Editorial

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Will Humanoid Robots Become an Assistive Technology for People with Special Needs?

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Editorial

Humanoid robots will certainly be part of our lives in a medium or long-term future. They have been designed for use in controlled environments to better satisfy human needs. Engineering and neuroscience research have determined some of the characteristics that will make them become our social "other"; this is demonstrated by the fact that a motion for a resolution regarding civil laws on robotics has recently been proposed to the European Parliament, as explained in document 2015/2103 (INL) [1]. The range of robotic applications that are available is extremely vast, diversified and in continuous growth, from those used in minimally invasive robot-assisted surgery and rehabilitation, to those targeted to be employed in hospitals/care homes as well as personal robots used as motivational coaches. Other uses involve assisting or socially engaging older people to provide with long-term social and emotional support or help people with special needs in living healthier lives connecting with significant others.

Social robots can enhance mood, emotional expressiveness and social bonding among patients with dementia [2,3]. They are employed with children with autism spectrum disorder for intervention purposes enhancing social skills, joint attention, turn taking and emotion understanding [4-6] with interesting results in suppressing autistic stereotypic behavior and maintaining visual gaze. In classrooms and school environments, they can be improve learning [7-9], problem-solving abilities, math and science skills [10]. They can also be able to assist users in airports and supermarkets [11] or represent a companion at home [12,13]. They are specifically designed to recognize faces with two cameras that allow them to measure the distance between eyes, mouth and other face points and call people by their names. Nowadays exist humanoids able to "read" basic emotions and act consequently considering the expressivity of mood of those interacting with them [14]. Some of them can even simulate emotions, making people feel understood and not alone, and simulating empathy through the activation of the mirror neuron circuit [15]. Kinetics technology can help them imitate moves [16] while speech recognition software can make them "understand" what people say in many different languages. Not surprisingly, the mirror circuit responsible for social interaction is activated during human-robot interaction [17], which might make it possible for humans to consider them as real companions with intentional bodies.

Robotics could partially fill in some of the identified gaps in current healthcare and home care/self-care provisions for promising applications in these fields that we expect to play relevant roles in the near future. The humanoid robot NAO is a fully programmable research platform for Human-Robot Interaction for entertaining, educating and improving communication skills. Robotics are also employed as assistive technologies for older people suffering from Mild Cognitive Impairment (MCI) and living alone at home in order to help them remain in their familiar environment as long as possible.

If technology and research have gone this far, how come robots are not yet seen walking around with people, helping at the supermarket, teaching, keeping company to elder people or steadily doing any activity in a daily basis or in uncontrolled environments. Why it is so hard for humanoids to leave the lab-structured environment and find a place where they can be lastingly used?

Our research program aimed to provide evidence that large mutual influences between cognitive neuroscience and robotics enable a better understanding, which leads to an increased acceptance of future robotic in society and health care provider services. In our lab, we have developed some applications to use NAO within the context of typical memory training conducted in a small group format. The purpose was to introduce the robot in a protocol usually employed in memory training for people with amnesic MCI making NAO "adapt" to this environment without manipulating the setting. The interest in MCI individuals is due to the wide range of rehabilitation chances that persons with this impairment allow; a second motivation is that in case their impairment converts in dementia, they will already be familiar with this technology. In our experiments, NAO "substitutes" the psychologist during some protocol's exercises-read a story and makes some questions about the narrative in order to stimulate explicit memory or sings some Italian songs asking for their title or the singer's name. Data from pilot studies indicate that NAO has been accepted as "co-tutor robot". Our current efforts are still concentrated on making the interaction as empathic and flexible as possible.

Considering our experience, there are many reasons that prevent robots from currently becoming real companions. From the technology point of view, they need a lot of power to work, and batteries are not efficient enough to make them work at least for a day, so it is necessary to be near a plug almost permanently, which consistently limits the robot's possible movements. A second reason is that they are not really user-friendly since significant computer programming skills are yet necessary. Finally, the available programs are not always applicable to different contexts (e.g. NAO has been programmed to move over a table and interact with a certain number of individuals sitting around the table, but if people's number changes, the situation must be arranged because NAO's movements will not automatically adapt to the new environment).

Our group has devoted a large amount of time to both decide tasks and develop relevant programs but it remains to be examined how people react to the robot behavior, and this may make a huge difference in how the robot is perceived. Humanoid robots are meant to appear as a living thing, with biological movements, but when NAO robot reaches to the center for participating in the stimulation sessions, it is normally turned off and inside a trolley. Would not it be very different if NAO could get to the work area walking or holding hands with its programmer?

We need to use neuroscientific methods (eye tracking, EEG, fMRI, fNIRS) to have an objective measure of how the human brain reacts during the interaction with humanoid robots, but it will also take a lot of time to be creative, in order to render robots humanized. In our setting, NAO correctly performs his exercises but with repetitive postures whereas communication requires postures, facial expressions, emotions, and intentions. In order to fulfill this purpose, research must also be done through qualitative or social research methods like action research, testing exercises and observing the people's reaction in an uncontrolled but limited environment, away from the programmer lab. The view will certainly be clearer when robots be will adapted to specific real environments where they "socialize" with humans with protocols that reduce the number of possible behaviors giving information to reprogram the robot for fitting in the selected environment simulating intentions and emotions or even introspection [18,19].

In such perspective, our current work is addressed to modify NAO's expressivity while performing the same exercises but in a more flexible manner, reducing predictability, personalizing the interactions through face recognition, and including specific gags between the tasks. Preliminary findings showed that our approach is effective highlighting NAO's inherent capabilities in order to represent the ideal low-cost tool that supports treatments for individuals with special needs.

Humanoid robots must take their first steps outside the laboratory, in environments where the programmer will initially be needed until the robot's behavior becomes more flexible and less predictable to simulate human behavior. The aim is to produce social robots with intentions and social cognitive capacities that are typical of the human brain.

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