

## **EPSRC DTG Centre in Healthcare Technology – PhD project outline**

**Project Title:** Developing an ‘altered reality’ visual display system for visual rehabilitation after stroke

**Supervisors:** Ben Webb, Associate Professor of Visual Neuroscience, School of Psychology, Faculty of Science; John Crowe, Professor of Biomedical Engineering, Faculty of Engineering

**Project Outline:** In the UK, approximately 150,000 people a year have a stroke – ‘the brain equivalent of a heart attack’. In up to a quarter of stroke survivors, the blood supply to visual pathways in the brain is interrupted, causing sight loss in regions of the field of vision. Sight loss has a serious impact on their quality of life, increasing trips and falls, impairing reading, and participation in social activities. Yet there are currently no effective treatments for sight loss after stroke.

To improve sight after stroke, a rehabilitation system has to either reactivate damaged parts of the visual brain or encourage undamaged brain pathways to compensate for the sight loss. Vision training techniques are becoming established as effective treatments for other sight disorders, such as age-related sight loss or amblyopia (‘lazy eye’). However, because of the severe brain damage after stroke, the capacity of the visual brain to repair itself or compensate for sight loss needs to be enhanced before implementing visual training.

Dr. Webb’s laboratory is developing and testing the efficacy of a visual rehabilitation program that increases the visual brain’s capacity for plasticity and self-repair that can be exploited by vision training techniques to improve sight after stroke. The visual rehabilitation program will be delivered by a bespoke ‘altered reality’ visual display system in a home environment. John Crowe (Electrical Systems & Optics Research Division, Faculty of Engineering) has widespread experience of developing medical devices for clinical use, including appropriate user centred design that will be necessary for the intended home use system.

The successful PhD student will develop the ‘altered reality’ visual display system for delivering a visual rehabilitation for sight loss after stroke in a home-based environment. The altered reality display consists of a video camera attached to a head mounted visual display, fast graphic processing unit (GPU), and eye movement tracker. Video of what a participant is currently viewing is recorded by the camera, streamed through the GPU, where it is filtered by custom written image processing software, and played back in real time through the head mounted display. With this bespoke technology, we can change how aspects of the visual scene appear to a stroke patient in near to real time to both increase the capacity for visual recovery and implement different forms of vision training.

The PhD project will involve the development of the software and hardware for the altered reality visual display system to safely deliver a visual rehabilitation program for stroke survivors in a home-based environment. During the PhD, three interrelated lines of enquiry will be pursued: (1) optimisation of image processing algorithms for real time filtering of different aspects of the visual scene; (2) design and build of a new head mounted interface for delivering visual screening and visual interventions; and (3) incorporation of software into the system to enable adherence to, and effectiveness of, the therapy to be monitored remotely. The PhD student appointed will need to possess good programming (in multiple languages, e.g. C, C++, Python, Matlab) and software design skills and knowledge of real time image and signal processing (using, for example, specialist fast graphics processors).

The pathways for recruiting stroke patients with homonymous visual field defects from Nottingham University Hospitals and the Nottinghamshire Community are already in place. Dr. Webb has established collaborations with Dr. Nikola Sprigg, Consultant Physician in Stroke Medicine and Nottingham Stroke Research Consumer Group, who will identify and oversee recruitment of stroke patients from the Stroke Unit at City Hospital and Nottinghamshire Community, respectively.

This project will foster relations between medical device developers in the Faculty of Engineering and colleagues in Psychology; with whom to date there have been preliminary discussions but no formal collaboration, but where multiple opportunities clearly exist.