

## Human-Robot Interaction (HRI) For Children with Autism to Augment Communication Skills

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**Abstract.** This paper presents a case study of robot-based intervention program for children with autism. The study focuses on two-way communication between children with autism and a humanoid robot NAO. The aim of this study is to develop a set of teaching and learning modules on communication through question type conversation and song-based approach. Module developed in this study is programmed using NAO's choregraphe, being imbedded later on and perform action. Both children participating in this study can communicate verbally and have been diagnosed with mild autism. Response from this exposure shows that the human toddler-like robot can be used as a platform to augment and facilitate communication effectively with children with autism.

### Introduction

The relationship between an obsession to make life easier with an availability of affordable robots have encouraged the robotics community to explore deeper in human-robot interaction (HRI) studies. HRI deals with the research where the intelligent robots are used to improve quality of life of human being in supporting the daily activities and social including the behavioral aspect without compromising the safety aspects of both human and robot. The robotic application in children with developmental disorder offers unique exercises and experiences not only to the children but also parents, clinicians and society as well.

In this study a humanoid robot NAO from Aldebaran is used as a social mediator to attract and interact with children. According to previous study children with autism seem to connect well with machines and robots [1] and this may encourage them to response better in therapy. The NAO robot has a friendly exterior as it has a human toddler appearance [2]. Communication and social skill are the two general areas being affected by the autism disorder. Children with autism often found lack in initiating conversation or spontaneous action through verbal and nonverbal language. Furthermore they possess limited vocabulary or words that make their communication harder [6]. Studies on robotic approach to improve communication among these children are emerging with variety of robot and application to offer. Somehow, no solid evidence on the effectiveness of this approach had ever been proved. To serve the need, this project tried to explore the potential of utilising the NAO as an alternative platform in HRI to augment communication skill [1][3][4][5].

Solid contents of intervention modules were developed for this purpose so as to analyse the effect of implementing two-way communication interaction between children with autism and the humanoid robot NAO. The cognitive impairments they possess cause difficulty in making interaction human-to-human. Studies show that using technological things such as robot or interactive multimedia could possibly augment the children interest [3] and this could be an alternative approach to initiate their communication ability.

The aim of this study is to explore the response of two children with autism towards humanoid robot that has been programmed with two-way communication ability. The interaction started with an Introductory Module consists of short conversation between the child and the robot. This is followed by Module 2 where an interactive story telling program is used to teach the child to join the conversation. The final module consists of NAO playing a television program, 'Barney and Friend' song, 'I Love You'.

## Method

In this study, the same protocol from previous pilot experiment was used [7]. The experimental protocol illustrated the flows of the steps involved in this study as shown in Figure 1. All responses will be recorded in video mode and kept as a qualitative data. The video was analyzed and all responses related with autistic behaviors were assessed using behavior score sheet.

This study took place at Pusat Jagaan Sayang (PJS), seksyen 7, Shah Alam. Subjects participated in this study are stationed here during weekdays for special education and therapy of daily living. They are likely comfortable here and will not be distracted by a new surrounding which should be avoided. Figure 2 shows the actual room setup for the experiment. Two external video cameras have been used to record the candidates' responses. Both cameras recorded the candidates' responses from front view and the humanoid robot NAO responses from rear view. Two different view of recording enable detail analysis of responses with regard to the modules. Subjects were accompanied by a teacher from the same center in every session and teacher has the right to stop or suspend the session on any occasion.

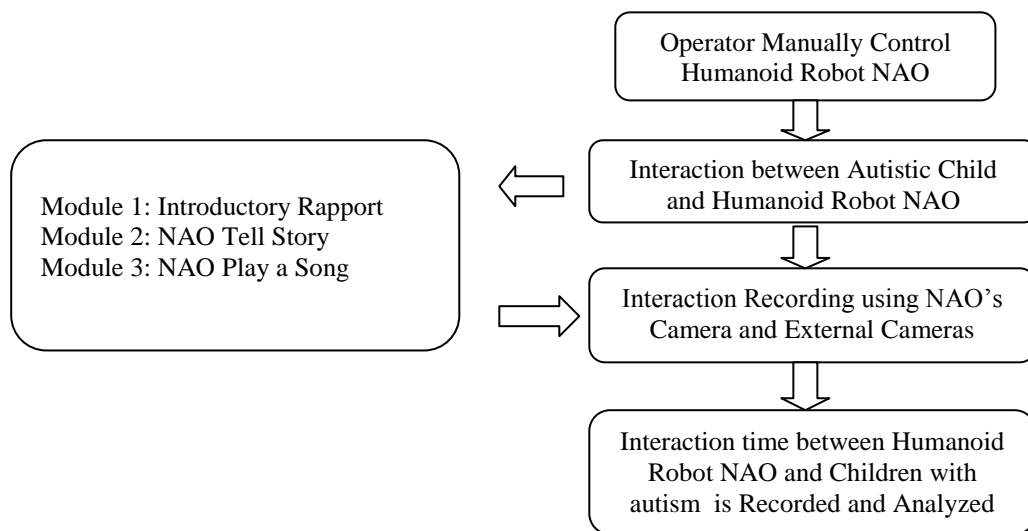


Fig. 1: Protocol flow chart in Pilot Experiment Setup

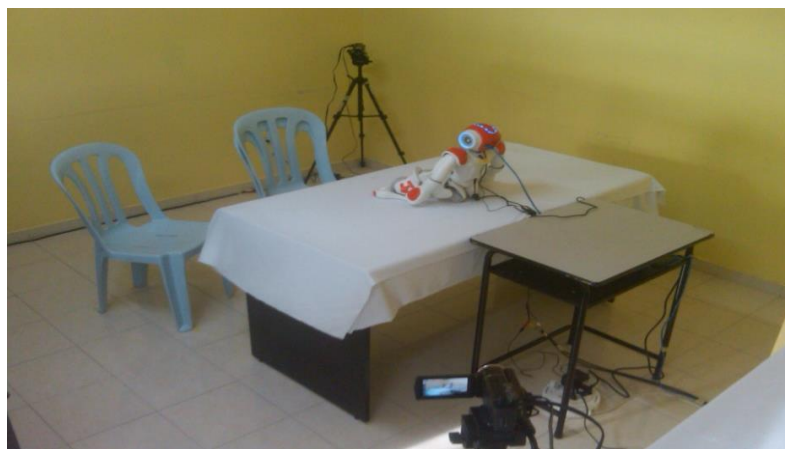


Fig. 2: The room setup for the experiment

**Contents of the Interaction Module.** Modules used in this study consists of 3 separate parts which targeting the two-ways communication responses. Between each module, there are 10 sec breaks allocated to relax the child before continuing to the next module. Designed for minimum

movement, still the module can display NAO in action during questioning session. According to previous pilot study, responses received from participants were very encouraging. Pertaining to this, some of the content in the module which is the last part of the interaction session were reused in the current module of 1 and 3. This could possibly support the improvement plan in module 1 and 3, at the same time to ease the programming work.

The interaction content in Module 1 focuses on two-way communication between the child and NAO which is not present in the previous pilot study. Details about the amendment are: Named by Introductory Rapport; in sitting position, NAO start to introduce itself then followed by asking two simple question to participant: 1.) What is your name?, and 2.) are you happy today? The main part of this module come after the introduction when NAO asking about it's blinking L.E.D eyes. It blinks randomly to attract the subjects's attention before asking about the blinked eyes. The response received will proceed to the eyes colour guessing where NAO displays a blue L.E.D and it will ask the participant to guess the colour display. The purpose for this is to test the response of eyes contact between participant and NAO. Beside that, this module also aim to teach participant to create an eyes contact.

The interactions were supported in Module 2 and Module 3, where the aim of Module 2 is to attract attention to the story told by humanoid robot NAO. During the story telling session, the questions were addressed between the situation of the story. The questions asked were related to the action should be taken according to the situation. In Module 3, the final module, NAO plays a song from children television show, 'Barney and Friends', titled 'I love You' to teach them the value of friendship and morale. Figure 3 shows the flow of modules in this experiment.

**The Subjects.** Subjects in this study are from Sayang Day Care Center (PJS), Seksyen 7, Shah Alam. Two male children were selected, child KA aged 9 and child HH aged 7. Both have been diagnosed with mild autism. Other criterions are:

- No hearing and vision deficits
- No nystagmus and no self-injury
- Able to understand, speak and follow simple commands in English

Both were assessed using behaviour score sheet developed specifically for this study. The contents of behaviour score sheet were taken from Gilliam Autism Rating Scale: Second Edition (GARS-2). There are 42 items that describing the characteristic behaviour of persons with autism in GARS-2. But, only ten items were used for the communication subscales in this study. The items were selected to suit the areas available in the study.

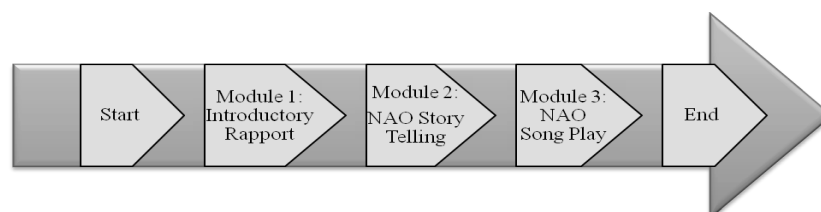


Fig. 3: Flow of the three interaction modules

## Results and Discussion

Responses from both participant, HH and KA has been recorded in video mode and were analyzed according to GARS-2. As mention before, to suit with current study not all of the items in the subscale of GARS-2 are assessible, therefore some of the items had been extracted out. Out of the three subscale only 'Communication' is laid out and discussed. Figure 4 shows the autistic behaviour exhibited by KA during the HRI. KA showed several typical autistic characteristics. 10 characteristics that suitable for communication subscale were observed. In this experiment, the major deficiency occurred was the humanoid robot NAO only can talk in English and the candidates only can understand a basic English. The obvious behaviour we found was he will looks

away or avoid looking at humanoid robot NAO when NAO is active (sound or movement is executed). This response not seen in Module 1 because the module was intentional designed to observe either the children with autism will have an eyes contact when they been asked to do so.

The problem of making eyes contact with other people is obvious criteria possessed by children with autism. Besides that, children with autism also only talk in single tone. They cannot differentiate which tone should be used to show their speech contents. In this experiment, we try to stimulate the child to talk. We had assigned several questions between the parts of the Modules. The usage of speech or sign with flat tone, affect or with dysrhythmic patterns only observed during first Module. This characteristic may be shown because the child saw the robot for a first time and he may not familiar with the robot.

Figure 5 shows the result of the second participant, child HH. This result is obtained using the same observation procedures used for child KA. Each characteristics was observed and score is given according to the scale prescribed in GARS-2. The graph shows that the child HH possess slightly higher autistic feature compared to child KA. As shown by child KA, the same characteristics exhibited by the child HH. The only difference between them was the child HH had answered the question inappropriately. Problem in English might affect the response given by those candidates as described earlier, since both can only understand basic English. Basic English here refers to English syllabus for year 1 primary school. However a teacher who they familiar with has been assigned and attached together to assist them with the English.

During the modules development stage, the critical point which has been highlighted was the simplicity of the contents. The contents of each module should be simple and easy to understand not

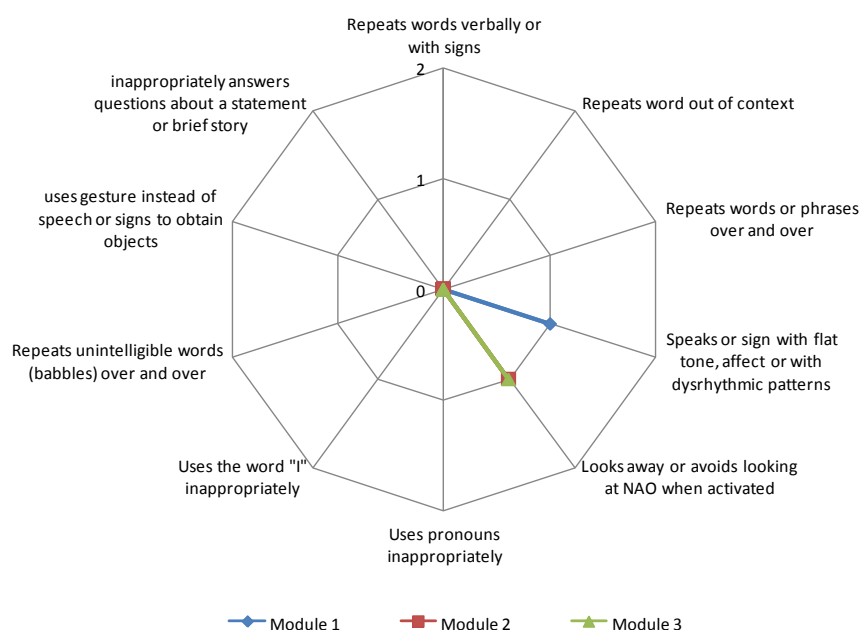


Fig. 4: Behavior response of child KA

only by the candidates but also children at the same age for it has been designed according to the syllabus of primary school and current rhythmic trends. For the selection of song, it has been made according to the most popular nursery rhythm in the near area and the survey for this has been done among active nursery in the area of Seksyen 7, Shah Alam. Nonetheless not all children used to hear what others used to and this had more or less distorted those candidates in their response since they seem have never heard one of the song played by NAO though it is well known among other children.

Figure 6 shows the score obtained by each candidate in percentage. Both subject scored at least one subscale in each module under autism behavior with subject KA seems to be more consistence compared to HH. In Module 1, subject KA did not show facial expression and speak with flat tone when interacting with NAO, giving him 1 minus point. In Module 2 and 3, KA was found losing

his attention against NAO when he sometimes looked away when NAO was making conversation with him. For subject HH, Module 1 shows less autistic behavior during the experiment. The obvious behaviour shown was he unable to concentrate for a longer time. We had been informed that both children involved in this experiment also possess hyperactive behaviour when they not do any works, they are easy to be distracted. Child KA also cannot make an eyes contact for sometime when he been asked to talk and answer the question.

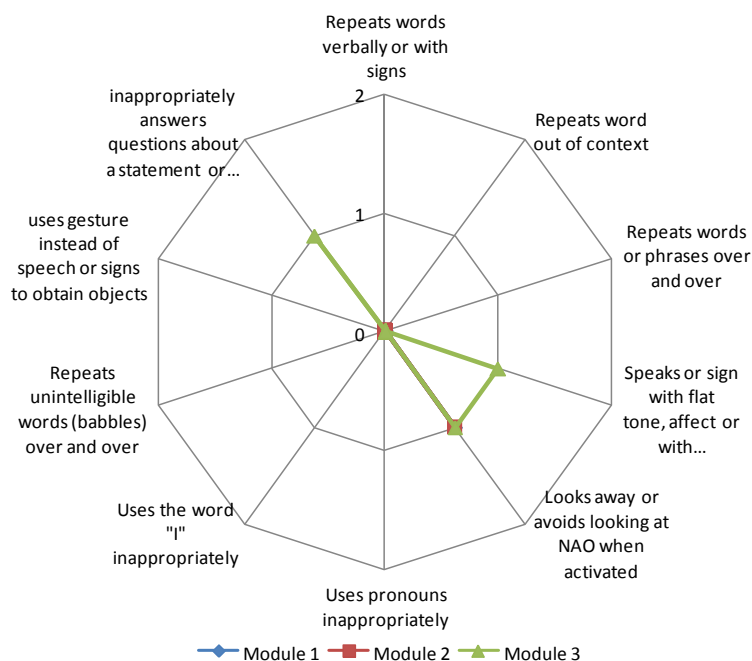


Fig. 5: Behavior response of Child HH

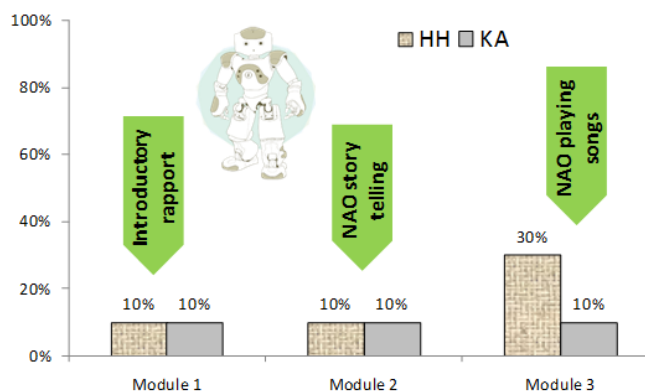


Fig. 6: Comparison of Score For Each Module in Percentage

The second participant, child HH 7 years old, show higher autistic behaviour compared to child KA. The ability to understand the English might be one of the causes that intensify the autistic behaviour shown by HH. The eyes contact was a common problem observed and evaluated. child HH also was detected gave a flat tone voice when talk with the NAO. The flat tone speech is been categorized as one of the autistic behaviour where the voice of the children is same for every thing they talk.

## Conclusion

The modules in this study were developed from basic level of introductory to social interaction. The contents are light, enjoy and easy to understand. Robot seems to be very effective and attractive especially those with human-toddler looks like. Response from both subject in this study are good

and they seems to have enjoyed and learnt something from the first time they met the NAO. We had made a follow up interview with the principals of Sayang Day Care Center to know whether the candidates show a positive response after the experiment session. They have started to talk about NAO and keep asking to meet with NAO again. The responses received in this study shows that the intervention program for children with autism using HRI approach can help in augmenting the communication skills among children with autism.

### Future Works

The shortage at certain areas of modules has been detected and the modules will be improved according to the response received from the experiment conducted. More subjects ( of children with autism and typically developing children will be used in the future to obtain more evidence toward this robot-based intervention program specifically in the commnication subscale.

### References

- [1] B. Robins, K. Dautenhahn, R. Te Boekhorst A. Billard , Robotic assistants in therapy and education of children with autism: can a small humanoid robot help encourage social interaction skills? Springer-Verlag , (2005).
- [2] Syamimi Shamsuddin, Luthffi Idzhar Ismail, Hanafiah Yussof, Nur Ismarubie Zahari, Saiful Bahari, Hafizan Hashim, Ahmed Jaffar , Humanoid Robot NAO: Review of Control and Motion Exploration. ICCSCE (2011).
- [3] Hideki Kozima, Marek P. Michalowski, Cocoro Nakagawa, Keepon A Playful Robot for Research, Therapy, and Entertainment. Springer Int J Soc Robot 1: 3-18(2008).
- [4] Ben Robins, Farshid Amirabdollahian, Ze Ji, Kerstin Dautentahn ,Tactile interaction with a humanoid robot for children with autism: A case study analysis involving user requirements and results of an initial implementation. 19<sup>th</sup> IEEE International Symposium on Robot and Human Interactive Communication. (2010)
- [5] Florent Guenter, Lorenzo Roos, Andre Guidnard, Aude G. Billard, Design of a Biomimetic Upper Body for the Humanoid Robot Robota\*. Proceeding of 5<sup>th</sup> IEEE-RAS International Conference on Humanoid Robots, (2005).
- [6] Lyn Kern Koegel, Intervention to Facilitate Communication in Autism, Journal of Autism and Developmental Disorders, Vol. 30, No. 5, 2000
- [7] SyamimiShamsuddin, HanafiahYussof, Luthffi Ismail, FazahAkhtarHanapiah, Salina Mohamed, Hanizah Ali Piah, Initial Response of Autistic Children in Human Robot Interaction Therapy with Humanoid Robot NAO. IEEE 8th International Colloquium on Signal Processing and its Applications (CSPA2012)