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Thought-controlled robots could immerse paralysed people in the physical world

European scientists are creating new virtual reality systems that are so good they can fool people into believing they're real, and the results are offering new ways to interact with the physical world.

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Research on how the brain perceives the body – and how this perception can be altered – is leading to the development of thought-controlled robot surrogates for paralysed people and treatment for phantom limb pain in amputees.

Dr Mel Slater from the University of Barcelona in Spain is in charge of the EU-funded VERE project which is helping to develop thought-controlled systems that could allow a paralysed person to interact with the physical world, for example by controlling a robot from a first person perspective to grab a drink out of the refrigerator or a book off a nearby shelf.

The team first set about developing a way to control the movement of a graphical avatar using thought alone. Using a helmet covered with electroencephalogram (EEG) sensors, scientists can record electrical signals in the brain and use these to direct the avatar.

'When you ask someone to think of moving their right hand then the pattern of electrical signals is different than when they think of moving their left hand,' Dr Slater explained.

'This motor imagery method is one way where brain activity can be used to control something external, whether a virtual body or a robot or anything else.'

Users are put into a virtual environment where they can look around using the same head motions they would use normally. The user also wears goggles that let them see from the robot or avatar's perspective.

In order to track the user's eye movements and direct the avatar accordingly, the team uses displays that flash at different frequencies. When the user looks at a certain area of the display, the scientists can measure which frequency they are sensing and therefore in which direction they are looking.

Motion capture cameras can track subjects and can even be used to create a reflection on a mirror in the virtual world, helping to generate the illusion for participants that the virtual graphical avatar is their own body.

The VERE project team is using the control capability to develop robots that paralysed patients can manipulate to interact with the world. Such trials are already being successfully performed in the lab.

Changing perceptions

Dr Slater has found that the illusion that the avatar's body is ones' own can be so strong it can change perceptions of reality.

'For example, putting adults in the body of a young child leads to their perceiving the world as larger, and also to changes in implicit attitudes towards being child-like,' he said.

Another experiment had participants' avatars speak while a vibration was applied to the thyroid cartilage around their voice boxes as if they uttered something in real life. Participants were tricked into believing they had in fact said something.

Video courtesy Mel Slater/VERE

The power of such technology to shift people's perception holds promise for use as a psychological tool, for instance to boost self-esteem.

This was demonstrated in a study which asked people to comfort a crying child as their avatar. Afterwards, participants took the perspective of the child and watched themselves be comforted by an avatar of their image, which had the effect of lowering their own self-criticism.

The key to the process is making patients identify not just with – but as – their virtual avatar. While this could seem spooky, Dr Slater cautions that there is no more reason to fear such techniques than one would fear going to a therapist. His team has an entire line of research dedicated to making sure such reality controls are ethical.

Phantom limbs

Altering people's perception of what is – and is not – their own body is also being used to treat phantom limb pain in amputees.

Losing a leg or an arm is traumatic, but many amputee patients continue to feel pain originating from a missing limb as if it were still attached to the body, a phenomenon known as phantom pain.

A survey of amputees in the United States published in 2005 found that almost 80 % suffered phantom pain sometime or all of the time.

In a famous psychological experiment, subjects watched a rubber hand be stroked in front of them, while their own hand was stroked out of view. Patients were tricked into believing that what they were feeling was coming from the dummy hand being touched instead of their own hand.

In the PHANTOMMIND project, a team led by Dr Herta Flor at the Central Institute of Mental Health in Mannheim, Germany, is using their own twist on this illusion to help treat phantom pain patients.

Dr Flor’s team gave patients the illusion that they were moving their missing limb by using mirrors to reflect an image of their remaining limb onto where their missing limb should be. The researchers also took brain scans of the patients to determine how their brains processed such stimuli as treatment progressed.

The scientists found that weeks of such mirror therapy could reduce pain by about a third on average. While it didn’t work for all patients, for those that did see an improvement, the half of the brain that controlled the missing limb reorganised to become closer to the ‘normal’ half of the brain controlling the good limb.

Refining such methods to better convince patients into accepting a mirrored limb as their own could yield more effective treatments to help amputees in the future.

VERE's Dr Slater believes that understanding how virtual reality affects how we see the world will become more important as avatars representing real people or entirely computer-generated people will be ever more present in everyday life.

‘The idea of experiencing aspects of the world but from the perspective of having a different body, even if virtual, appears to be a powerful way to endow people with enhanced understanding of their social reality,’ he said.

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