Researchers demonstrate direct brain control of humanoid robot

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A classic science-fiction scene shows a person wearing a metal skullcap with electrodes sticking out to detect the person's thoughts. Another sci-fi movie standard depicts robots doing humans' bidding. Now the two are combined, and in real life: University of Washington researchers can control the movement of a humanoid robot with signals from a human brain.

Rajesh Rao, associate professor of computer science and engineering, and his students have demonstrated that an individual can "order" a robot to move to specific locations and pick up specific objects merely by generating the proper brain waves that reflect the individual's instructions. The results were presented last week at the Current Trends in Brain-Computer Interfacing meeting in Whistler, B.C.

"This is really a proof-of-concept demonstration," Rao says. "It suggests that one day we might be able to use semi-autonomous robots for such jobs as helping disabled people or performing routine tasks in a person's home."

Video: University of Washington

The controlling individual – in this case a graduate student in Rao's lab – wears a cap dotted with 32 electrodes. The electrodes pick up brain signals from the scalp based on a technique called electroencephalography. The person watches the robot's movements on a computer screen via two cameras, one mounted on the robot and another above it.

Right now, the "thought commands" are limited to a few basic instructions. A person can instruct the robot to move forward, choose one of two available objects, pick it up, and bring it to one of two locations. Preliminary results show 94 percent accuracy in choosing the correct object.

Objects available to be picked up are seen by the robot's camera and conveyed to the user's computer screen. Each objects lights up randomly. When the person looks at the object that he or she wants to pick up and sees it suddenly brighten, the brain registers surprise. The computer detects this characteristic surprised pattern of brain activity and conveys the choice back to the robot, which then proceeds to pick up the selected object. A similar procedure is used to determine the user's choice of a destination once the object has been picked up.

"One of the important things about this demonstration is that we're using a 'noisy' brain signal to control the robot," Rao says. "The technique for picking up brain signals is non-invasive, but that means we can only obtain brain signals indirectly from sensors on the surface of the head, and not where they are generated deep in the brain. As a result, the user can only generate high-level commands such as indicating which object to pick up or which location to go to, and the robot needs to be autonomous enough to be able to execute such commands."

Rao's team has plans to extend the research to use more complex objects and equip the robot with skills such as avoiding obstacles in a room. This will require more complicated commands from the "master's" brain and more autonomy on the part of the robot.
"We want to get to the point of using actual objects that people might want the robot to gather, as well as having the robot move through multiple rooms," Rao says.

One goal of future research is to make the robot's behavior more

adaptive to the environment, which means the robot's programming must enable some kind of learning to occur. Rao's team is well positioned for such research because it is one of the few groups in the world simultaneously investigating ways of controlling robots with brain waves and exploring advanced ways for robots to learn from experience.

Early in the experiments, Rao considered the question of whether the robot should be equipped with wheels rather than legs, which in some settings might make movement easier and more stable.

"We thought about this, but decided that our goal was to design applications for a human-centered environment in the home or work place," he says. "So, to move and perform in those environments, the robot would have to be humanoid – to walk up stairs, for example, and to grasp objects designed for human use."

For the demonstration, the robot was in a different room but in the same building as its human "master." However, physical proximity is not a requirement for this brain-computer system to work: the individual and the robot can be anywhere in the world as long as there is Internet connectivity between their two locations.

Robots that act as human "agents" are a staple of science fiction literature and futuristic television shows like "The Jetsons," in which the family had a robotic maid. Rao calls what his team has done "a primitive first step" down this road.

Another video demonstration is available:
uwnews.washington.edu/ni/video/movie_robot3.swf

Source: University of Washington