Mobile Application for Behavioral and Social Skills Learning for Autism Children using Facial Expression Recognition

Gan Hao Zhan and Chandra Reka Ramachandiran

Abstract--- *Autism Spectrum Disorder is a neurodevelopment disease which is prevalent recently. This study addressed the possible factors that cause ASD, as well as the treatment for the disorders. However, with the implementation of current technology, this study aims to propose a mobile application as a solution that helps autism children for behavioral and social skills learning by using facial expression recognition, which can provide brief understanding of basic facial expression and emotion to children with ASD and slowly develop their social skills. Overall, the proposed mobile application is able to detect facial expression and emotion using live feed from camera of the mobile device. Besides, there is also simulation of certain environment to represent the daily life interaction with people which could aid in developing social communication skills.*

Keywords--- *Autism Spectrum Disorders, Behavioral Learning, Social Skills, Facial Expression Recognition, Mobile Application.*

I. INTRODUCTION

Autism Spectrum Disorders (ASD) is a range of neurodevelopment diseases which includes not only autistic disorder but also Asperger's and Pervasive Developmental Disorder—Not Otherwise Specified (PDD-NOS)[1]. Those with the disorder will have deficits in social communication and interaction, which also comes with restricted interests and repetitive patterns of behavior. Children diagnosed with ASD are highly dependent on routine which does not tolerate with any changes. However, autism is a heterogeneous condition, such that every child with ASD will not experience the exact same symptoms and profile [2]. The symptoms of ASD start to appear and can be detected as early as 18 months, but is often not diagnosed until 3 years old or later [3, 4].

Social skills are the abilities to communicate and interact between people to form a connection which able to express and understand each other verbally or nonverbally or both[5]. These include but are not limited to expressing ideas and emotions, smiling, making eye contact, understanding and giving feedbacks to others. Possessing good social skills often has a positive correlation with developmental result, which includes peer acceptance, mental health and academic achievements [6]. Limited abilities in social skills will affect the relationship and interaction with peers, family and others which also limits the child from achieving key developmental milestones and manage relationships between peer and family. Therefore ore, imparting social skills are important for child development especially children diagnosed with ASD, who are naturally stunted in that

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specific department and require additional assistance, as they do not innately understand social cues and such as easily as other children of the same age would.

Facial Expression Recognition is introduced in this paper to help children with ASD in social skills and interaction as well as behavior learning. Human facial expression is essential in communication between people, people tends to get more information from nonverbal communication than verbal message itself, it helps to convey emotions and message to the listener [8]. Facial expression recognition is an artificial intelligence technology that use techniques such as binary patterns evaluation and algorithm calculation to identify the facial expression, there are 3 major stages in any image processing with computer vision technology—such as facial expression recognition—which includes image pre-processing, feature extraction and classification [9]. The system should be able to recognize these basic expression/emotions such as neutral, happy, sad, angry, disgust, fear, surprise, etc. By using this technology, it will help children with ASD to identify the facial expression and emotions being expressed, and what it means that the other party is feeling at the moment. Thus, even without an instinctual ability, they can learn using the technology that whatever they said may have been received well or poorly and use that context to learn how to communicate more effectively.

II. BACKGROUND

Research background addressed the factors, complication, treatment of Autism Spectrum Disorder as well as implementation of technology to aid with the disorder.

2.1. Possible Factors that Cause Autism Spectrum Disorders

In the paper by Rochel Preiserowicz[10], the author stated that the main cause for ASD is still unclear, because autism is one of spectrum disorders which there are many different variables that take part in different level of the disorder. However, Preiserowicz comes up with conclusion that there are few possible causes of autism, which is genetic factor and environmental factor. It can be genetic mutation, effects of gestational diabetes on the fetus or parental age when having the baby. There is possibility that combination of genetic and environmental factor that the child (infant or fetus) is exposed to can cause autism[10]. In a similar work done by Ratajczak[11]agreed that autism could be the outcome from multiple causes, including genetic defects or brain inflammation, which inflammation mainly results from environment factors, such as infection or toxicants. Some suspected risk factors are determined that caused autism, which are lead poisoning, perinatal anoxia (infant oxygen deficiency), maternal alcohol consumption [12].

In addition to this, Karimi, et al.[13] claims that autism is an epigenetic disorder which environmental factors pose main influence on autism that can be divided into prenatal, natal and postnatal. Similarly, environmental factors including mercury, radiation and diesel exhaust is involved in ASD apart from genetic factors[14]. However, Bhat, et al. stated that ASD could be a combination of chromosome alteration from environment factors, variation or mutation in neural connectivity and different part of brain. Amaral[15]and Matsuzaki, et al.[16] supports the conclusion that combination of genetic and environmental factors will highly increase the possibility of autism rather than solely by genetic factors nor environmental factors.

2.2. Proposed Treatment for Autism Spectrum Disorder

According to Bhat et al. [14]and Weill, et al. [17], autism spectrum disorder cannot be cured as there is no medications to treat the core deficits of ASD, however additional therapy is effective to treat comorbid disorder such as anxiety, insomnia and etcetera which can turn that disability to ability. To add on this idea, Joshi et al. [12]stated that therapeutic intervention that can assist in autism children management can be classified as medical intervention, behavioral intervention, educational interventions as well as dietary intervention. Educational interventions are proved to be cornerstones to ASD management which includes behavioral strategies and habilitation therapies[1]. These interventions help with communication and social skills, academic achievements, language and leisure skills, daily living skills and maladaptive behaviors. Myers et al. also affirms that medications are not primary treatment to ASD as it is not proven to rectify the deficits. However, it is often used to control the comorbid disorder[18].On the other hand, Myers et al. [1] and Brentani et al.[18]mentioned that there are some specific methodologies that is often adapted to the intervention to enhance the effectiveness of the results, which are Applied Behavioral Analysis (ABA) and Treatment and Education of Autistic and Related Communication-Handicapped Children (TEACCH).

2.3. Implementation of Technology for Autism Spectrum Disorder

In the study by Boucenna et al. [19] affirm that ICT-based approaches and methods such as new technologies, algorithm or interface that can detect and recognize user emotion which can provide influence on the therapy and education for children with ASD is continuously and rapidly being developed. However, the authors claimed that most of the existing technologies are needed to be improved as the feedbacks of the technologies are lack of reliability to follow the special education method that suits for children with ASD. The authors proposed to integrate robots into intervention, which focusing on imitation skills and joint attention will brings important clinical impact to the user. On the other hand, Vlachouand Drigas[20]stated that mobile technology is attractive to all children, which children with ASD could not resist to play even they lack communication skills. Besides, mobile technology tools are promising for interventions as it can assess and diagnose the behavior by continual yet constant observation and records. n addition to that, the investigation by Didehbani et al.[21] proved that virtual reality is feasible to be used in intervention for children with ASD (High Functioning Autism), which it provides interactive and visually stimulation to be used in clinical treatment. It is able to practice meaningful social interaction and communication by simulating different daily life social scenario that specifically suits for different age from childhood to adulthood which can be delivered remotely via internet, such as meeting a new friend, confronting a bully, workplace or school communication etc.

III. PROBLEM STATEMENT

Children diagnosed with autism spectrum disorder will have deficits in social communication and interaction. They are having difficulties of identifying emotions and nonverbal cue from the other party including facial expression and body posture, which provides a lot of information while conveying message in daily life social interaction. Besides, children also have maladaptive behavior which could prevent the communication going on. Even though there are therapy that helps to manage the condition. However, during their social skills intervention, it

is hard to visualize or represent certain situation, such as confronting bullies, friend who ask for help, playing with friends etc. Therefore, it will decrease the effectivity of helping the child with ASD to learn through the intervention.

IV. AIMS AND OBJECTIVES

This study aims to propose a mobile application as solution to aid autistic children that facing problem in social interaction and communication by implementing facial expression recognition technology.

The objectives of the research were:

- To help autistic children understand emotions and facial expression of themselves and other party.
- To overcome the barrier of basic communication of autistic children.
- To help autistic children to understand the social situation in daily life and embracing empathy in them.
- To develop social interaction and communication skills which able to assist autistic children express themselves.
- To design and develop a mobile application that is suitable and helpful in field related to Autism Spectrum Disorder.

V. RESEARCH QUESTIONS

The research in this paper addressed below questions.

- How does facial expression recognition technology correlate to the field related to children diagnosed with autism spectrum disorder?
- How does the mobile application able to address and aid the condition of autistic children?
- What are the effects of adapting the technology in the intervention or treatment of Autism Spectrum Disorder?
- What are the parties that benefits from the proposed mobile application?
- How does the proposed mobile application increase the effectiveness of behavioral interventions to autism children?

VI. SIGNIFICANCE OF THE WORK

This finding of this paper will contribute to the field related to Autism Spectrum Disorder, no matter psychiatrist, teacher, parents of autism children or the child himself as child diagnosed in ASD has widely increase recently, many researchers have been looking into this area. The proposed mobile application will aid the psychiatrist to represent and visualize the situation while having an intervention to teach the child about social and communication skills. Besides, it is not limited to only psychiatrist, parents and teacher of the autism child could easily communicate with the child as the mobile application is easily accessible if one has a mobile device. Thus, the mobile application will greatly increase the assistance of the party while treating the child with lower cost than other aid application which requires specific and expensive devices such as virtual reality device.

VII. METHODOLOGY

7.1. Research Design

In order to develop a mobile application that suits for children with ASD, data collection is needed to identify the requirements of the mobile application. This study is a qualitative research as each of the individual autism child is different to each other in terms of condition and profile. Therefore, this study is to observe and identify the requirements that help to dive further into the problem and develop the solution.

7.2. Sampling

The sampling technique of this design will be non-probability sampling technique. Snowball sampling is one of the purposive sampling which suits this study, as psychiatric will be contacted and can easily reach out to autism child with certain or related symptom for data collection. Other than that, it also able to connect to the network in the related field to obtain more data which helps with the study.

7.3. Data Collection

The method of collecting data will bein-depth interview with psychiatric of ASD which could provide better insight of the condition of autism children and the treatment method for the disorder. Besides that, observation of intervention should also be conducted to understand the context and relationship between the autistic children and the psychiatric or parents, as well as how the intervention is conducted. The respondents should be consented that the information given will be recorded and used for research purpose, all the data information will be recorded down by video recording and written notes.

7.4. Data Analysis

The data obtained will be sorted and analyzed. Based on the objectives of the study, framework will be drafted and developed to identify the basic patterns and similarities, such as similar behavioral problem, social problem etc. After that, the interpreted data should have connection and patterns that is able to answer to the research questions and requirements for developing proposed mobile application.

7.5. Design Limitation

The limitation of the proposed design is that it is time consuming and cost expensive as each of the individual children profile is different, therefore interviews and observation should be repeated for different child, in order to obtain data that are unbiased and suitable for generalization.

VIII. OVERVIEW OF THE PROPOSED SYSTEM

The main functionality of the mobile application will be focus on understanding and identify the basic facial expression and emotion by using facial expression recognition from the camera feed on the mobile device and able to simulate different social scenario to teach the user the social situation and communication skills. During the simulation, the simulated characters will have some non-verbal cue such as body posture, movement or facial expression which will indicate their feeling and thought, thus will lead the children to react appropriately to the situation after identifying and analyzing it.

This mobile application can be use as a practice for facial expression as it will display the detected facial expression and emotion accordingly. As the child have some emotional issue, this application will aid to provide the suitable ways or methods to express their emotion, how they can manage with their emotion such as drawing as a channel to express when feeling sad or angry.
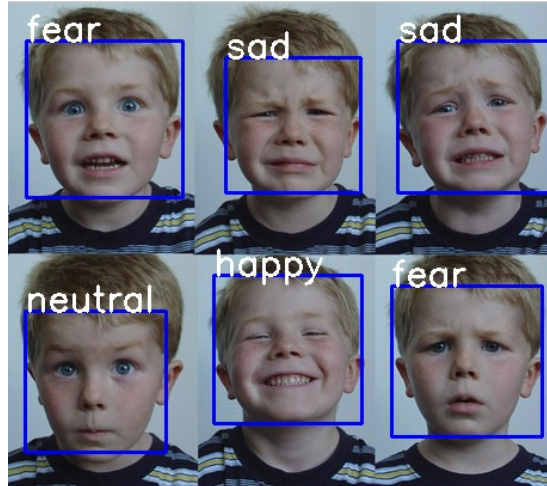

Figure 1: Facial Expression Recognition Example[22]

The virtual simulation scenario should be able to represent daily life scene such as in a library, sports day, greeting new friend etc.

Figure 2: "Getting to Know You" – Small-Talk in Conversation at the School Yard [21]

Figure 3: Classroom Project – Actively Participate in a Group in the Classroom[21]

In different scenario, the child using the application should be able to achieve certain goal with the guidance of adult, such as psychiatric, parents or teacher. The reaction of the child should be monitor and will be recorded in the

system for further analysis. This will lead the child to have a conversation with other more confidently and appropriately, such as greeting others, introduction and express interests.

Additionally, conversation bot (chatbot) could be included in the application for basic communication which appearance can modify based on the interest of the child and able to display/read emotion as well as react depending on detected emotion to keep him/her engaged in the conversation. (e.g. Are you feeling sad? Do you mind sharing what is on your mind?)

IX. CONCLUSION

The main factor of Autism Spectrum Disorder is remained undefined; however, the studies concludes that the possible factor that caused ASD is a combination of genetic and environmental factors, which environmental factors can be categorized as prenatal, natal and postnatal."About every disorder, prevention is more important than cure"[13].A lot of researches have been conducted to have deeper understanding of ASD, which could help us to identify and prevent the action that leads to ASD. Besides that, there are a lot of researches focus on integration of technologies and traditional intervention to provide more effective treatment for children with ASD, such as robotics, mobile application, virtual reality etc. In this study, the author proposed a solution, mobile application using facial recognition technology to aid the field related to autism, which includes education, medical and family. Thus, benefits autism children to develop social interaction and communication skills as well as behavioral learning.

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