Non-Visual Navigation Interfaces

Overall aim

Satellite-based Global Positioning Systems (GPS) are widely used for location and navigation tasks. Visually disabled users of GPS must rely on audio-based user interfaces, the vast majority of which employ synthesised speech output. Synthesised speech, however, is inadequate in rapidly changing situations where good situation awareness is needed, where the user must pay attention to other systems that use speech output, or where the user must frequently communicate with other people (locally or remotely). A solution is needed that both requires minimal attention and provides good situation awareness, whilst releasing the speech channel whenever possible.

Motivating context

A particular context for this kind of application is that of marine navigation in small yachts. This domain is particularly rich, demanding, and fast moving in terms of rapidly changing navigational problems. Furthermore, although the domain is worth studying in its own right, many of the findings and solutions will also be more widely applicable. Indeed, technologies designed to help the visually impaired have a long history of finding uses as supplementary systems for the sighted.

Sailing as a sport is in large measure accessible to the visually impaired, and is actively promoted by the Royal Yachting Association's Sailability Foundation. Effective sail trim and steering can be based on the physical motion of the boat and on the perceived impact of the wind. Helming a sailing vessel, albeit with sighted assistants, is said to offer an unequalled sense of liberation and achievement to visually impaired yachtsmen. Devices such as audio compasses, have been developed to help visually impaired yachtsmen to sail in a prescribed direction. However, the audio interfaces are relatively unsophisticated, and limited to synthesised voice output.

Underlying problem

GPS (Global Positioning System) Navigation equipment has greatly simplified yacht navigation in recent years, and offers real-time displays of current position, direction of movement and distance and bearing to any specified target location, or, indeed, to a sequence of such targets. These displays are, however, inherently visual.

Marine Navigation is generally more demanding that land-based GPS navigation. On land, the direction in which one is moving at any instant is unambiguous, whereas on water there can be significant differences between the direction of movement through the water and the direction of movement relative to any fixed target. The most obvious influence in this regard is tidal flow, which can be comparable in speed to that of the boat. Whilst, for land navigation towards a fixed target, it is normally sufficient to indicate the bearing and distance of the target from the current position; on water, additional information is required, including the current direction of movement relative to that target, together with measures such as the deviation from an idealised path from an initial point to the target (the "cross-track error"). Such information is routinely generated by standard GPS equipment.

Most GPS equipment broadcasts this information on a standard network interface (NMEA 0183). Computers or PDAs, can interrogate this interface. In the medium term, one aim could be to develop PDA-based software that would generate an appropriate, real-time, spatial audio representation of the enhanced navigational information required to enable a visually impaired yachtsman not just to steer a compass course but to navigate towards a series of fixed targets.

Generalisation

The problem generalises in a number of interesting directions. Non visual presentation of navigational data may be more widely applicable in the marine environment, where there are many conflicting demands on a user's attention. Alternatively, relative, rather than absolute, movement is significant on land when a target is moving; possible applications might include tracking animals or birds fitted with radio collars, or tracing goods containers fitted with GPS beacons.

Scenario simulation

Whilst it would, in principle, be possible to develop and test prototype interfaces for evaluation in the real context of sailing for visually impaired users, it is also possible to explore the possibilities for non-visual presentation of navigational data by use of simulations.

Moving towards a stationary target across a moving medium is mathematically equivalent to moving towards a moving target across a stationary medium – although there are some differences if there are obstacles, either stationary or moving, within the field of the navigation.

Hence, for example, a scenario could be constructed in which the “user” of a prototype interface is guided through a virtual environment towards a moving target, much along the lines of a virtual reality game.

Of course, such a virtual environment could also involve a moving substrate (e.g., a flowing river….!), or even flying through (moving) air, where the flow was either uniform or turbulent.

Essential components

Despite the obvious attraction of developing virtual environments and fancy guidance intererfaces, the essential components of this kind of investigation include:

- Identification of the relevant navigational information to be presented;
- Experimental evaluation of the effectiveness of any prototype interface.

A more ambitious goal might then be to develop an application in which both the environment and the non-visual interface could be configured for further experiments.