Client: University of Warwick
Source: Professional Engineering (Main)
Date: 28 July 2010
Page: 29
Reach: 76665
Size: 605cm2
Value: 5922.95

Mental leaps

Technology is meeting the challenge of fixing problems with one of the most complex pieces of engineering in existence – the human brain

By Ben Hargreaves

Great strides have been made in the treatment of sometimes devastating neurological illnesses such as epilepsy but the hope is that more effective remedies – epilepsy affects 1% of the population – will be created.

It is part of the remit of Professor Christopher James, the new joint director of the Institute of Digital Healthcare at the University of Warwick, who, with 16 years' experience in biomedical engineering, is well aware of the power of technology to combat illness and disability.

Much of his research has centred on improved automated analysis techniques for electroencephalography (EEG) brain signal data in epileptic patients and he is now working on further biomedical and pattern-processing improvements in diagnostic and prognostic tools for epilepsy and other disorders. James, who leads the UK and Ireland section of the Institute of Electrical and Electronics Engineers, says the technology that surrounds us is already having an impact on biomedical engineering.

He says: "One of the biggest things that has helped biomedical engineering move forward over the last 10 years has been the digital age in terms of communication – the fact that we've got a communication infrastructure which allows a high throughput of data to be squeezed over wireless and other networks and the fact that we can make devices which are very small, have high processing power but are low-power."

"You c softw

An example, he says, is cochlear implants, which help profoundly deaf people hear and are increasingly being implanted at earlier ages. "They are small, they are powerful, and they are low power. Some groups are looking at ways of making them self-powering – to 'scavenge' movements of the body to charge the batteries internally."

The cochlear implant software is flexible enough to be reconfigured and improved.

"You can change the software on the fly," says James. "For example, cochlear implants have processing algorithms which, relatively speaking, are pretty crude. Through more research you can come up with interesting new algorithms and it is simply a case of uploading a new algorithm to the device. The sophistication of the device can increase using the same level of technology."

James' doctorate was in the analysis of EEG data of the brain activity of epileptic patients and he maintains his keen interest in the field. Epilepsy is one of the most prevalent brain conditions and EEGs are commonly used to diagnose patients with the condition. Interpreting the results of the EEG is complex, however.

"There's no real definition of a 'normal' EEG," James explains. "A normal EEG is one with an absence of abnormalities."

Neurologists and epilepsy specialists must laboriously sift through the data from the EEG, looking for signs of

→

Client: University of Warwick
Source: Professional Engineering (Main)
Date: 28 July 2010
Page: 29
Reach: 76665
Size: 605cm2
Value: 5922.95

➔

epilepsy, but James has helped develop automated methods that rely on special pattern-processing algorithms to aid and speed up diagnosis.

He has also worked on methods for identifying which parts of the brain are responsible for seizures in patients who do not respond to anti-epilepsy medication, a significant minority. EEGs can be run on some patients while they are having a seizure to identify the source of the fit; once the area of the brain has been identified a surgical intervention can take place. Another research area is in the prevention of seizures before they happen in patients who do not respond to drugs or for whom surgery is too risky.

The institute is also working on brain-computer interface (BCI) technology to help severely physically disabled people communicate but with a focus on bringing down the cost of devices such as brain signal amplifiers to help make BCI more widespread. "One of the big pushes in my neural engineering lab is to take BCI out of the lab and into real people's homes," James says. He is working on types of interface that employ fewer signal channels and using BCI as a rehabilitation tool.

"Telemedicine", or the diagnosis and treatment of illnesses remotely within the home, is another key area of research. The institute will be working with patients who suffer from bipolar disorder (manic depression) to assess and diagnose mood swings that are usually reflected in increases and decreases of activity.

The patients wear a device with a tri-axis accelerometer which can pick up dramatic changes in their sleep, rest and daily activity patterns. These changes can be symptomatic of the illness. ■

You can change the software on the fly

➔