# 3D volcanic plume observation from space

**Company:** University of Bristol

**Location:** Bristol

**Code:** 18/62

**Company Description:**

The Faculty of Engineering at the University of Bristol has created an inspiring, collaborative and highly dynamic research environment for all staff and students, including access to world-class facilities – the Smart Internet Lab, the Quantum Engineering Technology Lab, the Bristol Vision Institute, the Bristol VR Lab, the Bristol Robotics Laboratory, the BLADE laboratory, the National Composites Centre.

The supervision team comprises the uniquely qualified partnership of an internationally renowned volcano expert, experienced spacecraft systems engineer and computer image processing expert at the University of Bristol:

- **Professor Lucy Berthoud** in the Aerospace engineering department is co-lead of the University of Bristol Satellite Programme. She is also co-director of the University of Bristol Satellite Laboratory and Chair of the Space Universities Network.
- **Dr Matthew Watson** in the School of Earth Sciences focuses on the science question: 'How do we better quantify emissions from volcanoes in order to understand (a) the information content they transmit from the subsurface, (b) their effects on the local, regional and global environment and (c) the risks volcanic ash poses to aircraft?'
- **Dr Andrew Calway** is based in the Department of Computer Science and a member of the Visual Information Laboratory (VIL) and the Bristol Robotics Laboratory (BRL). His research covers 3-D tracking and scene reconstruction using vision, in simultaneous localisation and mapping (SLAM), including relocalisation, fast and robust feature matching, and place recognition.

**Project Description:**

The aim of this Earth Observation-themed activity is to investigate the feasibility of processing of images of a space-based TIR imaging instrument which could be to image volcanic ash clouds. It is an independent project but contributes towards the University of Bristol Satellite project.

During the eruption of the Eyjafjallajökull volcano, airspace closure cost the airlines £200m a day. To improve airspace management, a detailed knowledge of the 3D structure of the ash cloud, ideally in real-time, is required. Currently, there is a lack of both the observational data and algorithms required to attempt a full 3D structural retrieval.

The purpose of this project is to investigate the potential for observing ash clouds from satellite image data and to develop a proof of principle algorithm. It builds on recent work at the University of Bristol to measure ash clouds using fixed camera and UAV images. The graduate will initially review existing algorithms for volcanic plumes and computer vision algorithms for cloud segmentation in IR imagery. They will then begin to apply these techniques to:

- UAV IR image data from an expedition to a Guatemalan volcano

- Images from the multi-angle imaging spectroradiometer (MISR) on the Terra satellite

Firstly, they will calibrate the image data using terrain maps and image correspondence. Then they will apply a University of Bristol-developed algorithm for retrieval of coarse 3D ash cloud structure based on image segmentation and space carving methods to both sets of images. If time, they will then use the algorithm to integrate the images over time to produce an evolving 3D reconstruction. Lastly, they will develop a plan for future work. This internship has the potential to make a real contribution to the way that volcanic plumes are measured.

**Applicant Specification:**

**Technical**
The applicant will develop a knowledge of volcanoes and volcanic plume observation, of photogrammetry, image calibration and segmentation and space carving methods. They will also develop an understanding of visual and infrared cameras and imagery, as well as how to access MISR's MINX software tool for image analysis. These are interesting skills for anyone working in Earth observation.

**Soft**
The applicant will work closely with the Aerospace, Computer Science and Earth Sciences departments at the University of Bristol, as such they will develop both team-working and communications skills. They will be joining an experienced team of Space and UAV experts, volcano specialists who frequently travel to hotspots around the world to gather data and computer vision specialists who have been working on applying new techniques to imagery. They will also be contributing to the University of Bristol Satellite project. This project is part of a close-knit community which involves 50+ students from multiple disciplines per year.

**Minimum Requirements:**

- A bachelors or master's degree in computer science/aerospace/space engineering with either a 2:1 or a 1st
- Knowledge of MATLAB
- Programming experience in C, C++ or Python
- Experience of modelling
- Proven motivation to work in the space domain
- Ability to communicate effectively both written and verbally
- Evidence of interdisciplinary project experience within an academic environment

**Preferred Additional Requirements:**

- Experience of space and/or earth observation projects
- Experience of modelling 3D geometry
- Experience of photogrammetry
- Experience of working in teams


**Further details:**

8 weeks minimum fixed term contract to be agreed with successful candidate but nominally with a start date around 1 December 2018, with a completion at latest by 28 Feb, 2019. Salary is £1,500 per calendar month.

**Closing Date for Applications: 21st November 2018**

Applications should be made through the online form attaching a CV, before the closing date. Please note that elements of the form left incomplete will be deemed to render the application ineligible. They will be checked for eligibility and forwarded to the employer.