Brain Computer Interface

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In the mid 70's, amidst the research of computers and computing technology, a small group of researchers lead by E. E. Fetz and D. V. Finocchio were looking at something different: a live monkey brain. Their research had one goal, and that was to see what happened in the brain when the monkey moved its arm. This experiment was one of the first experiments in a new and exciting topic in biomedical engineering: the brain computer interface.

The brain computer interface is a man made device that creates a communication port to the brain. A brain computer interface would take information from the brain, transform it to make it usable, analyze it to see what the brain wants to do, and send the data to an external device, like a prosthetic arm. At the external device, the data will be processed and the brains command will be executed.

Typically, the cerebral cortex is the area of interest in the brain computer interface. The cerebral cortex is the area of the brain responsible for playing a key role in memory, attention, perceptual awareness, thought, language, consciousness and motor function.

The first real study to be printed of inserting devices into the cerebral cortex to record information was published November 5th, 1996, by Miguel A. L Nicolelis and colleagues described an experiment of inserting 48 micro wires into various locations of a live rat brain. There results showed that implantations can be used to study and process information from the brain over long (several weeks in their test) periods of time.

From here the idea of actually doing something with that collected information began to float around. In September of 1999, Garrett Stanley and a team of researchers from University of California, Berkeley, studied visual processing in cats. Using multi electrode arrays implanted in visual center of the thalamus (lateral geniculate nucleus), visual information was recorded and amplified. After the signals were applied to an algorithm, identifiable visual recordings were made of what the cat saw.

Finally, in 2006, Andrew Schwartz and his team from the University of Pittsburgh implanted microelectrodes into a monkey brain. The trained monkey was successfully able to control a robotic arm, and feed itself zucchini, using a brain computer interface.

The way these BCI's work is technical but can and generally works as follows. The chip is implanted in the area of the brain responsible for the desired motor function. The chip itself is very small, and contains numerous pins to be inserted into the brain. These pins, which touch the neurons, measure the minute differences in voltages across active neurons, and interpret this as a signal.

These signals are stored and then synthesized using various complex transforms (such as time frequency transforms) and run through a program, typically something like Matlab or C++. Non invasive EEG BCI's record the voltages via electromagnetic waves produced by the brain. ii. The information that the program produces comes in packets of waves, typically spikes. The number and size of these spikes correspond to a desired action. On the external device is a computer, which has been programmed to recognize which wave forms correspond to which action. The external device then performs the desired action.

In the reverse, for example artificial sight or hearing, an audio or visual signal would be collected and then transferred to a BCI. Here, the BCI would create this small difference in voltage around the correct neurons. The neurons would then respond, and fire, hopefully creating an accurate image / sound.

There are mainly two types of BCI's: Invasive and Noninvasive. There is also semi invasive, but works similar to invasive. Invasive BCI's are attached directly to the gray matter in the brain, and require surgical implantation. Invasive can be used to restore visual information, like eye sight, and can also be used to take motor information. The motor information can be used to control a robotic limb, or restore movement to a paralyzed limb. i. Non invasive BCI's do not require surgical implantation into the brain. They, instead, are externally mounted on the head, and use one of several types of sensors to read EMG waves from the brain. Both require physical therapy and training, but invasive requires a more complex physical therapy program.

Currently, there are few companies listed in the market that produce BCI's. Among them is Cyberkinetics Neurotechnology Sys., Inc, a start up located in Massachusetts. Their flagship product is the Brain Gate chip, which has already been installed in patients. A competitor, Plexon, produces tools for brain stimulation, data recording, and other devices involved in the BCI industry. There is also room for non invasive BCI's in the gaming market, and a BCI game interface will be available this December.

http://www.springerlink.com/content/n586q68157037627/
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