraduate and/or a Masters degree, the University is happy to accept applications from candidates with relevant professional qualifications and work related experience.

The Interview

The interview will be held on the 9th May 2017. All successful applicants will be interviewed. You will be asked to make a short presentation on a recent research project you have led. You will also be asked to provide an example of your written work (e.g. a dissertation) ahead of the interview.

For further information or an informal discussion on this project, please contact Professor Ian Maddock (Director of Studies) via telephone on +44 (0)1905 855180 or by email i.maddock@worc.ac.uk

Application forms are available at:

<http://www.worcester.ac.uk/researchstudentships>

Completed application forms should be sent by email to: research@worc.ac.uk or sent via post to: Research School, Jenny Lind Building, Henwick Grove, St Johns, Worcester, WR2 6AJ