APPLICATION OF ROBOTS TO IMPROVE SOCIAL AND COMMUNICATION SKILLS AMONG AUTISTIC CHILDREN

M.Z. Ismail[1], N. I. L. Azaman[1] and N.K Khalid[2]

[1]Faculty of Mechanical Engineering,
Universiti Teknologi MARA (UiTM), 40450, Shah
Alam, Selangor, Malaysia.

[2]Centre for Foundation and General Studies,
Universiti Selangor (Unisel), 40450, Shah
Alam, Selangor, Malaysia.

Corresponding Author's Email: [1]zaiyad@salam.uitm.edu.my

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ABSTRACT: Autism Spectrum Disorder (ASD) typically appears during the first three years of life. It exhibits certain characteristics such as impairment in social interaction and communication skill. This paper analyzed the use of robots in augmenting social and communication skills among ASD children. The features and characteristics of seven widely used robots and their impacts were included. There are variety of robots worldwide being used as therapy assistants in ASD therapy with multiple functions and appearances. Thus, future study can focus on how to combine the features and advantages of each robot to create more efficient robots in helping children with ASD.

KEYWORDS: *Autism Spectrum Disorder (ASD); Robots; Therapy Assistants; Impairments in Social; Communication of Behavior*

1.0 INTRODUCTION

Autism Spectrum Disorders (ASD) are neurodevelopmental disorders which are characterized by impairments of the growth and development of the brain that affect the normal preparation in the areas of social interaction and communication skills. The growing number of ASD increases steadily and it cuts across family income, lifestyle, and educational level [1].

Social learning and communication skills play important roles to overcome this problem. When a child is having trouble in social and communication skills, it is harder to learn the language, contribute in conversations, and play with other kids [2]. Recently, the use of robotic technology has been identified and explored to support ASD children in improving their social and communication skills. Furthermore, treatment in the early stage of ASD is very critical to help children grow independently. This is due to the rapid process of growth and development of the brain which occurs at the age of 6.

Rapid progress in robotic technology offers excellent innovation treatment and new education for children with ASD. This paper focused on reviewing robotic technology used in autism treatment that helped children improve their learning in social and communication skills. Currently, variety of robots around the world has been employed as therapy assistants for autism treatment with different looks and functions [3]. Rehabilitation by robots is now becoming a trend in healthcare realms [4-5].

2.0 BACKGROUND OF AUTISM SPECTRUM DISORDER (ASD)

Statistically, ASD is one of the fastest growing disorders worldwide [1]. ASD typically emerges during the first three years of life [6]. It often occurs four times more prevalent in boys than girls [1, 4, 7]. According to Centre for Disease Control (CDC) in the United States, the probability of ASD is 1 in 68 children.

ASD is classified by three main behavioral disorders which are impaired social interaction, impaired communication (verbal and nonverbal), and impaired repetitive behaviors or restricted interests [6-9]. The first one is the most significant behavior in human life. Compared to normal kids, children with ASD give their attention more on toys and have less interaction with others, causing poor social skills. Secondly, impaired communication is a situation where they have a tendency to mimic others' speech rather than form their own sentences. The last characteristic is the presence of repetitive behaviors which are the form of recurring motor movements such as flapping the hand, walking and spinning in circles [6, 9].

3.0 BACKGROUND OF ROBOTS FOR REHABILITATION IN SOCIAL AND COMMUNICATION SKILLS

The application of robots in ASD therapy displays an increasing trend in recent years. Many types of robots with different functions and characteristics are being used such as Nao, Robota, Probo, Keepon, I-Sobot, Tito, Kaspar, Labo and Ifbot. Some of these robots have significant criteria in communication skill such as imitation and eye contact.

3.1 NAO Robot

Humanoid Robot NAO, as shown in Figure 1, is an autonomous humanoid robot developed by a French Company called Aldebaran-Robotics [9]. This small sized humanoid robot is able to interact with ASD Children. It can be programmed autonomously and is able to perform verbal and non-verbal interactions. The Robot NAO is popular and becoming people's choice as it has the ability to make eye contact, verbal communication, imitation skill, and create attention, react appropriately to the behaviour of others, perform turn-taking, and generate attention among children with ASD [4, 10-16].

A study [4] found that the NAO robot is approachable to children because of the eye contact impact which are observed when the children are communicating with the robots. The comparison of scores is carried out based on the evaluation of behaviour score sheet of Gilliam Autism Rating Scale-Second Edition (GARS-2) which is an autism screening tool developed to measure the autism level. E. Bekele et al., asserted that children with ASD spend more time looking for the robot compared with the human administrator [11].

A study [12] presented the effectiveness of an applied behaviour analysis (ABA)-based intervention done by a NAO robot and a trainer in encouraging ASD children to start a conversation. The result showed higher attention and less repetitive behavior among the children with robot. Another study [3] proposed that ASD children basically lack of response to Joint Attention. Children with ASD demonstrate improved performance within system across sessions with the NAO robot over the course of interactions [10]. These findings show potentials in system capabilities support and Joint Attention application [18].

Figure1: Humanoid Robot Nao

Besides, children with ASD are found to spend relatively more time looking at the NAO robot compared with human in attention task for imitation skills [13]. In addition, children with ASD play together with NAO robot using Lego therapy [16]. In another study [17], a pilot study was conducted using NAO's appearance and capabilities such as blink eyes, speak and play music. Hence, this would significantly reduce children's autistic characteristics in communicative behaviour [17].

3.2 ROBOTA

Robota is a humanoid robot that has the capabilities of moving its hands and feet as well as dancing. The Robota constructs a series of multiple degrees of freedom doll-shaped humanoid robots, whose physical features resemble those of a human baby [18]. Using Robota doll within 101 days, a study [19] found that children with ASD show improvement in imitating others, taking turns and exchanging roles. Moreover, the children interact with the investigator using Robota as a mediator. Similar result was found when observing ASD children with Robota [20]. They also conclude that the behaviours of touch, imitation, and eye contact increase, scoring highly on the last day of experiment [20-21].

3.3 PROBO

Probo is known as a storytelling social robot. Probo is used to teach ASD children how to respond to simple greetings such as "thank you" and "hello" [22]. The authors also found that, ASD children would

mostly be able to say "thank you" independently and spontaneously, without the need of any prompting when interacting with Probo [22]. In addition, Probo receives an increasing attention as an assisting tool for reconstructing the social and emotional skills of children with ASD [23]. Children with ASD show improvement in identifying both sadness and happiness [23].

3.4 KEEPON

Keepon is a small creature-like robot designed for simple, natural and nonverbal interaction with children. Therefore, when ASD children are dealing with a robot that has appropriate predictable behaviour, they can approach the robot in a relaxed and playful mood [24]. At the same time, they will spontaneously start explorative interactions. The child might subsequently learn to predict and control the robot's behaviour because of its dependence on physical and social situations. Autistic children, who have difficulty in interpersonal communication, are able to approach Keepon and gradually establish physical and social contact.

On the other hand, children with ASD perform better in the acquisition phase of the reversal learning task when interacting with the robot compared with human [25].

3.5 I-SOBOT

I-sobot is the 7-inch humanoid robot that facilitates "praxis on imitation" for a range of gross motor actions based on karate and dance. Next, children who play with I-sobot improve their ability to recall actions during the imitation skills test [26]. This is supported by a study [27] where ASD children aged between 4 and 11 years improve their social skills using I-sobot [27].

3.6 TITO

Tito is a 28 inches tall robot in red, yellow and blue colour. Tito consists of four wheels to emulate a humanoid shape. It also has two arms that can move up and down rapidly, a head that can rotate and rise, a mouth, two eyes, a nose, hair and a hat. Children who are paired with Tito present more visual contact compared with the children paired with human [28]. They discovered that Tito is more

predictable and less complex in its interaction modalities. They also state that children who are paired with Tito mediator showed greater attention than the children who are paired with human mediator. These findings are made based on facial expressions, body movements, everyday actions with objects or/and common actions without objects among Tito, guardian, and ASD children. Hence, Tito, indeed, has appealing characteristics when interacting with autistic children [28].

3.7 KASPAR

The first version of KASPAR was built in 2005. KASPAR is an expressive robot that has attributes like human being. ASD children display high interest in playing and have more cooperative attributes [29]. Based on these observations, the kids enjoy playing games while interacting with the robot [29].

4.0 CONCLUSION

This paper analyses how the use of various types of robots may help ASD children to improve their communication and social skills. In general, ASD children show good response to robot-based intervention. The different features of robots and the impact in therapy are presented in this paper.

For future work, more contributions can be done to perform evidence-based clinical studies in behavioral interventions to suit participants with a large sample size and long-term treatments. Some important criteria of the robots are highlighted. Due to the massive potential of robot-based therapy, the use of robots as therapists may persist with better outcomes. There are great chances to see these ASD children to be able to live and do things independently.

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