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Autistic Children's Kansei Responses Towards Humanoid-Robot as Teaching Mediator

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Abstract

Autism is often being associated with the deficits in social communication, interaction as well as imagination. Autistic patients may experience the impairment in social interaction usually being related to their inability to interpret others' emotion and even to express their own feelings. As a result, children with autism are often been labeled as lacking the ability to express their emotion. The main objective of this paper is to present a pilot study in studying the autistic children's' emotions and feelings upon being triggered by the humanoid-robot, NAO. Kansei Engineering, which is a powerful emotion extraction mechanism is adopted in the study to assess the children's' emotion. The experiment involved two autistic children and one normal child who were given four interaction modules in separate intervention session. The experiment conducted is to observe how robot triggers the emotion of these children. The result shows that different types of modules which would trigger different emotional reactions. This result provides a basis for further investigation of the assessment of autistic children's feeling and emotion. The result will ultimately contribute to finding best possible therapy for autistic children towards the used of humanoid-robot.

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1. Introduction

Robot is an interesting man-made invention that is becoming increasingly popular and highly advanced. Previously used to conduct the 3Ds (dangerous, dull and dirty), robots today are as ubiquitous as computers and mobile gadgets in the near future[1]. Robots are being upgraded to suit its usability and to coexist next to human race. Humanoid, is one of the advancement in the field of robotics where it is better known as robots which fabrication is akin to a human body, complete with appendages such as head and limbs. Robots are now being increasingly developed for a real-world application such as rehabilitation, eldercare and also assistive therapy for educational purposes. Robot is said to being able to elicit the interest and attention of the autistic children[2].

Autism Spectrum Disorder (ASD) as according to the National Autism Society of Malaysia (NASOM) is a lifelong developmental disability that blocks learning, language communication, emotional as well as social developmental of a child, where in Malaysia, the rate of autism occurrence is said to be 1 in every 150 children (2010) where this number had increased by a staggering 30% over the

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last 3 years. The increasing number on the reported cases is alarming and to date, there is no one proven cure for autism. Despite of having no cure, a proper and right intervention is said to enable this children to somehow minimize their autistic behavior and over time, allow them to lead their own independent life[3]. Robots, typically humanoid has provided a new bridge in the study of intervention for the children with autism as an intervention tool. As much as technology such as gadgets and computers were said to help the children with autism, the same situation applies to the robots[4]. Though at its' infancy stage, the study encompassing humanoid-robot with the autistic children had shown several promising results.

Nevertheless, even with extensive amount of study conducted, there were no work conducted on the children's perspective and emotions while engaging with the humanoid-robot[5]. To date, as according to Conn[5], there is neither affective model nor a fully published work being done in the study of the autistic children emotion using robots. Kansei Engineering has been greatly captivating to industries as well as academia in assessing users feeling and emotion[6], and incorporate them to product design[7,8]. Thus, it had become the motivation for this pilot study to adopt Kansei Engineering in the investigation of the autistic children's feeling and emotion while interacting with a humanoid-robot.

2. Related works

This section describes related work to this research.

2.1. Autism Spectrum Disorder (ASD)

Autism is a developmental disorder that caused impairment in social communication, interaction or imagination whereby the impairment is known to affect children in either in one, two or all given three aspects[9]. These traits are also known as the 'triad of impairment'[10] which is the impairment in social communication, impairment in social interaction and impairment in imagination. Autism is said to vary in severity where it differ from one child to another[11.] These children have different ability to learn and absorb information from their surroundings. In addition, autism children were known to not being able to express their emotion where they usually express their dissatisfactory through shouting, crying and throwing tantrums. Even though there were no proven working cures, the right intervention is perceived to enhance these children ability and minimize their autism traits. Researchers and therapist today are working on various kind of therapy to find out the best way in helping these children to breakthrough their autistic's shell and to be able to communicate and interact with their surroundings.

2.2. Humanoid-robot intervention

The advancement of robotics and artificial intelligence has provided a new hope in the therapy for the children with autism. This is due to the robot being able to provide the same impact as other technology like mobile gadgets and laptops. Many types of robot had been invented for the purpose of interacting with the autistic children, which range from simple machine-like robot, soft toys, animals robot[12,13] and the latest is the humanoid-robot. Humanoid robot is also one part of the evolution of the Socially Assistive Robot (abbreviated as SAR) system and is currently known as the new potential approach in the research for autism and the proven to be beneficial in previous study[4,12,13]. Humanoid robot is said to hold a great potential in teaching and therapy session for the autistic children where it allows them to detect and learn about different emotion, expression as well as social behavior of a human being[14]. In 2008, the humanoid-robot NAO had been officially launched and introduced to the market[3]. It is designed to the appearance of a human toddler and since then been used as a platform to study the interaction between the robot and children with autism.

3. Methodology

Autistic children is often said to be emotionless making it difficult for others to interpret their emotion. This is mostly because of their impairment in interaction where they have limited or no ability to understand others' emotions. This has led them to become completely indifferent towards others[15] in their surroundings. This research adopted Kansei Engineering due to its unique mechanism in extracting implicit feeling and emotion[7,8,16]. The experiment was performed to assess two autistic subject's emotional responses and one normal child as a control set for the experiment.

This study began with collection of the Kansei words related to humanoid-robot interaction and autistic children. The Kansei words obtained were then arranged into a checklist form using five point semantic differential scales. The Kansei words were identified from past literature involving the use of robot for intervention. Among the words are Amusing, Attractive, Depressing, and Stimulating. In the instances where the subject is unable to fill in the Kansei checklist, the teacher observes and fills in the checklist while the children is involved in the interaction. In this experiment, the teachers played a very important role. This is due to the fact that the teachers being close to the children and they can accurately interpret the kind of response the autistic children displayed. Humanoid robot NAO is used as stimuli in this research.

3.1. Interaction modules

The interaction modules were designed to capture the children's emotion while engaging with the humanoid-robot. A qualitative study has been conducted through a semi-structured interview session to determine the module that could better elevate the children's feelings. From the interview, three important elements were found to be able to ignite the children responses almost immediately; Static Robot, Robot Talking and Robot Gestures. Static Robot is said to be able to initiate some responses from the children due to their non-familiarity with the robot. The research then set the flow of activity as shown in figure 1.

The children were first presented with a static robot. This is a very important stage as being a debut to the child, it is very essential to ensure that the subject will be comfortable with the presence of robot. Then the robot NAO starts with the first module on greetings where it will be saying "Hello" and prompt a few question such as "How are you today?" and "Do you want to learn with me today?" In between each question, some interval time were given to allow the children to answer or at least provide some response to the question. Then NAO proceed with second module, saying "Please". During this module, the children were taught on proper manner if they were to ask something from their teachers or parents. Upon completion of the second module, the session breaks for three minutes. This break allows the teacher to fill in the Kansei Checklist, which also the children to some rest. At the end of the three minutes, NAO prompts for the beginning of the third module. In this module, the children were taught about the right place throw garbage, in which a dustbin has been prepared next to NAO.

Fig. 1. Flow of activity for the interaction experiment.

The module is continued with NAO making a sneezing sound and was taught the right manner to sneeze with their mouth closed and say "Alhamdulillah". The fourth and final module is singing and dancing with the children. The content of this module is teaching the children to raise their hands should they want to ask a question. NAO prompted the children by asking if they want to sing with him, upon raising their hand the singing start. The entire flow of the activity takes only 10 minutes, with only one break in between the experiment. Upon completion of this module, the teacher fills in the Kansei Checklist for the module.

3.2 Experimental Setup

Figure 2 shows the experimental setup for the research. Prior to the experiment, a few precautionary steps were being taken in order to avoid any unwanted scenes. Above all, safety should come first. The following were rules set for the experiment:

i. Teachers must present throughout the session
ii. The children must maintain at a safe distance from the robot
iii. At any sign or discomfort is shown by the children; the children is being restless and uncomfortable, the session will be immediately be aborted.

4. Results and discussions

The data obtained from the experiments were analyzed and interpreted qualitatively. Nevertheless, the analysis of the Kansei checklist was conducted through a straightforward descriptive interpretation and further supported by post-evaluation made by the teachers. The data were tabulated in graphical form to ease the process of interpretation and translation of the children's emotion. Figure 3 shows the line-plotted graph from the data for the 4 different modules.

From the figure, it can be seen that the tabulation of the data for the children shows that these children were expressing their emotion while interacting with the humanoid-robot. From the data tabulated, it is clear that both the autistic children and normal children were enjoying the interaction session. This is depicted by the high scores marks for the positive emotion on almost all modules. From figure (a), the subject Mild_2 and Normal_1 scored almost the same responses for the given Kansei words. This is mainly due to the fact that these children were being exposed to the robot NAO for the first time and they never actually see or play

with the robot before. On the contrary, the subject Mild_1 starts off with an average lower score on the positive emotion as compared to the other two.

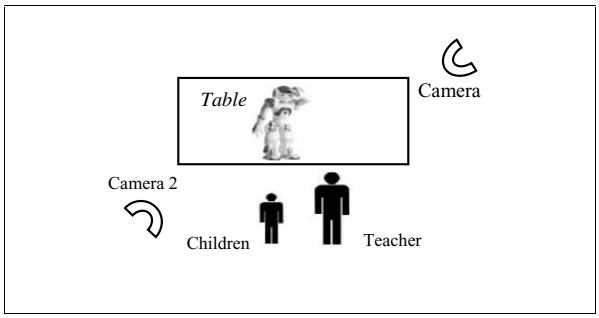

Fig. 2. Experimental Setup.

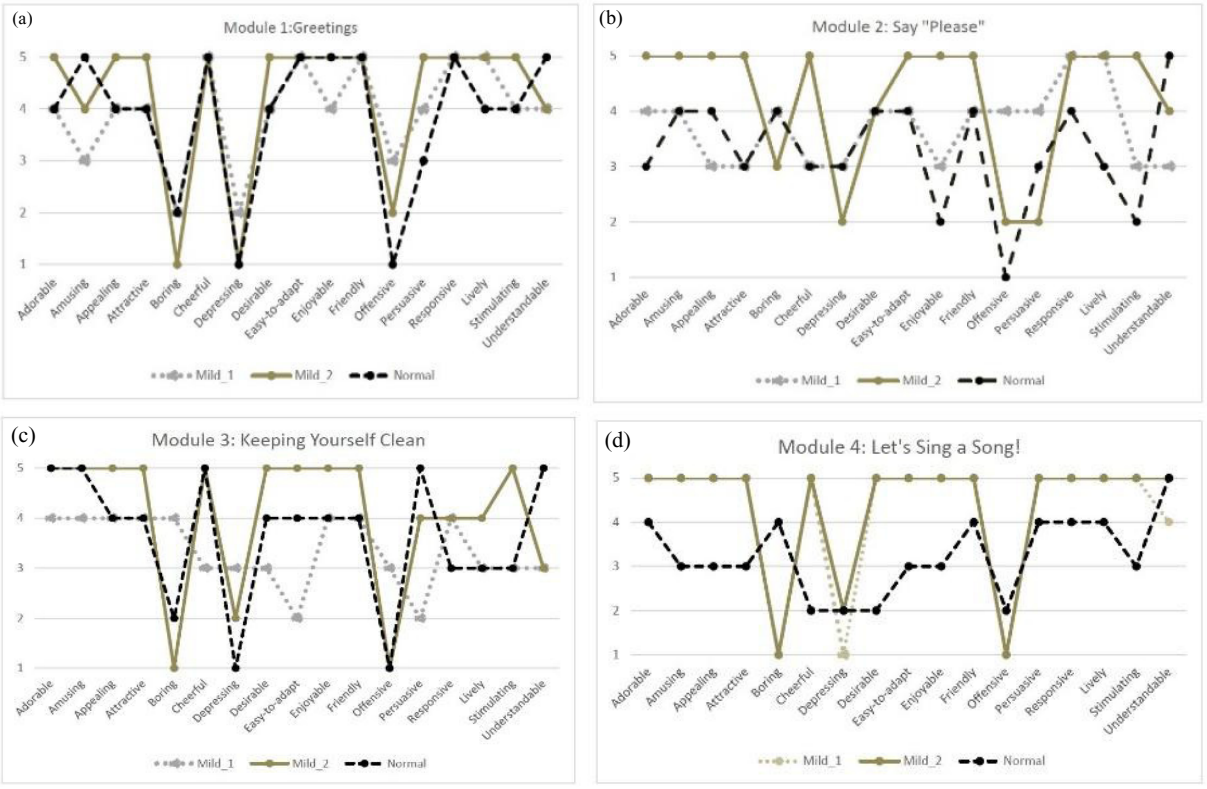

Fig.3. Emotional responses from different module (a) Module 1: “Greetings”; (b) Module 2: Say “Please”; (c) Module 3: “Keeping Yourself Clean” and (d) Module 4: “Let’s Sing a Song!”.

The main explanation on this situation is that the subject Mild_1 had been interacting with the robot before back in 2011, where during the previous experiment, a different color NAO is brought for the interaction session. The subject Mild_1 was clearly showing a sign of withdrawing from the experiment during the beginning of the interaction. According to the teacher, the subject Mild_1 were expecting the same NAO robot from the previous experiment which is in orange color instead of the blue NAO that were being used for this study. Here, the subject Mild_1 were showing very visible traits of autism, in which the children with autism like routines

and they do not like changes. Since he had already engaged with the orange NAO before, he was expecting the same color robot for this intervention session and he mentioned to the teacher that the blue colored NAO was not interesting.

As the experiment progressed, when NAO starts to speak and move, a different feedback was captured from the subject Mild_1. He begins to show signs of interest. Compared to all the other subjects, he participated better and were able to answer all the question given by NAO. The module created was with the intention to capture the children's emotional responses. This can be seen while comparing the line graph from module 2 to module 3 and 4. In module 2, the graph clearly showed a lower score for the positive emotion especially for the subject Mild_1 and Normal_1. The keyword "boring" were being rated from average to high score and positive emotion such as "attractive", "adorable" and cheerful were rated averagely. This result is further supported by the teacher's statement when she made the entry in module 2. The flow of the activity and interaction were deemed not enough which has caused the children to become bored with the module. Module 2 does not involve much movement by the robots and the relatively long interval time taken between dialogues has caused the subjects to become restless. This is the main reason why the emotional word "boring" were being rated as 4 for subject Mild_1. However, a different situation is observed during the third and fourth module. The module 3 and 4 were programmed for the purpose to provide the children with more interaction and NAO will be having more movements. This is to observe if the show any adverse difference in their emotional feedback when the robot act and talk mimicking a human being.

From the graph plotted in figure 3, subject Mild_1 got an average score for both positive and negative emotion where the tabulation of score ranging from 2 to 4. According to the teacher, this situation occurred because during module 3, the robot NAO was interacting with the children using a two-way conversation. Despite being verbal, the Mild_1 subject was not well-versed in English and this has affected his eagerness to engage with the robot. Still, subject Mild_1 successfully answered the entire question asked by NAO due to the simplicity of the programming where the children only need to answer with Yes or No. Compared to subject Mild_2, despite of being non-verbal and not be able to answer the question prompt by NAO, she displayed a very visible emotion while engaging with the robot. Being non-verbal, the child does not respond much from one module to another but interacting with the robot itself has made her happy.

In general, the main intention of capturing the children' emotion while interacting with the robot were successfully achieved. From the data tabulated, it can be seen that both the autistic children and normal children were enjoying the interaction session. This is depicted by the high scores marks for the positive emotion on almost all modules. From the data and the supportive explanation, it is evident that the different arrangement in modules can kindled a different emotions by the children where the NAO ability to speaks and moved does influenced the children emotion toward the interactions. The same thing were being said by the teacher where she mention that the more movement and gestures made by the NAO robot, the better the feedback and emotional responses that can be captured from the children. The result gained from the pilot study has addressed the main concern whether the emotions of the children with autism were assessable. From the data collected as well as the qualitative interview session conducted it is proven in spite of being emotionless is one of the traits for the autistic children, the right intervention will be able to ignite and initiates their emotion.

5. Conclusion and recommendation

This paper described the study on the emotional responses given by the children while engaging with the humanoid-robot NAO. Kansei engineering was adopted to assess the children emotions where the outcome of the study had successfully proven that different interaction offers by the robot evoke different emotions by the children. As being suggested by the experts, our result shows a somehow similar outcome where the modules with the humanoid-robot NAO singing and dancing marks the highest score for almost all the positive emotions. Additionally, based on the video footage review, it is notable that the children were showing a more apparent emotional response while the robot talks or making a hand gestures. Future study may adopt the same approach and method to better understand the children's emotion while interacting with humanoid-robot. This is to ensure that the children could get the maximum benefits offered by the humanoid-robot. In addition, future work shall also consider on a larger number of subject to be involved in the evaluation experiment, so that it will produce better results. Investigation on design elements that should be embedded to robot interaction can be performed to obtain a better clue for intervention to enhance learning of autistic children.

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