For the past eighteen months Paul Gnanayutham (De Montfort University), Chris Bloor (University of Sunderland) and Eamon Doherty (Fairleigh Dickinson University) have been working on new Applications for the Brain Computer Interface Devices. This study has taken this team to research into various applications for users with special needs. The applications researched here are still in their embryo stage and need more testing before the can be widely available.

Researching Applications for Brain Computer Interface

Not all users with special needs can use a mouse, trackball, and keyboard or have the ability to speak to a speech recognition system. So we need a device that provides communication capabilities for those who cannot use any of the regular input devices.

There are many brain body interfaces; e.g. HeadMouse™ - using wireless optical sensor that transforms head movement into cursor movement on the screen
Tonguepoint™ - a system mounted on mouthpiece.
Cyberlink™ - a brain body actuated control technology that combines eye-movement, facial muscle and brain wave bio-potentials detected at the users forehead.

All Brain Computer Interface devices have their advantages and disadvantages. A user with cerebral palsy will not have good motor abilities to operate the 'Tonguepoint™'. A user with spinal vertebrate fusion may not be able to turn his or head and the HeadMouse™ will be of no use to this user. At present only the Cyberlink™ (www.brainfingers.com) seems to be applicable to the brain injured because it uses a combination of signals and does not rely on one particular signal.

Cyberlink™ can be used as a control technology that combines eye movement, eye blink, facial muscle and brain wave bio-potentials detected at the user's forehead to generate a mouse input that can be used for communicating. Cyberlink™ uses the forehead as a noninvasive site, for convenience and also because it has a rich variety of bio-potentials. The signals for communications are obtained by attaching probes on the forehead of the patients. Basically there are 3 silver/silver chloride contact electrodes (i.e. non-invasive), which are placed on a headband to pick up EEG (brain wave), EMG (muscle movement wave) and EOG (Eye ball movement) signals when applied on the forehead. These are then fed into an amplifier box and then to the mouse port, so the computer just sees the device as a mouse, which, is used to control the cursor. Cyberlink™ comes with various games for recreation and training. These are used to introduce the cyberlink to the new user but there is one particular program we are interested in our study, that is the CAT™. Application. This lets a user access a computer desktop using the Cyberlink™, it uses the EOG, EMG and EEG to move around in the desktop and also open files and application by blinking or other signals from the cyberlink. CAT™ can be configured according to the needs of individual users. The team in all the applications described in this article, used CAT™.

Doherty and Bloor used the Cyberlink™ to communicate with traumatically the brain-injured non-verbal persons in the United States. Any communication would have been impossible before with this group of brain injured people. The special users were also able to write simple words when prompted, using the soft keyboard and Cyberlink™.

University of Sunderland has been carrying out extensive research in the area of brain body interface devices for communication for the brain-injured persons. For many years brain injured people were written off as vegetative patients but now there are some groups of brain injured who are able to communicate using the brain body interface devices. There is still more research to be done in this area.

The team of Gnanayutham, Doherty and Bloor has been working to get the research to go further into diverse areas, the last two years. This article deals with some of the new research carried out by this team. Many of the ideas here are still in research stages and need extensive testing on users with special needs before they can be released to the public.

Robots have been in science fiction for many years. Some users with special needs already use these robots for simple household chores. The brain-injured group of users has not harnessed this technology. The team has been working to make a brain injured user perform simple tasks using a robotic arm. A paper was presented at the ICCIT 2001 at New Jersey, on how a robotic arm can be interfaced with a Cyberlink™ to perform simple tasks for the brain-injured. The equipment needed for this was a computer with one serial port for the cyberlink™ and a parallel port for the interface to the robotic arm.

A Visual Basic program displayed six paths for controlling the robotic arm. The paths ended up in one of the functions of: arm up, arm down, arm left, arm right, open claw and close claw. When one of these six functions were triggered, the program drove a motor to perform the operation requested by the user. The Robotic arm was able to move left, right, up, down and use claws to pick up a small object. This showed that in future the brain-injured could use robotics to do some basic tasks such as picking up small object and moving it closer to the Cyberlink™ user.

Gnanayutham took this technology to India, where the Brain Computer technology was tried using simple Visual Basic Interfaces which let the users communicate by using simple phrases and access applications such as the Internet. The interfaces were translated to the local language, and included simple phrases such as Thank you, Yes, No, I am hungry etc. The users were able to go the Internet site and access the sites set as default by the care-givers. Using the Internet worked as long as the browser refreshed periodically without any user intervention. The sites that can be viewed using the interface were such as news and sports sites. This gave the users some recreation. The participants in India were a mixed sample with ages from 8 to 70 yrs. The older participants had Parkinson disease and after effects of strokes etc. They had become non-verbal after various illnesses. They were able to use a simple Visual Basic YES/No interface to communicate with their families. Some of them were able to communicate with their families after many months.

The Brain Body Interface was also tested at the Mother Theresa Institute for Cerebral palsy children. Out of thirty children tested, twelve were able to use the Brain Body Interface, via the Visual Basic Interfaces and communicate with their care-givers. The rest of the children couldn’t communicate because they were unable to comprehend the text on the Visual Basic Interface. The main lesson learnt in India was that it is impossible to create one interface and expect it to be used for every participant with traumatic brain injury. Each participant had a slightly different version of disability. Any program that we create has to cater for individual needs. Cyberlink™ was the best choice of Brain Computer Interface for this research since it used variety of signals to communicate. There is still a lot of research being done in the University of Sunderland in this area. The team is grateful to the following Indian Institutes for their help and encouragement, Vimhams, AIMS and Missionaries of charities.