Chapter 64
Use of Humanoid Robots for Students With Intellectual Disabilities

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ABSTRACT

In parallel with the significant developments in robotics, humanoid robots have become popular recently. It is known that when humanoid robots are used for educational goals, students become more interested in learning activities, develop better situation awareness through exercises and physical activities, and learn more effectively. Therefore, humanoid robots will possibly play a key role in education in the future. Since humanoid robots have enhanced social skills, are able to repeat a particular sequence many times, and provide real-time feedback, they can improve the engagement of students with intellectual disabilities and may find significant acceptance in specific target groups, such as students with autism spectrum disorder. In this chapter, the authors investigate the use of humanoid robots for students with intellectual disabilities and review existing approaches in this domain. In addition, limitations and challenges to the use of humanoid robots for educational goals are discussed. Finally, the authors investigate research challenges in this domain and state future research directions.

INTRODUCTION

Intellectual disability indicates certain limitations in mental functioning, daily living skills, and social skills. The most common causes of intellectual disabilities are genetic conditions, problems during pregnancy or at birth, and health problems (Reichenberg, Cederlöf, McMillan, Trzaskowski, Kapara, Fruchter… Lichtenstein, 2016). It is known that students with intellectual disabilities have difficulties in understanding complex information, using logical thinking to solve problems, following instructions,

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and using judgment (Downing, 2010). When working with such students, a number of techniques, such as using concrete examples to explain new concepts, identifying expected behaviours clearly, planning ahead with class activities, using appropriate communication methods, putting skills in context, learning about the need and characteristics of the students, asking for the students' input about how they feel they learn best, and involving families in learning activities, might be quite useful (Heward, 2009; Şişman, & Yaman, 2017). Such students may benefit from strategies such as hands-on learning, play-based learning, group learning, positive reinforcement, chaining, and activity splitting (Bragdon, Uguray, Wigdor, Anagnostopoulos, Zeleznik, & Feman, 2010).

In the last decade, human-robot interaction has been an emerging field of research and humanoid robots with good interaction abilities have been developed. Humanoid robots have capabilities including sitting, standing, walking, task sequencing, playing sound files, speech, speech recognition, and object recognition. It has been demonstrated in many studies that humanoid robots can be used to increase engagement of students (Kory Westlund, Gordon, Spaulding, Lee, Plummer, Martinez, Das, & Breazeal, 2016). Due to their reduced social skills and impaired understanding, educating children with intellectual disabilities presents significant challenges for new teachers (Robins, Dautenhahn, Te Boekhorst, & Billard, 2005). Since a humanoid robot can be programmed to provide immediate helpful feedback to the student, repeat things that the student has not learnt well, help the student work at his/her own pace, respond to his/her specific needs and put higher emphasis on certain subjects (Chang, Lee, Chao, Wang, & Chen, 2010; Kucuk, & Sisman, 2017), a humanoid robot can be viewed as a novel educational tool that could improve engagement of children with intellectual disabilities.

HUMANOID ROBOTS IN EDUCATION

In parallel with the increase in computing power, cost reductions in memory and storage, improvements in battery technologies, and developments in sensing and perception technologies, there has been an increasing interest in the development of humanoid robots. In spite of a certain lack of studies at a large scale on the topic, it is generally agreed that humanoid robots are an exciting and engaging tool for students (Keane, Chalmers, Williams, & Boden, 2016). Although there are many other reasons that justify the use of humanoid robots in education, the most important ones are as follows. First, humanoid robots can move and physically interact with students and the environment. Second, adjustable sensory stimulation can promote better perceptive experience for students. Finally, humanoid robots are generally perceived as independent and intelligent agents by students and therefore they can take play mate roles and mediate activities in cooperative situations without replacing teachers or peers within an activity (Pennazio, 2017). Even basic humanoid robot platforms designed for public use may open up numerous possibilities in terms of interactions in education. The interaction design space can be investigated along three dimensions (Özgür, Lemaignan, Johal, Beltran, Briod, Pereyre, Mondada, & Dillenbourg, 2017).

- **Passive Robots vs Autonomous Robots:** Although some basic robots are passive and can be manually moved, complicated humanoid robots can be entirely autonomous and may not allow manual manipulation (Özgür, Lemaignan, Johal, Beltran, Briod, Pereyre, Mondada, & Dillenbourg, 2017).
- **Independent Robots vs Multi-Robot Environment:** Although some robots can act independently and are unknown to other robots in the environment, multi-robot environment refers to activities in which the interactions between robots are absolutely necessary.