When the mind controls the machines

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More than a hundred patients suffering from severe motor impairments have voluntarily participated in the development of non-invasive brain-machine interfaces. The main purpose of these machines is to allow the patients either regain some of their mobility or improve their social relationships. Today, three presentations took place in Sion during the closing seminar of the TOBI European research program, which has been coordinated by EPFL for approximately four years.

Stroke survivors, as well as patients suffering from other serious conditions, may have to deal with the partial or complete inability to move one or more of their limbs. In the most severe cases, the sufferer may become fully paralyzed and in need of permanent assistance.

The TOBI project (Tools for brain-computer interaction) is financed by the European Commission under the Seventh Framework Programme for Research (FP7) and is coordinated by EPFL. Since 2008 it has focused on the use of the signals transmitted by the brain. The electrical activity that takes place in the brain when the patient focuses on a particular task such as lifting an arm is detected by electroencephalography (EEG) through electrodes placed in a cap worn by the patient. Subsequently, a computer reads the signals and turns them into concrete actions as, for instance, moving a cursor on a screen.

Tests involving more than 100 patients

Based on this idea, researchers from thirteen institutions together with TOBI project partners have developed various technologies aimed at either obtaining better signal quality, making them clearer, or translating them into useful and functional applications. During the research, more than 100 patients or handicapped users had the opportunity to test the devices. Three of the technologies developed within the framework of TOBI were publicly presented at the closing seminar of the research program that took place in Sion from 23 to 25 January 2013:

- **Robotino, for helping rebuild social ties when bedridden**. Combining EEG, signal recognition, obstacle sensors and the internet, researchers have been able to develop a small robot equipped with a camera and a screen that can be controlled remotely by physically disabled people. Thanks to this device, the patient can take a virtual walk in a familiar environment, meet her/his relatives and talk to them, even if they are thousands

of miles away from each other.

- **Braintree, for writing texts and internet surfing**. Researchers have also developed a graphical interface specially adapted for web browsing by severely disabled people. By thinking, the patient is able to move a cursor in a tree structure in order to type a character or choose a command. Depending on the specific situation, the sensors can also detect residual muscular activity to complement the management of the device.
- **Functional electrical stimulation**, to restore some basic mobility. Coupling EEG with electrical muscle stimulation can allow a patient to voluntarily control the movement of a paralyzed limb. In some cases, intensive training using this system has allowed the patients to regain control of the limb and keep it without assistance. A report on this technique can be seen in the video above.

The results of the TOBI research program have restored patients' hope. They will constitute the basis of subsequent developments to be conducted among the research partners or at industrial level. As for EPFL, such results will be the core of its health research chairs at the new EPFL Valais Wallis academic cluster, which can also count on the participation and support of the SuvaCare rehabilitation clinic in Sion.

"Our results are already very promising," says José del R. Millán, professor at the Centre for Neuroprosthetics (CNP) at EPFL, holder of the Defitech Foundation Chair in Non-Invasive Brain-Machine Interface and TOBI project coordinator. Nevertheless, he adds: "The road is still long before the "turnkey" product is made available to physicians and patients. Each brain has its own way of transmitting its signals and the devices' calibration requires the investment of significant resources. However, we have paved the way for a new critical approach to the physical and social rehabilitation of patients."

More information: www.tobi-project.org

Provided by Ecole Polytechnique Federale de Lausanne