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HEALTH

Could the Paralyzed Use Thoughts to Command Robotic Limbs?

By Antonio Regalado
Staff Reporter of The Wall Street Journal

In a striking advance that holds much promise for physically disabled people, Duke University scientists have devised a way to read a monkey's thoughts and transmit them as commands to a robot.

If the experimental results can be extended to people, researchers believe that they may someday be able to give people who are paralyzed as a result of spinal-cord injuries or illnesses such as Lou Gehrig's disease the ability to use their thoughts to command robotic limbs, wheelchairs, even their own rewired bodies to do their bidding.

Researchers already know which areas of the brain control such activities as vision, memory and motion. More recently, neuroscientists have started to understand how those activities are directed by specific groups of nerve cells. The latest work, which was led by Duke neuroscientist Miguel Nicolelis, is the first time that scientists have been able to use this growing understanding to decode instantaneously the intention of a primate to move in a certain way. They then went the extraordinary next step and applied this mind-reading ability to command a distant robot to carry out the animal's thoughts, such as reaching for a fruit.

In an experiment, to be described tomorrow in the British science journal Nature, Dr. Nicolelis and his colleagues were able to mimic the monkeys' arm movements with one robot stationed nearby and another located hundreds of miles away at a laboratory at the Massachusetts Institute of Technology. When the motor thoughts of a monkey reaching for a piece of fruit were transmitted to MIT over the Internet and directed the robot to make identical movements, "it was a historic moment, the start of something totally new," said Mandayam Srinivasan, the MIT engineer who assisted the project. Initial reports of the experiment's success appeared in August in Galileu, a Brazilian news magazine based in Sao Paulo.

Scientists familiar with new mind-reading experiment said it represented an important step forward in helping paralyzed people augment their capabilities. "You could get a robotic arm to do whatever you thought about. You could restore paralyzed people's ability to interact with their environment," says John Donoghue, a neuroscientist at Brown University who is one of the growing cadre of researchers working on similar technology.

While many paralysis patients pin their hopes for a cure on research aimed at regrowing neurons, Dr. Donoghue said he believes a "patch for the nervous system" built from electronics is likely to happen first. Such systems could reroute brain signals to control a wheelchair, prosthetic limb or even a patient's own limbs.

While translating thoughts into movement is a nearly instant natural process, this study is the culmination of nearly four years of intensive experimentation by Dr. Nicolelis, 39 years old, a native of Sao Paulo, and his research team. In the new study, Dr. Nicolelis implanted dozens of hair-thin electrical wires into four areas of each monkey's cortex, the part of the brain where nerve signals that direct physical movement originate. Using these probes, the Duke team was able to record the electrical firing of as many as 100 individual neurons over a period of many months.

The Duke team used a computer program to correlate nerve signals with specific actions the monkeys were trained to perform. By analyzing the electrical firing pattern of many neurons at once, Dr. Nicolelis's team eventually learned how to predict what motion the monkeys would make about one second before their arms actually moved. In the study being reported this week, the researchers were able to translate this information into computerized commands that directed the simultaneous actions by the robots. The robots' movements were accurate to within five to 10 millimeters, Dr. Nicolelis said.

"Predicting the movement," Dr. Nicolelis explained in an interview, "proves you are reading the motor thought." Nevertheless, he readily admits that neither he nor anyone else understands how the messages being recorded are assembled, processed or used by the brain. "We don't know what the brain is doing," he said, "but no one does."

Still, Dr. Nicolelis and others in the field say they expect to be able to test such "brain-machine interface" technology in people within the next 10 years. One key hurdle that must be overcome is developing brain implants that can safely and reliably record numerous nerve signals at once.

Several efforts being financed separately by the U.S. government and corporations such as **Plexon Inc.** and **Bionic Technologies** Inc. are working toward this goal. Recently, the Department of Defense's Advanced Research Projects Agency, announced that it will spend about $10 million over three years to fund several research groups that have begun developing next-generation brain implants, some that carry onboard computers and that are able to transmit data through the skull with radio waves.

The push reflects a belief held by many researchers that developing brain machines is now primarily an engineering problem—though one that could take a decade or more to master. "To get signals out of the human brain with a cortical implant will be possible, but to get them reliably will take a while," said Bill Heetderks, director of the National Institutes of Health's Neural Prosthetics Program.

Monkey Think, Robot Do

Scientists at Duke University have found a way to read a monkey's thoughts, and make robots simultaneously do what the monkey thinks. Here are the basics:

1. Microwires implanted in a monkey's cortex record brain activity while the monkey performs a simple task, like reaching for a piece of food.

2. A computer, using data recorded from the monkey's brain, predicts where the monkey's arm will move.

3. The computer sends signals to two servers, one on a local area network at Duke University, the other 600 miles away at MIT.

4. The servers feed the signals to robots at Duke and MIT, which mimic the monkey's arm movements in real time.