International Conference on Robot PRIDE 2013-2014 - Medical and Rehabilitation Robotics and Instrumentation, ConfPRIDE 2013-2014

Humanoids In Autism Therapy: The Child Perspective

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Abstract

Robots are now widely used for psychological intervention in the mental care sector. The tremendous technology changes have become incredibly important to the industry. Through innovation, industry offers treatment or solution for those who suffered with autism spectrum disorders (ASD). From the literature reviewed, physically pleasing robots or humanoids have replaced humans to assist with brain-impaired children. Since this is a new area in Malaysia, literature has been scarce. Thus, this article will examine the provision of relevant theories supported the use of humanoid in autism and their impacts on society.

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Peer-review under responsibility of the Center for Humanoid Robots and Bio-Sensing (HuRoBs)

Keywords: humanoid; brain-impaired children; autism; intervention and autism spectrum disorders (ASD)

1. Introduction

The new millennium has propelled technology-driven revolution with dramatic success. Robots have been used to substitute human way back in the 19th century. They are beneficial to society, regardless of the fields that they are being utilized. The health sector has been identified as one of the fields that benefit most as a result of using robotics.

For decades, people fascinated with the technology’s fiction of robots that look and act like a human. To date, robots are no longer curiosities and most of the industry adapts to use and produce because they believed with the
technology would lead them to be a competitive advantage\(^1\). Perhaps, robots could become a human best friend. Children are often more willing to engage and interact with robots as compared to adults \(^2,3\).

Based on The National Autism Society of Malaysia, (NASOM), in Malaysia, the statistic showed that there are 1 in every 150 children has been identified with autism spectrum disorders (ASD)\(^4\). In the United States autism disorder affecting children between one in 80 and one in 240 children. Thus, the use of robotic systems is hoping to act as a therapy for these autistic children \(^5\).

Furthermore, robots are capable to improve human motivation to use such technology. Robots are capable to stimulate autism children inspiration to communicate with their robot partner rather than interact with the therapist\(^6\). Nevertheless, \(^7\) found that these children have difficulty to respond immediately to the humanoid actions as compared to the human actions.

It has thus remained an open question whether the beneficial effects of social robots extend more broadly across the autism spectrum. Humanoid robotics research covers on perception, processing and action that are embodied in anthropomorphic form in order to emulate some subset of the physical, cognitive, and social dimensions of the human body and experience\(^1\).

Study of \(^8\) has shown the positive effect of a humanoid on autistic children. Yet, recent studies in robotics still focus on different view of robotic. For example, \(^9\) focus on finger direction recognition and \(^10\) focus on robot’s error of which shown that there is still lacking of study in humanoid robotic for Autism children. Therefore, the purpose of this paper is to review the provision of new theories that embodied autistic children relative to humanoid robots and their impacts on society.

2. Previews Of Autism Research

2.1 Autistic child

Autism refers to the term Autistic Spectrum Disorders (ASD) with a range of indicators of a disorder that can occur in different degrees and in a variety of forms\(^11\). However, the exact cause of autism is still unknown.

There is no precise definition that can specifically define and categorized an autistic child. Thus, researchers tend to define autistic child based on specific diagnostic criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders\(^12\). An individual autistic child can then be defined based on their levels of difficulties, abilities and overall intellectual functioning. According to National Autistic Society\(^13\) autistic children that suffered from brain impairment categorized as:

1. Impairments in social interaction:
   Autistic children have difficulty in forming a relationship and understanding others’ intention and feelings towards them.

2. Impairments in social communication:
   Involve verbal and nonverbal communication. Autistic children difficult to understand gestures and facial expression. They also not able to interpret what people say and respect others’ intention and emotional states.

3. Impairment in imagination and fantasy

Autistic children have a limited imagination and do not involve in the development of role-play.

Those autistic children who suffered with autism spectrum disorders (ASD) is hardly to get engaged in learning because they show little reciprocal use of eye contact in interacting with others. It is evident that ASD affects males than females and reduces their ability to have an independent life\(^14\).

However, there are three general characteristics that can be detected in an individual child with autism namely, difficulties with social relationship, difficulties with both verbal and non-verbal communication, and restricted repetitive and stereotyped behavior and activities. ASD concurrences between autistic children who have their own uniqueness abilities and disabilities\(^14\).
The physiognomies of autism: “Autism is a lifelong pervasive developmental disorder affecting social ability”\textsuperscript{14}. People with autism form an actual diverse group, but they all exhibit impaired social interaction and communication, and have a limited range of imaginative activities. Additionally, it is common to find repetitive behaviour patterns and resistance to change in routine\textsuperscript{15}.

Autistic children are difficult and more complex to perceive human social behaviour to communicate and interact. Autistic Spectrum Disorders (ASD), with a range of manifestations that can occur in different degrees and in a variety of forms. The exact cause or causes of autism are still unknown. Autism is a lifelong developmental disability that affects the way a person communicates and relates to people around them\textsuperscript{16}.

2.2 Humanoid Robot

Autistic Spectrum Disorders (ASD) develops before the children learned to speak. Therefore, humanoid robots give benefits towards autism therapy for early detection. By using this technology, it can interactively encourage autistic children to communicate and respond to the robot\textsuperscript{17}.

A humanoid or the so-called interactive social robot is specifically designed to interact with human beings. Humanoid can generate expressive social interactions with humans. Humanoids can become a therapeutic playmate, encourage and facilitate social interactions with others, become a social agent model for autistic child\textsuperscript{13} and enhance autistic children’s social interaction learning\textsuperscript{18}. A study has shown that autistic children are more concentrated and stimulate with humanoid robots which remotely operated robot “puppets” that’s able to dance to pre-recorded music\textsuperscript{19}.

Therapists and medical experts believe that the most suitable size for humanoid robot must be roughly the size of the autistic children age between 2 – 5 years old. The reason why humanoid robots should follow the size of autistic child because it will make them more enjoyable to play and have a good eye contact to imitate the movement of the robot\textsuperscript{14}. Although humanoid has the ability to replace human in treating autism child, care must be taken by researchers as not to be too dependent on the humanoid. This is because; humanoid also is being developed to aid humanity only. Based on the Aurora Project, even though robots may not wholly predictable, it has simple behaviors compared to human behavior, which is more complex to understand autistic children.

Rich diversity of projects wherein perception, processing, and action are embodied in a recognizable anthropomorphic form in order to emulate some subset of the physical, cognitive, and social dimensions of the human body and experience. This work seeks to create a new kind of tool; fundamentally different from any we have yet seen because it is designed to work with humans as well as for them\textsuperscript{1}.

Autistic children may hurt themselves. This is because, they tend to be careless or mistreat the robot. Therefore, the industry must guarantee the humanoid robot safe from sharp edges, least of faulty and not easily broken\textsuperscript{17}. In order to treat the autistic children, the robot should have a unique appearance, features and interaction methods. However, parents and therapist claimed autism children also experience stress-free to use interactive touchscreen game\textsuperscript{20}.

In relation to that, the following section will discuss on Technology Acceptance Model (TAM) of which can be used by researchers to ensure the right features, appearance and interaction methods of humanoid robotic can be designed to cater to the needs of these autistic children.
Table 1.0: Comparison between Theory of Action Reasoned (TRA) and the Technology Acceptance Model (TAM)

<table>
<thead>
<tr>
<th>Models on Technology Acceptance</th>
<th>Theory of Action Reasoned (TRA)</th>
<th>Technology Acceptance Model (TAM)</th>
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<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>TRA is a modified model for predicting user acceptance of information system. In TRA, behaviour is preceded by intentions, which means autism, children intentions, determined by their attitude to use such technology. Autistic child’s intention to use humanoid robot and touchscreen game is motivated by positive evaluation of their behaviour, while the attitude is the reflection of the autistic children noticeable behavioural beliefs [21].</td>
<td>This model also anticipates with the child’s intention to use humanoids and computer usages that hypothesize their behavioural intention able to determine autistic children actual behaviour towards humanoids [22]. Autistic child's positive attitude has a strong positive association on human robot acceptance, which directly result the consistency of TAM [23].</td>
</tr>
<tr>
<td><strong>Attributes</strong></td>
<td>Attitude and subjective norm are two conceptually independent determinants of intention that constitutes TRA. Intention toward performing behaviour is identified from an autism children decision to engage with that behaviour.</td>
<td>TAM as a robust framework, explore users’ attitudes and beliefs concerning to use the technology. Generally, perceived ease of use and perceived usefulness have significant effects on autism children attitudes toward technologies or devices.</td>
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Table 2.0: A summary of humanoid robot and interactive touchscreen for children with autism

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Humanoid Robot</th>
<th>Touch Story (Interactive Touchscreen Game)</th>
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</thead>
<tbody>
<tr>
<td>Autism Children Focus</td>
<td>Imitation of movement and gesture.</td>
<td>Understanding of description.</td>
</tr>
<tr>
<td>Nature of Interaction</td>
<td>Robot movement.</td>
<td>Given a task or game to complete it.</td>
</tr>
<tr>
<td>Mobility of the System</td>
<td>Fixed in place, but it can move arms, legs and head.</td>
<td>The screen is fixed, but the graphic can be draggable on the screen.</td>
</tr>
<tr>
<td>Autistic Children Expressive Behaviours</td>
<td>- Enjoyment - Imitation - Joint Attention</td>
<td>- Enjoyment - Problem solving - Game completion - Cooperation and shared experience</td>
</tr>
<tr>
<td>Effects of Adaptation of the System</td>
<td>Real time movement which response to the autism children reaction</td>
<td>Choice of stories presented and hand movement to drag pictures.</td>
</tr>
</tbody>
</table>

Figure 1.0: The Technology Acceptance Model (TAM) Adopted from Davis (1989) Technology Acceptance in ASD Therapy
Technology Acceptance Model (TAM) is the extended version of the Theory of Reasoned Action (TRA). The TAM model consists of two key determinants, which is perceived usefulness and perceived ease of use. Nevertheless, Davis, reported perceived ease of use is the predecessor of perceived usefulness. This model also anticipates with the child's intention to use humanoids and computer usages, which interactive touchscreen games that hypothesize their behavioural intention able to determine autistic children actual behaviour towards humanoids and touchscreen game.

According to perceived usefulness and perceived ease of use are the most important determinants of technology usage. The TAM model argues that perceived ease of use is influenced by external factors such as autistic children's attitudes toward such technologies. According to the autistic child's positive attitude has a strong positive association on human robot acceptance and touchscreen game, which directly result the consistency of TAM.

Perceived usefulness of the robot also encourages autistic child's behaviour to learn new skills, such as social skills to improve their interaction. They can play and enjoyed interacting with the NAO robot by imitating the robot movements. This is because, autistic children are more concentrated to give feedback and focus on the robotic light, sounds and colour. Autistic children also feel safe and build their confidence through interaction with robots.

According to TAM is the most popular model that narrowly analyses the level of technology acceptance among users. Both of perceived usefulness and perceived ease of use are separate constructs that independently predict users' intention to use technologies. TAM's goals are to provide an explanation of the determination of computer acceptance that is general, capable of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified.

3. Conclusions And Future Work

Most of the organizations now are highly dependent on the technology to generate their businesses. In addition, there are some challenges that might occur when a healthcare slows in embracing robotics and the usability of human-computer interaction.

Significantly, robotics could provide various services such as industrial robots and entertainment. Robotics is also capable to perform home tasks and helping elderly and disabled.

Autistic children positively interested with robots which is not too human-like, this is because ASD children responsively in exploring robot's mechanical parts. Humanoid able reduced the difficulties as compared with human interactions. The use of a humanoid robot able to stimulate social behaviours of autistic children.

Nevertheless, few studies have focused on the user’s attitude and intention to use service robots, which have a direct effect on their perception of robotics. Therefore, Technology Acceptance Model (TAM) needs to be applied to determine the right design and features of humanoid robots that can be developed to cater to the needs of autistic children. It is crucial determinants to ensure successful marketing of robotics.

Acknowledgment

The researchers express their gratitude for the financial support from Niche Research Grant Scheme (NRGS) UniversitiTeknologi MARA (UiTM) and Principal Investigator Support Initiative [Project File: 600-RMI/DANA 5/3/PSI (76/2013)].

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