Brain-Machine Interface

Gabrielle Murphy
ELE 282 Biomedical Engineering Seminar I
Biomedical Engineering, University of Rhode Island
April 7th 2003

A brain-machine interface is an interface in which a brain accepts and controls a mechanical device as a natural part of its body. The purpose of the brain-machine interface is to provide a method for people with damaged sensory and motor functions to use their brain to control artificial devices and restore lost ability via the devices. Studies are going on because scientists feel that they must first understand how the brain encodes and manipulates vast amounts of complex information.

One of the main research projects that is underway is being conducted at the Brown University Laboratory and led by Dr. John P. Donoghue, a professor of neuroscience who leads the brain science program at Brown. This project is a research effort for Brain Interface Machines to study the brain as it coordinates motions and to be able to write a program that is able to translate the thoughts into specific movements. The research in this lab is directed at understanding the form of higher-level information coding in the cerebral neocortex. The neocortex is the structure in the brain, a gray covering on the cerebrum, that differentiates mammals from other vertebrates and it is assumed that the neocortex is responsible for the evolution of intelligence. More specifically, they examine how the cortex represents information used to guide our actions John Donoghue and his company that he founded with some colleagues, Cyberkinetics has been conduction the monkey studies to pave the way for human tests. To date most studies of the cortex involve examination of one cell at a time in order to deduce the actions of that specific area of cortex.

In a lab at Brown University there are rhesus macaque monkeys that sit in a chair, facing a computer screen gripping the handle of a joystick and watching a computer screen that has a green dot on it and with the joystick they try to chase that dot with a red dot. Soon the monkeys with the aid of a computer and programs are able to chase the dot and drive the cursor with the thought signals sent from their brain.

The experiment, which was conducted on three monkeys, is set up by implanting a four-millimeter square array of 100 electrodes in the area of the brain that issues commands to the monkeys arm, the motor cortex, which is located just beneath the skull and about half way between the ear and the top of the skull. After this has been inserted wires are connected to the computer from the electrodes. These wires feed the electrical signals generated by the neurons firing near each electrode into the machine.

As the plugged in monkeys practice the video game, the array flashes pick up the brain activity as EKG like graphs that are audible and sound like popping rice crispies. Pattern recognition software that used by the team that paired the spiky patterns – it fishes out the spikes which each represent a single firing of a single neuron the neurons made as they fired the related trajectories of the monkey's arms as they moved. Using about three minutes of data the computer can build a model capable of extrapolating the monkey's arm movements from the brain signal and using that brain signal it can be translated into joystick output so that when the monkey thought about making a move the cursor made that move as the computer used the brain signal to drive the cursor, which can be translated into using the brain signal to drive a robotic arm. When the game was switched from the monkey having a joystick to it not having one and it only using only brain control the monkey took slightly longer to hit the red dot.

The result of this and other studies shows that the brain is very adaptable at adjusting to moving an artificial arm or cursor instead of a real one. This is a step in the direction of developing prostheses for humans. Only one of the neural prostheses pioneers has tested the interface machines on humans. Dr. Philip Kennedy has developed a procedure to give voice to stroke and other paralyzed victims. This program allows for a patient J.R to communicate through a computer.

The future of the outcome of such research is that this can improve the ability for paralyzed people to control prosthetic limbs and thus leading to more life-like prosthesis and further advancement in restoring movement and control to those who have lost it to either paralysis or amputation.