The Ergonomics of Attention Responsive Technology

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Abstract

ART (Attention-Responsive Technology) is a new three year UK research project which will enable individuals to access technology efficiently in situations where their mobility is either impaired, as a result of disability or age, or because movement is undesirable due to environmental hazards. The system works by monitoring both the individual and the ICT (Information and Communication Technologies) devices (termed here 'objects') in his/her environment and then uses knowledge of the individual's gaze behaviour to determine to which ICT device they are attending. This information is relayed to a user-configurable control panel, which then displays as a graphical user interface (GUI) only those controls that are appropriate, both to the user and to the particular object in question. The user can then choose to operate the object. ART therefore acts as an enabling technology, with the system fully user configurable and able to cater for future developments in technology.

Background

Numerous disabilities seriously restrict mobility but leave saccadic eye movement control intact and so these movements can be used as a communication or a control aid. Systems already exist which afford physically impaired individuals the ability to interact with a computer or other devices using their saccadic eye movements. For instance an individual can 'type' by looking at keys on an on-screen keyboard, or move the computer cursor according to their point of gaze.

Unfortunately, these systems suffer from the so-called 'Midas touch' problem (Jacob, 1990). That is, a system which uses the user's point of gaze to activate controls directly is prone to false alarms as the point of gaze is unconsciously drawn to objects which the visual system finds 'interesting'. As a result, users of such systems generally find that such direct eye movement control can be unreliable and fatiguing, which renders the long-term utility of such systems less than ideal.

In order to control numerous objects in the environment typically a complex menu system of some kind is required which encompass all of the potential objects together with their various levels of control. This can either end up as a physically large menu selection display or else a deep menu structure. Neither is ergonomically acceptable.

The ART system

This project overcomes the problems associated with eye-movement control of ICT devices by using eye movements to select an object for control; not necessarily to operate the object per se. In everyday tasks our point of gaze generally precedes action, i.e. we look towards an object before we reach for it (Land and Hayhoe, 2001). In this way, saccadic eye movements can therefore be used as an indicator of the intention of the individual when interacting with his/her environment (Vertegaal, 2002).

In the initial formulation, actual control of a device will be by a GUI using a touch sensitive tablet PC – although this can be replaced with numerous other potential interfaces/controls to suit a particular user. The project is concerned with the appropriate selection of objects in an environment and less with their actual operation, thus the GUI itself is not a major issue. The interface is configurable to the individual in question, ranging from a fully featured panel to a simple two-switch set up depending upon the individual's physical and cognitive abilities. Where necessary the panel could be replaced by a head- or breath-operated switch.

It is envisioned that a user, potentially in a wheelchair, is located within an environment that contains numerous ICT devices or objects. In a domestic setting such objects will include: TV, media centre, lights, curtains, air conditioning, door entry system, computer, kitchen appliances etc. Some of these objects will need to be controlled by the user and the objective of the project is to determine accurately the selection of these objects by the user through monitoring their eye gaze vector. The difference between this approach and previous eye movement control systems is that the user's point of gaze does not actually control the object, instead it pre-selects objects for operation. By presenting the user with a set of controls specific to the object, the system in effect then sets the chosen object into a state of readiness to receive a command.

Implementation

A suitable environment, which encompasses both domestic and office objects, is currently being constructed in a dedicated laboratory. The objects which the user will control are fitted, where necessary, with appropriate control systems (e.g. electrically operated curtains). Digital cameras, in fixed positions in the environment, are used to construct a computer vision system which provides a 3D environmental model. This determines the location of the ICT objects, together with the location of the user. As the user moves about in the environment, or as objects are moved, then their respective locations are monitored in real time.

Initially a head mounted eye movement system (ASL 501) is being implemented to acquire the participant's eye gaze relative to their head position. Head direction relative to the environment will be obtained via a 3D 'flock of birds' monitoring system. From these two measures the eye gaze vector relative to the environment is obtained. The system then calculates whether the user's gaze falls upon an ICT object and if so then an appropriate GUI for that object will be triggered on the tablet PC. This obviates the need for a complex GUI to present the user with every available ICT device. Subsequent developments will replace the head mounted eye movement system with a remote eye monitoring system (Smarteye).

Discussion

The ART system provides the user with the appropriate controls for every device they might require, whilst maintaining a simple and usable control interface. It removes the need for a complex hierarchical user menu control system to handle a wide range of ICT devices. The ART system overcomes any possibility of the false operation of devices resulting from the user looking at the object 'inadvertently'. It is the user's decision whether to interact with the control panel; the control panel relies on the user to physically activate an appropriate control.

References

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