Brain-linked Robot Arm Closer to "Plug-and-play"

Advance brings neural prosthetics nearer for paralyzed and limbless people

By Liz Brown
Betterhumans Staff
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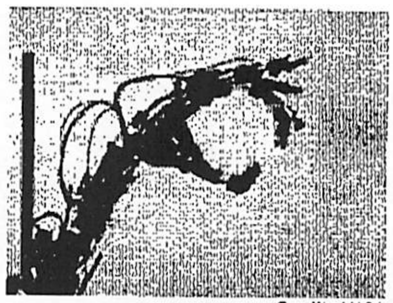
Neural prosthetics for people who are paralyzed or limbless are nearer with the development of a new brain-linked robotic arm that's a step towards a "plug-and-play" device.



Credit: NASA

Food for thought: A new robot arm wired to the brain has allowed monkeys to feed themselves just by thinking about it

Developed by US researchers at the University of Pittsburgh in Pennsylvania, the arm is about the size of a child's arm and moves like a natural limb. Complete with a simple gripper, it has allowed monkeys to grab and hold food while their own arms are restrained.

While previous work by Miguel Nicolelis and colleagues at Duke University in Durham, North Carolina has also enabled monkeys to control a robotic arm with their brain, the new device requires less preparatory work to use and is more directly applicable to real-world situations.

"In previous studies, because they have all this data from the monkey moving the cursor ahead of time, they knew which brain cells linked certain directions," says Peter Passaro, a graduate student researcher in the Laboratory for Neuroengineering at the Georgia Institute of Technology in Atlanta. "In this case, they didn't know ahead of time. So what they tried to duplicate is what you would find if you go into a human patient who's a quadriplegic—you're not going to have the arm movement to train them because they don't have it."

"Breakthrough" development

For their study, the researchers from Pittsburgh wired a robot arm to a monkey's brain using electrodes attached to probes that tap into neuronal pathways in the motor cortex. The motor cortex is the region of the brain responsible for voluntary movement.

This region of the brain contains thousands of neurons that fire in different directions for various movements. The direction which a neuron fires fastest is its "preferred direction."

To interpret these signals, the researchers developed an algorithm which translates the directions to the arm, telling it which direction to go. The algorithm fills in the missing neuron signals that can't be tapped, allowing the machine to get a useable signal from fewer electrodes. By finding a cell's preferred direction, the algorithm predicts the movement based on what the majority of the cells prefer.

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"This is a breakthrough in the development of neural prosthetic devices that will someday lead to devices that could help people who are paralyzed or who have lost limbs," says Andrew Schwartz, senior researcher on the project.

Hands and fingers next

The monkeys were trained to reach for food, and when the electrodes were added, their arms were restrained and the algorithm adjusted to assume the animal was reaching for food.

"Each cell is movement-sensitive and has a preferred direction, and each cell's preferred direction is like a vote," says Chance Spalding, a graduate student who presented the findings. "When all of the votes are added up it gives us the population vector."

The "votes," in turn, serve as the control signal, passing the monkey's intention to the robotic arm.

However, the monkeys have to modify their thinking to refine the control of the arm, as the algorithm isn't completely accurate, relying on only a small number of the thousands of neurons that move a real arm.

"The next step with this device is to add realistic hand and finger movement," says Meel Velliste, a member of the research team. "This presents quite a challenge because there are hundreds of different subtle movements we make with our hands and we need to interpret all of them."

The research was reported in San Diego, California at the 2004 annual meeting of the Society for Neuroscience.

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