Estimation of Concentration by Eye Contact Measurement in Robot-based Intervention Program with Autistic Children

Luthffi Idzhar Ismail a,*, Syamimi Shamsudin a,b, Hanafiah Yussor a, Fazah Akhtar Hanapiah c and Nur Ismarrubie Zahari d

aCenter Of Excellence for Humanoid Robots & Bio-sensing (HuRoBs), Faculty of Mechanical Engineering, Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Selangor, Malaysia
bFaculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.
cFaculty of Medicine, Universiti Teknologi MARA (UiTM) Shah Alam, 40000, Malaysia
dDepartment of Mechanical and Manufacturing, Faculty of Engineering, Universiti Putra Malaysia, Serdang 43400, Malaysia

Abstract

Lacking of eye contact in social interaction and communication is one of the impairments that being diagnosed with some of the children with Autism Spectrum Disorder (ASD). This paper presents the initial response of eye contact time between humanoid robot NAO and ASD children in Robot-based Intervention Program (RBIP) interaction and normal classroom interaction. Twelve ASD children from National Autism Society of Malaysia (NASOM) based on inclusive criteria and certain ASD characteristics are being selected to participate in this intervention program. The interaction between humanoid robot NAO and ASD children is being recorded for both RBIP interaction and normal classroom setup. The eye contact time in both interactions for each child is being observed and recorded. The eye contact of the ASD child is often seen in RBIP interaction as compared to the normal classroom interaction.

© 2012 The Authors. Published by Elsevier Ltd. Selection and/or peer-review under responsibility of the Centre of Humanoid Robots and Bio-Sensor (HuRoBs), Faculty of Mechanical Engineering, Universiti Teknologi MARA.

Keywords: Rehabilitation Robotics, Humanoid Robot NAO, Autism Spectrum Disorder, Robot-based Intervention Program, Eye Contact

1. Introduction

This research will focuses on the initial response of eye contact time for ASD children. ASD children will be monitored in both RBIP and normal classroom interaction. The interaction is involving the humanoid robot NAO and ASD Children as well as their respective teacher. The interaction in RBIP is targeted to improve their eye contact time in the human to robot interaction since it is believe that more eye contact will be made in RBIP compared to the normal class interaction. This research is aimed to benefits the ASD children based on inclusive criteria [1] that being made before they participate in this intervention program.

Eye contact is a form of nonverbal communication and is thought to have a large influence on social behavior. Typical pattern of eye contact behavior is one of the most significant symptoms of Autism Spectrum Disorder [2]. Eye contact and facial expressions provide important social and emotional information. People, perhaps without consciously doing so, probe each other's eyes and faces for positive or negative mood signs. In some contexts, the meeting of eyes arouses strong
emotions. Eye contact is also potentially an ideal model system for studying the neural, cognitive and developmental basis of a typical social interaction and communication in Autism Spectrum Disorders [1].

A recent review of the previous literature revealed that eye contact, modulates concurrent or immediately following cognitive processing or behavioral responses, a phenomenon termed as “eye contact effect” [3]. Perceived eye contact also facilitate the processing of face identity [4] and communicative facial expression [5] during the first half-year of life. In recent times, several models [6-9] have been proposed to account for the mechanisms underlying, and the development of a typical eye contact in individuals with ASD.

Autism Spectrum Disorder (ASD) is a brain developmental disorder that affected the development of social and communication skills of an individual [10]. ASD represent a continuum of neuro-developmental disorders characterized by impairments in social interaction, communication, and restricted or repetitive interests and behaviors [11]. ASD children are suffering from a normal environment like a normal people since they have a severe impairment across situation in the social interaction skills and they are also having a major problem and difficulties in communication skill where their communication is limited to stereotyped behavior, repeated activities and same interest.

2. Eye Contact Measurement

2.1. Interaction between Humanoid Robot NAO and ASD Child in RBIP

Figure 1 illustrates the interaction between humanoid robot NAO and ASD child in RBIP interaction. The teacher of the child is function as an observer and will not interrupting the interaction between ASD child and humanoid robot NAO. The teacher will only interrupt to stop the procedure if the child became too aggressive and if the child touches the robot. There are 5 modules in the RBIP interaction, which are as follow:

Module 1: Introductory Rapport
Module 2: NAO Talks
Module 3: NAO Hand Movement
Module 4: NAO Song Play and Eyes Blink
Module 5: NAO Song Play and Hand Movement
The interaction of RBIP is being recorded with 2 external camera and one mini camera attached at the NAO’s chest for analysis purposes. The eye contact time between the ASD child and humanoid robot NAO is determined manually after the interaction is done. The recorded version of interaction between ASD children and the humanoid robot NAO is being played again and being observed by certified personnel. The eye contact between ASD children and humanoid robot NAO is being determined using stopwatch. Three different personnel are obtaining three separate reading in order to avoid bias. Then, an average of eye contact time is obtained for each ASD children for their interaction in RBIP.

2.2. Interaction in normal classroom

Figure 2 illustrates the experiment setup in normal class interaction between ASD child and their teacher. The teacher will naturally communicate with the ASD child and try to engage eye contact with them. The ASD child will be asked some question by their teacher during human-human interaction and praise them for the completed tasks and homework. The interaction between the ASD children and their respective teacher is being recorded for analysis purposes. The average of eye contact time is obtained through the post analysis using the recorded video for each interaction by certified personnel.

3. Results and Discussion

The initial response of eye contact in both RBIP and normal class interaction is being observed, recorded and analyzed. Table 1 shows the child ID with their respective FSIQ and their total average of eye contact time in RBIP and Classroom.

Table 1. Child ID with their respective FSIQ and their eye contact time in RBIP and Classroom

| Child ID | Total Average Eye Contact Time (seconds) In RBIP | Total Average Eye Contact Time In Classroom (seconds) |
|----------|-----------------------------------------------|-----------------------------------------------------|
| 1        | 311.29                                        | 208.83                                              |
| 2        | 381.17                                        | 227.57                                              |
| 3        | 430.92                                        | 400.32                                              |
| 4        | 374.15                                        | 311.99                                              |
| 5        | 454.16                                        | 410.35                                              |
Figure 3 illustrate the curve of eye contact time between ASD child and humanoid robot NAO in both RBIP and classroom interaction for twelve children. The curve shows that more eye contact is being made during the RBIP interaction compared to the classroom interaction. The ASD children are more focus when they are interacting with the humanoid robot NAO. They tend to explore more and concentrate to the humanoid robot whenever the robot is move and speak. This positive response could be a benchmark for future works in helping the ASD child in education or even in normal life. The interaction between ASD children and humanoid robot NAO could benefit them to improve eye contact. Perhaps, humanoid robot NAO could help them to survive from the eye contact problem during learning process in classroom with the aid from humanoid robot NAO.

4. Conclusion

As far as the initial response of eye contact is concern, Robot-based Intervention Program could engage more eye contact during the human-robot interaction as compared to classroom setting, which is human-human interaction. The ASD child is more responsive to humanoid robot NAO compared to the normal interaction with their teachers. More repetitive exposure and interaction with the robot should be planned for future work as it can improve the eye contact of ASD children.

Acknowledgements

The authors gratefully acknowledge the Ministry of Higher Education Malaysia (MOHE), Universiti Teknologi MARA (UiTM) Shah Alam, Selangor and The National Autism Society of Malaysia (NASOM) for their support. A part of this project is supported by the Ministry of Higher Education Malaysia (MOHE) under the Fundamental Research Grant Scheme (FRGS) (600-RMI/FRGS 5/3/Fst/ (31/2011)).
References

[1] S. Shamsuddin, H. Yussof, L. Ismail, et al., Initial Response of Autistic Children in Human-Robot Interaction Therapy with Humanoid Robot NAO, 2012 IEEE 8th International Colloquium on Signal Processing and its Applications, pp.188-193, 2012

[2] A. Senju, M. H. Johnson, “Atypical eye contact in autism: Models, mechanisms and development,” Neuroscience and Biobehavioral Reviews 33 (2009) 1204–1214.

[3] Senju, A., Johnson, M.H., 2009. The eye contact effect: mechanisms and development. Trends Cogn. Sci. 13, 127–134.

[4] Farroni, T., Massaccesi, S., Menon, E., Johnson, M.H., 2007. Direct gaze modulates face recognition in young infants. Cognition 102, 396–404.

[5] Grossmann, T., Johnson, M.H., Lloyd-Fox, S., Blasi, A., Deligianni, F., Elwell, C., et al., 2008. Early cortical specialization for face-to-face communication in human infants. Proc. Biol. Sci. 275, 2803–2811.

[6] Abrahams, B.S., Geschwind, D.H., 2008. Advances in autism genetics: on the threshold of a new neurobiology. Nat. Rev. Genet. 9, 341–355.

[7] Charman, T., 2003. Why is joint attention a pivotal skill in autism? Philos. Trans. R. Soc. Lond. B: Biol. Sci. 358, 315–324.

[8] Loveland, K.A., Landry, S.H., 1986. Joint attention and language development in autism and developmental language delay. J. Autism Dev. Disord. 16, 335–349.

[9] Frischen, A., Bayliss, A.P., Tipper, S.P., 2007. Gaze cueing of attention: visual attention, social cognition, and individual differences. Psychol. Bull. 133, 694–724.

[10] K. C. Welch, U. Lahiri, Z. Warren, N. Sarkar, “An Approach to the Design of Socially Acceptable Robots for Children with Autism Spectrum Disorders,” International Journal of Social Robotics, vol. 2, pp. 391-403, 2010

[11] American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders: DSM-IV-TR (4th ed.). Washington, DC: American Psychiatric Association.