# MultiVis II: Multimodal Tools to Allow Blind People to Create and Manipulate Visualisations

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## OVERVIEW

Understanding and manipulating information using visualisations such as graphs, tables, bar charts and 3-dimensional (3D) plots is a very common task for sighted people. The skills needed are learned early in school and then used throughout life, for example, in analysing information, creating presentations to show to others, or for managing home finances. The basic skills needed for creating and manipulating graphs, for example, are necessary for all parts of education and employment. Blind people have very restricted access to information presented in these visual ways [9]. It is currently very hard for them to create, manipulate and communicate visualisations such as graphs and tables. As Wies *et al.* [26] say "Inaccessibility of instructional materials, media, and technologies used in science, engineering, and mathematics education severely restricts the ability of students with little or no sight to excel in these disciplines. Curricular barriers deny the world access to this pool of potential talent, and limit individuals' freedom to pursue technical careers". To allow blind people to gain the skills needed for the workplace new technologies are necessary to make visualisations usable. The aim of this project will be to use multimodality to allow blind people to create and manipulate visualisations using hearing and touch.

This proposal builds on work done on the MultiVis I project (GR/M44866). The main aim of MultiVis I was to investigate multiple sensory modalities to understand how they could best be used for presenting visualisations to blind people. We generated and evaluated many different designs of visualisations with great success [4, 17, 27]. The combination of sound and touch has been shown to be the most effective way of presenting visualisations such as tables, graphs and bar charts [12, 19, 28].

The novel aspect of MultiVis II will be to use multimodal techniques to allow blind users to create and manipulate visualisations themselves in flexible and efficient ways. One of the key things to come out of MultiVis I was that it is very hard for blind people to create usable visualisations, so they are not used. Primitive tools based around pins and rubber bands are used in schools to teach graphs, for example, yet in later life there are almost no computer-based tools that a blind person could use him/herself to create a visualisation. To facilitate creation we will investigate haptic and audio tools to allow users to create visualisations interactively, adding and removing points and interacting with the visualisation as they go.

One other key issue is that of navigating and manipulating visualisations. The single point of contact offered by current haptic devices easily leads to confusion and navigation problems with users getting lost when moving around displays, and being unable to compare different values separated in space [27]. We will investigate and develop ways to overcome these problems by allowing two-handed interaction and augmenting existing paper-based technologies with haptics and audio to maximise their usefulness. We will also look at using 3D sound to provide external memory cues (a fundamental problem for blind people when interacting with this kind of information) to mark interesting points. Finally, collaboration between two blind people using multimodal visualisations will be investigated. The main aims of this research are to:

- Investigate techniques to allow blind people to interactively create visualisations themselves;
- Develop a more natural, two-handed interaction with the visualisations;
- Create a mixed reality paper and haptic visualisation tool;
- Develop external memory and navigation aids to help people discover, mark and rediscover important data features;
- Investigate collaborative visualisation tools to allow users to work together.

The research proposed is of key importance to the UK. The Government's Foresight Committee reports that in the near future the "… richness and diversity of both the input and the output channels will increase - multi-modal input and output will become the norm. The senses of sight, hearing and touch will be seamlessly integrated, and exploited together to maximise the bandwidth of the psychological interface" [11]. The project will contribute directly towards this aim. In addition, the Disability Discrimination Act (1995) is important because making systems and information usable by disabled people is now a legal requirement but many techniques to enable this still need to be discovered. This research is needed now so that the UK can keep its place at the forefront of work in this area.

For the project one RA and one RS, equipment and travel for a period of 3 years are requested. The Royal National College for the Blind (RNCB) in Hereford will be partners in our research. Progress will be measured against the following milestones:

- *Year 1:* Develop and evaluate an interactive visualisation construction tool. Investigate basic awareness tools for collaborative visualisations;
- *Year 2:* Investigate two-handed interaction and haptic augmented reality. Evaluate collaborative visualisation creation tools;
- *Year 3:* Design and evaluate external memory aids. Produce paper on the results of detailed evaluations of the complete system. Produce final design principles and demonstrator applications. Produce final report. Host workshop to disseminate knowledge gained.