Acoustic Localisation of Coronary Artery Stenosis

EPSRC funded project at Brunel (with Queen Mary and NC State)

When blood flows past an arterial stenosis the turbulent wake causes acoustic shear waves to travel through the chest and to appear at the chest surface. This sound can be used by expert and experienced practitioners to 'listen' for the presence of a stenosis. This project will evaluate the potential for automating this diagnostic procedure in software and thereby make it cheaper and more widely available. Success in this would have a huge positive worldwide impact on social health and current diagnostic practice.

The project team are:

- Simon Shaw and John Whiteman, Brunel University.
- Stephen Greenwald and Malcolm Birch, Queen Mary University of London and Barts and the London NHS Trust.
- HT Banks, North Carolina State University.

The primary scientific idea driving this project is to measure the signals at the chest surface and then, by solving an inverse problem, determine as much as possible about their origin and its location, size and morphology. The inverse solver will need a direct (forward) solver in order to carry out the calculations and this is the post-doctoral research fellow's main task. The domain will be heterogeneous and three dimensional and the elastic wave equation, with added biological tissue viscoelasticity, will have to be solved many times in each inverse solve. To make the procedure feasible this forward solver will be implemented in a multi-core high performance computing environment. Funds are available to purchase computing equipment for this purpose and one of the Brunel team's earliest tasks in the project will be to survey the equipment available and to secure its purchase and deployment. The construction and refinement of the forward solver and its interface to the inverse solver will be the main task of the research fellow throughout the three year project. Mesh generation is also expected to be a major task. The inverse solver will be constructed by HT Banks and a PhD student or postdoc at North Carolina State University. They have many years of experience with the theoretical background to this and related inverse problems.

This science is young and there are many issues to explore before we can contemplate running this method on a real human or animal. Instead Greenwald, Birch and a second postdoc will build (tissue mimicking) gel-filled chest phantoms with a variety of artificially stenosed artery-simulating pipe networks carrying pumped blood-mimicking fluid. Careful measurement of both cause (stenosis) and effect (surface noise) will be taken and recorded and these results will be used to validate and calibrate the forward and inverse solver software.

This project is interdisciplinary and multi-site. It is also at the applied end of the research spectrum and so is only suitable for candidates who already have significant expertise in the development and deployment of finite element codes in a high performance computing environment. There will be opportunities to generate publications and give presentations which will often need to be such that they are accessible to non-mathematicians.

You must have clearly demonstrated, mature and exemplary skills in at least:

- Implementing finite element solvers in a high performance computing environment;
- Three dimensional mesh generation for heterogeneous multiply-connected domains.

Experience of developing and successfully implementing inverse solvers would also be a considerable advantage but is not essential.

If you want to do lots of coding for an international multi-site interdisciplinary team that is trying to solve a real-world problem then, if you have the experience detailed above, you are strongly encouraged to apply.

We regret that we are not able to acknowledge unsuccessful applications and nor are we able to provide any form of travel cost to those who are offered an interview.