Human-Robot Interaction Intervention Therapy Procedure for Initial Response of Autism Children with Humanoid Robot

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Summary: This paper presents the initial response of Autism children interacting with Humanoid Robot NAO in Robot-based Intervention Program. Twelve Autism children from National Autism Society of Malaysia (NASOM) is being selected based on their behaviour characteristics which has been identified by certified clinical specialist, psychiatrist, occupational therapy and psychologist. Their Intelligence Quotient based on Stanford Binet Intelligence Test has been first carried out and they have undergo the autism diagnose based on Autism Diagnostic Observation Schedule by certified psychologist from NASOM. The twelve of Autism Children will then participated in the Robot-based Intervention Program (RBIP), which started from module 1 until module 5. The interaction between Autism Children and Humanoid Robot NAO is being recorded with two Sony Video Camera and one mini camera mounted on the chess of Humanoid Robot Nao for initial response analysis based on Gillian Autism Rating Scale-2nd Edition. The interaction module between the children and robot has been developed by using the graphical user interface from choreographe of Humanoid Robot Nao.

Keywords: Human-Robot Interaction, Humanoid Robot NAO, Autism Spectrum Disorder.

1. Introduction

The procedure for initial response study of Autism children interacting with Humanoid Robot in this paper is part of our long-standing goal to contribute to a group of community that suffers from Autism Spectrum Disorder (ASD); a lifelong developmental disability. With statistics estimating 1 in every 110 children in the United States [1] and 1 in every 150 children in Malaysia (according to The National Autism Society of Malaysia, NASOM) are diagnosed with ASD, the need of suitable rehabilitation measures are crucial. Since autism has no cure, an appropriate therapy and treatment program will greatly improve the outlook for most young children with autism. As ASD children possess deficit in communication skills, robot-based interventions are expected to appeal to these children as robots are inherently simpler to interact with. Plus, machines and robots really seem to resonate with many ASD children.

Hence, the objective of this paper is to investigate the initial response of Autism children when they are interacting with Humanoid Robot NAO in Robot-based Intervention Program. The humanoid robot as shown Figure 1 is a friendly-looking, small-size and affordable humanoid produced by Aldebaran-Robotics in France. This study serves as the platform for fundamental investigation to observe the initial response and behavior of the children in the said environment. This is crucial in formulating the human-robot interaction (HRI) architecture for close integration of children with ASD with humanoid robot.

Eventually, one of the biggest challenges faced by children with ASD is the difficulty in communicating and understanding social interactions [2]. Humanoid robot with human-robot interaction (HRI) architecture has great potential to teach children with ASD how to detect and understand emotions and social behaviors [3]. Furthermore, robotics technology can become a useful therapeutic tool that will help parents to train their children at home. In fact, robots can provoke interactive and social behavior that is not naturally occurring in children with

ASD [4]. It also can reduce cost since the robot can easily be reprogrammed according to the ASD criteria.

Figure 1. Humanoid Robot NAO.

Apparently, HRI is the new potential approach in the research on ASD. In fact, HRI is part of evolution in Socially Assistive Robot (SAR) system for use as part of intervention for children with ASD [5]. Related work has studied SAR and HRI as effective tools for diagnosis [4][6] and socialization [7][8][9][10] of this special children. In addition to this, a pilot study on interaction of autistic children with robot was conducted on 2-to 4-years-old children with ASD [11]. This study revealed that simple robots would facilitate social interaction and its development in autistic children. However, most explored robotic

systems in the earlier works are mainly in the form of toys, not humanoid-form social partners [12].

2. The Interaction Procedure

The experimental procedure is designed to serve as a platform in fundamental investigation of HRI and humanoid robot in the therapy of children with ASD. The flowchart in Figure 2 shows the experimental protocol laid out for the pilot study. In this protocol, the robot will be controlled in manual mode. A total of 5 modules will be executed by NAO to entice reaction and interaction from the ASD children. When the robot is executing the modules, initial response and behavior of the ASD child will be recorded. The recordings will be analyzed in post-processing stage after the experiment.
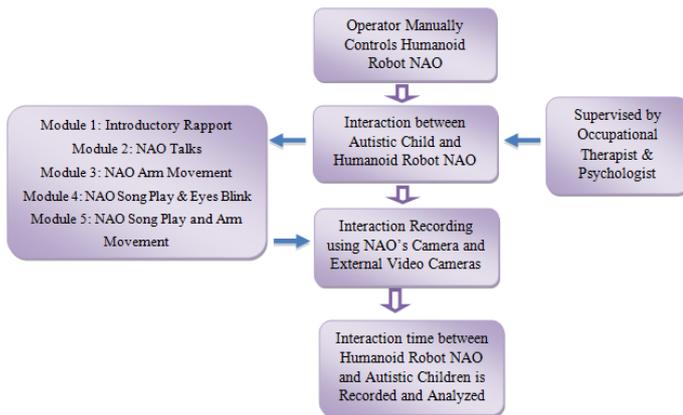
Figure 2. Flowchart of Experiment Protocol.

2.1. Experimental Set-up

In the proposed experimental set-up, the manual operator will not be visible to the children, Occupational Therapist (OT) and psychologist. The operator will be monitoring the video stream from 3 external cameras. He will also be controlling the robot from another room.

Throughout every stage of the experiment, the interaction between a child and humanoid robot NAO will be supervised by an OT and a clinical psychologist. The planned position of the ASD child, humanoid robot NAO, the OT, psychologist and the three cameras are shown in Figure 3 while Figure 4 shows the real interaction time between Autistic Child and Humanoid Robot NAO.

2.2. Modules

Module 1: Introductory Rapport

This module is separated into 3 sections; The first section begins with a 45-seconds period where there will no movement, speech nor music executed by the robot. The robot (in a static sitting position) will be placed on the table facing the child. This module aims to observe the child's reaction to the presence of the NAO robot.

In the second section, the humanoid robot NAO is still in its sitting pose. The robot shall turn its head to the right, left and then back to facing the child. This is done within the limits of its camera's visual field so that the child will always be in the robot's vision. The head turning cycle will be repeated continuously for 90 seconds. This is followed by a 15-seconds break.
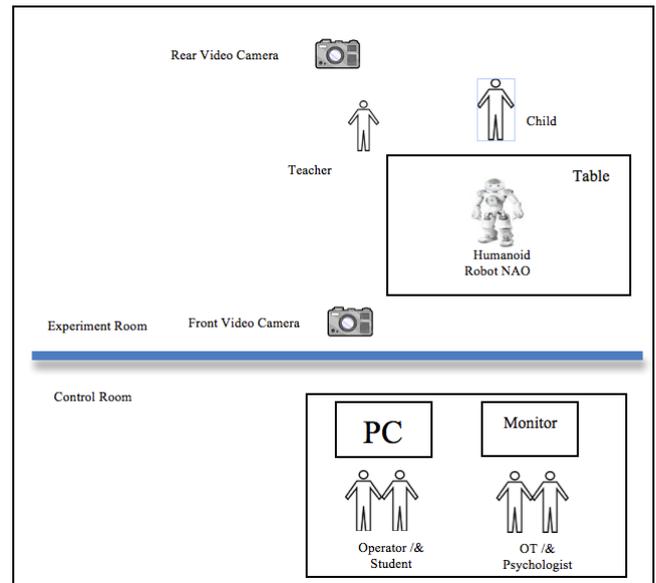
Figure 3. Layout of Interaction Procedure.
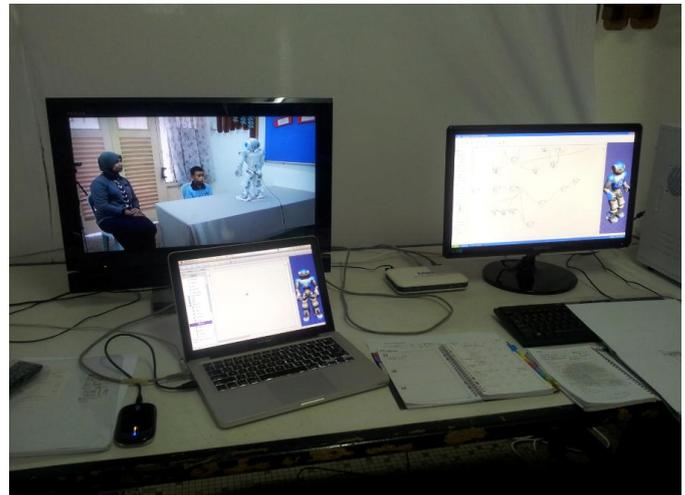
Figure 4. Interaction Time between Autistic Child and Humanoid Robot NAO.

Finally, in the third section the robot's eyes LED (2 x 8 LED of RGB full colour) will be blinking continuously with random red, green and blue colours for 40 seconds. After a 10 seconds break, the blinking sequence starts again for another 40 seconds.

Module 2: NAO Talks

The module starts with the robot saying 'Hello'. After 5 seconds, NAO repeats the word 'Hello' together with 'Good morning'. After another 10 seconds break, NAO shall continue asking the questions listed below. As such, each question will be repeated two times. There is a 10 seconds break in between each question.

a) How are you?
b) What is your name?
c) Where do you live?
d) How old are you?
e) Are you happy?
f) Do you like going to school?
g) What is your favourite colour?

Module 3: NAO Arm Movement

The humanoid robot NAO will extend its right hand halfway and wave to the child for 20 seconds. After a 20 seconds break, the robot repeats the same act. After 20 seconds break, the robot waves with its left hand twice with 20 seconds break in between the act. This sequence repeats for a timed duration of 4 minutes.

Module 4: NAO Song Play and Eyes Blink

The humanoid robot NAO will be playing a children nursery rhyme; 'Twinkle twinkle little star' through its audio loudspeakers. If the child does not show any response, the OT and/or psychologist will signal the manual operator to repeat the act of NAO song play again. After a 30 seconds break (the session continues with or without the child's response), NAO will play another children song; 'Humpty dumpty'. Again, if the child does not show any response, the OT and/or psychologist will signal the manual operator to repeat the act of NAO song play again.

Module 5: NAO Song Play and Hand Movement

The humanoid robot NAO will repeat the hand movement sequence (as in Module 6) whilst simultaneously playing a children song; 'ABC' through its audio loudspeakers continuously for 1.5 minutes. After a 1 minute break (the session continues with or without the child's response), NAO will play another children song; 'Itsy Bitsy Spider' together with the hand movement act for another 1.5 minutes.

3. Conclusion

As far as the initial response of the Autism Children is concern, they react differently when they are interacting with Humanoid Robot NAO compared to the normal interaction in their classroom or in their social life. Interacting with Humanoid Robot NAO generates more concerntration level to the Autism Children and they are more focus when they are exposed to the modules in the Robot-based Intervention Program. Thus, Human-Robot Interaction (HRI) could develop a strong bonding between the Autism Children and could help them in enhancing their social skills in their future life. More modules must be develop as to improve their behavior impairment, social skills, and communication skills since they are positively react to the interaction with the Humanoid Robot NAO in the initial response study.

Acknowledgements

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