Autistic Children and Music Playing with Humanoid Robot

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Abstract—**Mimicry is an important social skill for every person. A humanoid robot is used to play with autistic children in order to attract their attention and want to improve their concentration. Music therapy plays also an important role in this experiment. Robot plays with autistic children with music. The robot will imitate the notes which the child has played, and then the child has to imitate the robot in return. The purpose of the treatment is to improve their social skills including interpersonal synchrony and concentration can help them to adapt this society easier and make a better life in the future.**

I. INTRODUCTION

In recent years, research of autistic children has become more and more popular. Autism is a disorder of neural development. The characteristics of autism include impaired social interaction and communication, and repetitive behaviors [1, 2]. There are some methods available for autism therapy [3], such as behavior therapy, game therapy, art therapy, music therapy and so on. Therapists always need mediators to treat autistic children in general because they cannot play with autistic children directly. For example, art therapy through drawing, game therapy is done by game.

Autistic children are afraid of people because of their disease. Therefore, no matter which therapy we use, the problem of fearing people for autistic children is a big issue. For this reason, using a robot to cure autistic children can be the way of choice. A robot has such characteristics: less intimidating to the child, more predictable than a human. It can do the same procedure repeatedly and will not get tired. There is also some research that shows that robots indeed are attractive to autistic children [4, 5, 6, and 17]. We imagine robots as something between a toy and human [7, 8].

"Play Therapy" is a form of counseling or psychotherapy that uses an interaction game to communicate with people and help them, especially children. Play therapy is used to help towards a better social integration, growth and development. It is generally employed with children between the age from three to eleven. Therefore, we assume that letting robots play with autistic children is a good way to improve their social and communication skills.

"Music Therapy" is a professional area that completes an approved music therapy program by a music therapist. Music therapy can improve several aspects of the disease, such as mental functioning, motor skills, emotional development, social skills, and quality of life. Patients can get a feeling for the music by listening, singing, playing instruments, and moving. Music therapy for children is conducted either in a one-on-one session or in a group session, and it can help children with problems in communication, attention, and motivation, as well as with behavioral problems [9].

II. LITERATURE STUDY

A. Researches of Human-Robot Interactions

Kerstin Dautenhahn, Iain Werry, John Rae, et al. started using robots to help autistic children since 1998 [10]. This project which is called "The AuRoRA Project" [11] has been executed for over than 10 years. One of their former experiments was using a wheeled robot, Labo-1. They put Labo-1 and an autistic child together in a small room which size is 2x3 square meters. Labo-1 tries to catch the child, and it makes a sound when Labo-1 is near the child. Then, they recorded the interaction between the child and Labo-1 as a video. They analyzed the record and got feedback such as whether Labo-1 attracted the child, how much time the child played with Labo-1.

After Labo-1, they tried and developed many different types of robots one by one to support the Aurora project. The following robots are being used: Pekee robot, an upgrade version of Labo-1; Robota robot, a humanoid doll robot which has an infrared sensor and some rotatable joints; KASPAR, a humanoid robot that has many movable joints (over 11) and tactile sensors, and its eyeballs are rotatable. There are some researches that used KASPAR interact with the autistic children by tactile interaction, and get good results [5, 6].

There are also some robots for human-robot interactions (HRI). Paro is a seal-like robot that has five kinds of sensors which can perceive people and its environment. Paro is now always used to accompany with the old man [12]. Huggable has more than 1500 sensors on its skin can feel the environment, and its appearance is like a teddy bear [13]. NeCoRo is a robot that likes a real cat, and it has 7 sensors which can let it know the touch from the environment [14]. We can see that more and more robots are made for accompany or take care of human.

The ongoing development of small size robots results in better and more robust robots with the advance of the corresponding technologies. There are more and more organizations devoted to this field of research, for example, using a small size robot to help an autistic child. One group of Connecticut University has published a paper [9] is which they use Aldebaran's NAO robot to teach autistic children to play the drum, for rhythmic music playing interaction.

Daniel J. Ricks, Mark B. Colton, and Michael A. Goodrich also published a paper [15] in 2012. They made a humanoid robot capable of only upper body expression transforms. It can sing and play some specific toys.

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In Taiwan, Tsai, Cheng-Hung [16] used a humanoid robot to play pose simulated game. They used a normal webcam and let the child wore red gloves and stickers on their shoulder to capture the motion. Then, they use ZigBee to transmit data and compared the motion differences between each other.

B. Interpersonal Synchrony

According to the literature [9], they use NAO robot to teach autistic children to play the drum. They consider that this may be a form of mimicry which is an important social skill [18, 19].

Interpersonal synchrony is a dynamic process that appears from the interplay between the members of the group. They mutually influence each other as they move together, and this creates an emergent synchronous system that is self organizing. Synchronous activities can lead people cooperate with others, and can improve the feelings of affiliation [18].

III. EXPERIMENT DESIGN

A. Background and Goal

Our goal is to teach autistic children social or communication skills through interacting or playing with the robot. We think the robot could be a good mediator for improving social skills; specifically this is true for humanoid robots. There are two methods to make a humanoid robot like a normal human:

- Remote control the robot to make it like a human. However, many incidents will occur when we play with an autistic child. We need complementary behaviors to make a robot behave in the same manner as a human. The challenges here are that we need to design enough motion patterns to make the robot like a human and the robot (or we) must react in time.

- Make the robot act autonomously like a human. For this purpose, we need some kinds of sensors, such as camera, microphone, and tactile sensors. Building algorithms to generalize normal human's behavior and shows it autonomously is a good way to make the robot act like a human.

Figure 1. Darwin-OP and the glockenspiel.

There are some researches that show that the "Music Therapy" is also effective for autistic children [20, 21].

Music therapy indeed can prompt social, emotional and motivational development in children with autism. Moreover, music always acts as a social intermediary that forms a bridge between the participants. They use rhythm therapy to train the child's rhythmic gross motor and drumming actions, and hope that they can improve their cooperation and joint attention.

Therefore, we want to add music into the experiment and also use the humanoid robot play with the autistic children. In our experiment, we use the humanoid robot named Darwin-OP as our mediator. Fig. 1 shows the robot and the instrument he played.
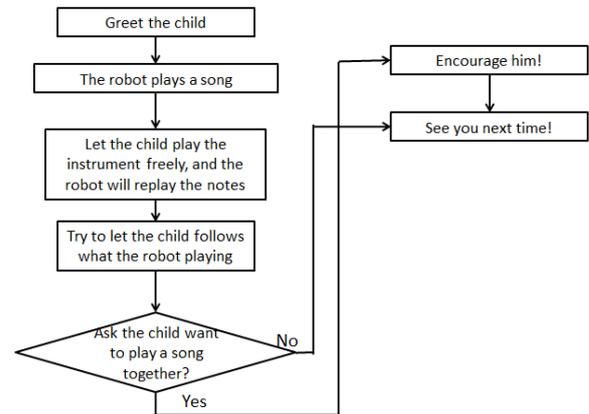
B. Experiment

Figure 2. The flow chart of our experiment.

There are three phases in our experiment. Fig. 2 shows that the three phases including attract the children's attention, imitating and training, and observe their reactions and paper tests.

At the beginning, robot will greet the child who comes in the room. Then play a song to the child to attract his/her attention. It is a very important step in our experiment, because the child with autism is hard to concentrate on one thing. The moving robot acts like a human and the song that the robot played are all interesting for the autistic children.

After the robot plays the song, we let the child play the instrument freely. The robot will imitate what the child just played, and we will see the reaction of the child. After a few minutes, we ask the child imitate what the robot play conversely. Robot teaches the child to play the song which it just played at the beginning by mimicry. It is training that the child will be more familiar with music and the instrument. Moreover, it is also can improve their coordination. We can observe the child would be willing to play the whole song after the training.

Final phase is the paper test. We can test them more about the ability of mimicry and the understanding with the different voice in the post test. The recorded video is also an important data in our experiment. We record the whole procedure during the experiment. In the video, we can see how the child reacts in every phase, and the effect of this

experiment to those children.

IV. CONCLUSION

In our previous experiment to the autistic children, we found that the humanoid robot indeed can attract their attention. We hope that in this experiment, we can improve their social skills. Because of their uniqueness, they are hard to adapt or integrate into the group. Learning mimicry and joint-attention can make them integrate into a group more easily.

Music therapy is not only used for the autistic children but also used for those who have psychological disorders. There is no doubt that music can make people relax and happy. We believe that music is a good non-verbal communication way to communicate with others, so it is easier to use for the autistic children. Make them have a better life has been the goal of our efforts.

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[12] http://www.parorobots.com/, robot Paro.

[13] http://robotic.media.mit.edu/projects/robots/huggable/overview/overvi ew.html, teddy bear Huggable.

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