

Effects of Adapted Model-Rival Method and Parrot-Inspired Robot in improving Learning and Social Interaction among Children with Autism

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Abstract—Educating children with autism is becoming a highly challenging task due to the nature of the disorder and limited interest of these children in interacting with people. Nevertheless, it is observed that most of the children with autism are good observers. This paper put forward and evaluates a novel teaching technique, Adapted Model-Rival Method (AMRM) and a parrot-inspired robot for children with autism to help improve learning and social interaction abilities through qualitative and quantitative analysis. We begin by discussing various medications, therapy, and teaching methods used in treating autism and emphasizing the importance and benefits of implementing an indirect teaching method. We then present our novel indirect teaching method, AMRM and the benefits of using a parrot-inspired robot as an intervention tool. Finally, we discuss the results of our study conducted for five consecutive days with nine participants.

Keywords—autism therapy; parrot-inspired robot; robot therapy; adapted model-rival method; bio-inspired robots

I. INTRODUCTION

The term ‘autism’ has been used to describe a various types of neuropsychological conditions since the early 1900s. Even though there are many symptoms defined in autism research, lack of interest in communicating and interacting with peers of same age, unusual interests and behaviors, hyperactivity, and self-harming behavior were identified most commonly in children with autism. It was reported by the Center for Disease Control (CDC) that 1 in every 150 children were identified with the symptoms of ASD in the United States in the year 2000. This number rose drastically to 1 in every 68 children as reported in the year 2012 [1]. Surprisingly, a report says that, 1 in 45 children are identified with ASD in the year 2016 [2]. It is alerting that, about 1 percent of the world population has symptoms of autism [3]. That is, approximately, 75 million people are identified with symptoms of autism spectrum disorder around the globe and the rate keeps increasing every minute. Even though, the cause and cure for ASD is yet to be identified, there are many medications and therapies available for improving the lifestyle of children with autism. In the recent years, studies involving autism therapy has

been carried out extensively. Improving learning and social interaction abilities of children with autism is utmost important to improve their lifestyle. Hence, we have developed a novel teaching technique, Adapted Model-Rival Method (AMRM) and a parrot-inspired robot, KiliRo to help improve learning and social interaction abilities of children with autism. AMRM is an indirect teaching method focused on utilizing the observing ability of children with autism and based on the theory that the abilities of the parrot-inspired robot would encourage children to get involved in learning and create stimulus for the children to learn and interact with peers.

II. TREATMENTS AND TEACHING IN AUTISM

The medical industry is working on inventing a standard medication for eradicating autism completely. Nevertheless, there are medications available to treat severe symptoms of autism including depression, anxiety, and obsessive behaviors. Selective Serotonin Reuptake Inhibitor (SSRI) and antipsychotic medicines are widely used in treating severe behaviors related to autism [4]. But the side-effects of using these medications are alarming. For instance, anticonvulsants medicines are used to treat aggression and self-harming behavior in children with autism that work by altering the electrical activities in the brain [5]. But the U.S. Food and Drug Administration (FDA) has issued warning on these medicines indicating people taking anticonvulsants medicines should be watched carefully for the warning signs of suicidal thoughts [6]. The side effects of consuming SSRI and antipsychotic medicines includes, nausea, sleepiness, weight loss and gain, insomnia, diarrhea and tremors [7] & [8].

Due to the limitations and side-effects of using medications to treat autism, alternate methods have gained more attention among the parents. Therapies are widely used in treating and helping children with autism in various needs. This includes, occupational therapy, speech therapy, applied behavior analysis therapy, animal assisted therapy, massage therapy, music therapy, and robot assisted therapy [9]–[13]. Teaching the children with autism is highly challenging due

to the nature of the disorder. There are many methods practiced around the globe to help improve the learning abilities of children with autism. On the other hand, it was reported that children with autism are good observers [14]&[15]. Hence, using an indirect teaching method by utilizing their observing capability could provide a new path for teaching these children and improve their lifestyle.

III. AMRM AND KILIRO

Adapted model-rival method is an adaption of the conventional model-rival method invented by Dietmar Todt, and the label-training procedure developed by Irene Pepperberg, to train parrots [16] & [17]. AMRM is focused on improving the learning and social interaction abilities of children with autism through an indirect teaching technique using the parrot-inspired robot, KiliRo. In this method, researcher teaches the robot in the presence of children with autism. The training includes, teaching English alphabets, Arabic numerals, and educating human relationships. When the researcher teaches, the parrot-inspired robot learns through its intelligence and answers the questions. Our robot uses quick response code on each of the cards shown to identify the alphabets and numbers. We expected that the participating children believed that the robot is learning and answering questions autonomously. To establish human relationship to the robot, face recognition and detection techniques are used. The AMRM method is still developing and will include more teaching sessions in the future experiments. This includes, teaching rhymes in English and regional languages, and demonstrations of different emotions through the robot based on various situations.

The semi-autonomous robot used in this study contains one head with two eyes and one beak, body with two wings and a tail, and two legs. The robot was fabricated to resemble a real parrot. The robot was able to walk forward and backward and move the tail up and down. We used Hi-Tec HS-35HD and 180 degrees' standard-scale HS-485HB servo motors for the robot's locomotion. We deployed wireless camera for visual monitoring, and Bluetooth speaker and a microphone for real-time communication. Alphabets and numbers used in this experiments were printed using a 3D printer with green, orange, and white color PLA materials. A member of the research team remotely operated the robot's locomotion and wings movements through the Bluetooth controlled joy stick. The learning abilities of the robot was simulated through live video and audio streaming via the wireless camera and microphone. The same approach is used in teaching alphabets, numerals, and the human relationship to the robot. An unseen researcher used a wireless speaker for communicating with participants to mimic the talking ability of the parrot-inspired robot, KiliRo. Nevertheless, the original robot is being developed with full suite of on-board autonomous functions. Semi-autonomous robot used in this experiment is illustrated in Fig 1.

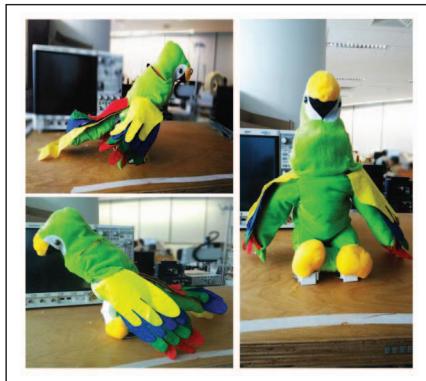


Fig 1 Semi-autonomous KiliRo

IV. EXPERIMENT SETUP

The study was conducted for 5 consecutive days with 3 sessions in each day. Nine children participated in the study. Each session was performed for a minimum duration of 15 minutes'. The study was performed at the same venue with the same participants. A few tasks, including, identifying the alphabets, numbers, and human detection and identification were simulated in the study based on the Wizard of Oz approach. A member of the research team remotely operated the robot's behavior using the live video feed for reacting to the situations. The parrot-inspired robot, KiliRo performed four tasks, namely, walking forward and backward, learning English alphabets and Arabic numerals, and identifying the humans and their relationships with participating children. participants were monitored for their behaviors during each session by the observers, who were then interviewed and requested to complete a closed-format questionnaire containing 14 questions. Parent/guardian of participating children, a pediatrician, and a child psychologist were involved in the study as observers. Both the pediatrician and the child psychologist were experienced for more than 5 years in their respective field and have been serving in public hospitals. A formal open invitation was sent to all potential participant's parent/guardian through the special education school where the experiment was conducted. The respondents were requested to complete 'The Childhood Autism Spectrum Test' (CAST) before conducting the study. CAST questionnaire contains 39 yes/no questions to evaluate the autism behavior in children [18]. Children scored more than 15 marks were included in the study as per the inclusion criteria by the CAST questionnaire.

Parent/guardian of participating children, the pediatrician, and the child psychologist were interviewed using informal and semi-formal interview methods for qualitatively analyzing the study. Parent/guardian of participating children were interviewed on the third day of the study and the pediatrician and the child psychologist were interviewed on the fourth and fifth day of the study respectively. For quantitative analysis, the study used a

closed-format questionnaire using 5-level ‘Likert scale’ and multiple choice questions format. The questionnaire used in this study is illustrated in Fig 2.

Informal and semi-formal interview and closed-format questionnaire results are stated in section A and section B below. The informal interview sessions were conducted as open discussion between the researcher and the respondents

1. Adapted Model-Rival Method likely to improve learning abilities of children with autism	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
2. Adapted Model-Rival Method likely to improve Social interaction abilities of children with autism	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
3. Parrot-like morphology would attract children with autism and create interest to interact with it	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
4. Recommended features for KiliRo considering learning and social interaction abilities	<input checked="" type="checkbox"/> Talking <input type="checkbox"/> Walking <input type="checkbox"/> Flying <input type="checkbox"/> Respond to touch <input type="checkbox"/> Respond to sound <input type="checkbox"/> Recognize face <input type="checkbox"/> Recognize voice <input type="checkbox"/> Wing flapping <input type="checkbox"/> Others please specify _____
5. KiliRo can be a good companion for children with autism	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
6. Parrot-like appearance is better than dog or cat-like appearance	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
7. The child speaks to KiliRo during the experiment	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
8. The child observes when KiliRo was learning alphabets and numbers	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
9. Child touched KiliRo amid the study	<input checked="" type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
10. KiliRo is recommended for teaching children with autism	<input checked="" type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
11. The child was happy being with KiliRo	<input checked="" type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
12. Cognitive abilities of children with autism can be improved through Adapted Model-Rival Method	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
13. Please choose which morphology is recommended for teaching children with autism	<input type="checkbox"/> Parrot <input type="checkbox"/> Dog <input type="checkbox"/> Cat <input type="checkbox"/> Bear <input type="checkbox"/> Seal <input type="checkbox"/> Human <input type="checkbox"/> Others please specify _____
14. Want it for my child	<input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4

FIG 2 QUESTIONNAIRE

V. RESULTS

Results from informal and semi-formal interviews and closed-format questionnaire show that learning and social interaction abilities of children with autism could be improved significantly using the indirect teaching method, AMRM using the parrot-inspired robot, KiliRo. Through observations, it was identified that, the talking ability of the parrot-like robot has increased the interaction interest in participating children. Hence we propose that the talking ability of the robot plays a vital role in improving the learning and social interaction of children with autism. The fifth day sessions were much interactive than the first day of our study, as the children seems to be much familiar with the robot, its actions, and behaviors. This showed that, the interaction with the robot could be improved significantly by running a long-term study.

(parent/guardian of participating children, the pediatrician, and the child psychologist). In this interview the respondents were free to exhibit their own views on implementing the AMRM and parrot-inspired robot for improving the learning and social interaction abilities of children with autism. They were also allowed to provide feedback and suggest needed features in KiliRo. On the other hand, in semi-formal interview sessions, the researcher asked a few pre-decided questions to the participants. Below are the few questions asked:

- 1) Do you think the indirect teaching method can be helpful in teaching children with autism?
- 2) What is your opinion on using parrot-like robot for improving learning and social interaction?

- 3) Is your child attracted to animals?
- 4) During this study, did you find your child interacting or trying to interact with the robot?
- 5) Do you have any suggestions?

A. Qualitative analysis

On the third day of the study, 9 parents/guardians were interviewed in two sessions. Informal and semi-formal interviews were conducted in first and second sessions respectively. Most of the parents/guardians' accepted the theory of AMRM, and insisted that the indirect teaching methods using a parrot-inspired robot would be useful in teaching children with autism. A few parents/guardians insisted that their child exhibit very limited interest in traditional teaching methods and they are eager to try the new indirect teaching method, AMRM. One parent specifically insisted that the learning through observation would work positively for children with autism based on the experience with her child. She pointed out that, her child observes how the television remote is operated by the family members and have learnt to operate it by herself.

During the session with the pediatrician and the child psychologist, both expressed interest towards the indirect teaching method. The child psychologist insisted that the natural talking ability of parrot would add realistic behavior to the parrot-inspired robot. The pediatrician expressed his support to the study by requesting the researcher to provide more robots when it is completely built to run long-term experiments in his hospital.

Through the informal and semi-formal interviews conducted, it was noted that the parent/guardian of children with autism, the pediatrician, and the child psychologist were supportive to the development parrot-inspired robot and the indirect teaching technique, adapted model-rival method. Fig 3 shows the interaction of children with the



robot.

Fig 3 Children interacting with KiliRo

B. Quantitative analysis

The 14 item closed-format questionnaire was completed by the parent/guardian, the pediatrician, and the child psychologist on the third, fourth, and fifth day of the study respectively. Table 1 shows the results of the questionnaire based on the 5-level 'Linkert scale' questionnaire. In the table, R represents the respondent of the questionnaire, Q represents the question, P represents the parent/guardian, PN represents the pediatrician, and CP represents the child psychologist. Hyphen indicates that the respondent has not provided any input.

It is seen that, for most of the questions asked in the questionnaire, the response from the parent/guardian, the pediatrician, and the child psychologist were agreeing. In other words, out of 114 responses, 60 responses were agreeing, 26 were neither agreeing nor disagreeing, 25 responses were strongly agreeing. Only 3 responses recorded disagreeing. Notably, for the AMRM and parrot-like morphology, very positive responses were recorded in the questionnaire. The question 4 in questionnaire asked about the recommended features in KiliRo for implementing AMRM to improve the learning and social interaction of children with autism. Fig 4 illustrates the expected features from the parent/guardian and the pediatrician and the child psychologist.

Table 1 Questionnaire results

R	Q 1	Q 2	Q 3	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 14
P1	4	4	3	3	4	2	3	3	4	2	4	4
P2	4	4	4	3	5	-	-	-	4	-	-	4
P3	4	5	4	4	5	4	4	3	4	5	3	3
P4	5	4	5	4	4	4	5	5	5	5	5	5
P5	4	4	4	4	3	4	4	4	4	4	4	5
P6	4	4	4	5	5	5	4	5	5	5	5	5
P7	4	3	4	3	4	3	4	-	3	3	3	3
P8	3	3	3	4	-	-	-	-	-	-	-	-
P9	4	4	4	4	5	4	-	-	4	4	-	-
PN	3	2	4	4	5	4	3	5	4	4	4	5
CP	3	4	4	4	3	4	4	4	3	3	3	4

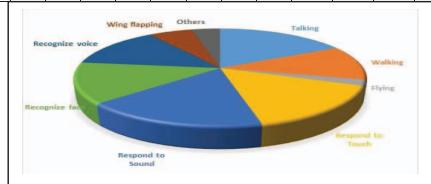


Fig 4 Expected features in KiliRo

VI. DISCUSSION

Numerous methods are followed in teaching and improving social interaction of children with autism. Educating children with autism is highly challenging due to their limited interaction interest with peers. The proposed AMRM using the parrot-inspired robot, KiliRo would create new path in teaching children with autism and improve their interaction interests. It is identified through the experiments that, the talking ability of the parrot-like robot attracts children and create urge in social interaction. Hence, we conclude that the adapted model-rival method and the KiliRo robot could help improve the learning and social interaction abilities of children with autism.

Future work includes, developing the fully autonomous KiliRo robot with all expected features from the parent/guardian, the pediatrician, and the child psychologist, and evaluating the robot through short-term and long-term user experiments. Another possibility includes, evaluating the AMRM and parrot-inspired robot, KiliRo with normally developing children and compare the effects with the traditional teaching methods. The third possibility of the future works includes, evaluating the indirect teaching method, AMRM and KiliRo in different countries and compare the results obtained.

Ethical Approval:

This study is approved by the Auckland University of Technology Ethics Committee (AUTEC), New Zealand and Human Ethics Committee, Bharath University, India. Informed consent from parent/guardian of children participated in the study, confidentiality agreement from the people who assisted during the study, and assent form from children participated in the study were obtained in accordance with the ethical committee.

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