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Autonomous Humanoid Robot Playing Scenario for Autistic Children

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***Abstract*—Using robot playmate to help autistic children is a relatively new idea for therapy. A Robot can repeat to do the same procedure precisely and does not get tired or bored. Morevoer, earlier experiments show that Autistic children show an open behavior to robots. In this paper, we want to discuss the possibility of using humanoid robot to play scenario for autistic children.**

I. Introduction

Autism is a disorder of neural development characterized by impaired social interaction and communication, and by restricted and repetitive behaviors. The diagnostic criteria require that symptoms become apparent after 18 months, or before a child is three years old [11][13]. Many types of therapies are used for treating autism [4], medical medicine therapy, behavior psychology therapy, social work therapy, artist therapy, art therapy, game therapy, music therapy and others more.

The idea to use a robot for therapy has been raised for more than ten years. Kerstin Dautenhahn et al. started to use robots to help autistic children in the year 1998 [5]. This project, "The AuRoRA Project" [1], has been executed for over 10 years. One of their former experiments was using a wheeled robot, Labo-1 [6]; Labo-1's length is 40 cm, width is 30 cm and weight is 6.5 kg, Labo-1 has 8 infrared sensors (4 is in front and 4 is at back). This robot also has a temperature sensor and a speaker. Labo-1 can do behaviors such as obstacle avoidance and child tracking using the devices mentioned above. They put Labo-1 together with an autistic child 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, 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. Robota robot [16] [15] [14], a humanoid doll robot. It has an infrared sensor and some rotatable joints; Tsai, Cheng-Hung [18] used humanoid robot to play pose simulated game. They use a normal webcam and some parts (red gloves and stickers on shoulder) that the child wore to capture the motion. Then, they use ZigBee to transmit data and compared the motion differences between each other; KASPAR [17] [9], a humanoid robot that has much more movable joints (over 11). Its eyeballs are rotatable and it has tactile sensors; NAO, a robot produced by Aldebaran, is used to teach to autistic children play the drum for rhythmic music playing interaction [8].

Francois Michaud and Catherine Theberge-Turmel [12] have concluded that a robot may be less intimidating and more predictable than a human. A robot can follow a deterministic play routine and also adapt over time and change the ways it responds to the world, generating more sophisticated interactions and unpredictable situations that can help capture and retain the child's interest. We agree with them.

The overall starting point of our research was to build a robot that can help autistic children's development. Thus, we chose the humanoid robot scenario-playing way to achieve it. The scenario-playing method is based on puppetry play.

Puppetry play has previously been used to train children to practice spontaneous, imaginary, and symbolic play [7]. It has been stated the this method can help bring them think concretely into the world of abstract concepts and ideas .

The method's main idea is to let robot play scenario with puppetry, but with humanoid robot's size we don't prepare the real puppets. Instead, we stick two piece paper of characters on robot's hands, act as real puppets.

We intent to check how much is the child willing or capable to understand what is happening. We tell the child a little fairy tale, where the story has a little twist. In the current version the robot takes a role in the fairy tale and acts as a rabbit. Suddenly, the robot switches the role and acts as a turtle. We hope to detect a possible surprise in the reaction of the child. We assume that such a surprise requires a basic understanding of the fairy tale.

II. Method

In our case, we use the fairy tale - "Turtle beats Hare" as our scenario. "Turtle beats Hare" is a tale talking about a turtle and a rabbit are having a racing competition, rabbit is lead at first but it lose to turtle in final because of its enemy underestimation and taking a nap in the competition.

Recent research suggests[10] that scenario-playing of a social story can improve social skills of autistic children. A social story means here a series of conversations about how people interact with each other.

Typical stories are ”Buy food”, ”Take a train” or ”Go to School”. Children with autism have always proved to be a group without imagination which may mean that it is does not matter whatever story or tale is. However in the current case, we chose the fairy tale without a human character. The reason is that we want to eliminate the factors of social stories and investigate if their pure curiosity and attention to humanoid robot can serve our purpose.

Our final goal is to design a robot and behavior that inspires and guides them. We attempt to utilize a humanoid robot's characteristics, but also keep the design less intimidating and more predictable to attract autistic child joint attention. Also we intent to foster autistic children in the way that we stimulate their imagination, spontaneous and symbolic play through this robot.

The technical realization is depicted in Fig.1. The child stands or sits in front of the robot, and then watches the scenario with a simple background picture on the wall (realized with a video projector) and its puppets, two stickers (see Fig.2) on his hands. After the scenario ends, the autistic child's reaction is evaluated and it is decided whether the scenario is repeated or not. If it is not repeated, a small test is conducted in which we like to check the understanding. This little test may be done by a test paper or an interactive games. During the procedure, we will also put a web cam in field to record children's reaction for analyzing their attention. The complete result will be summed up by test and related factors.

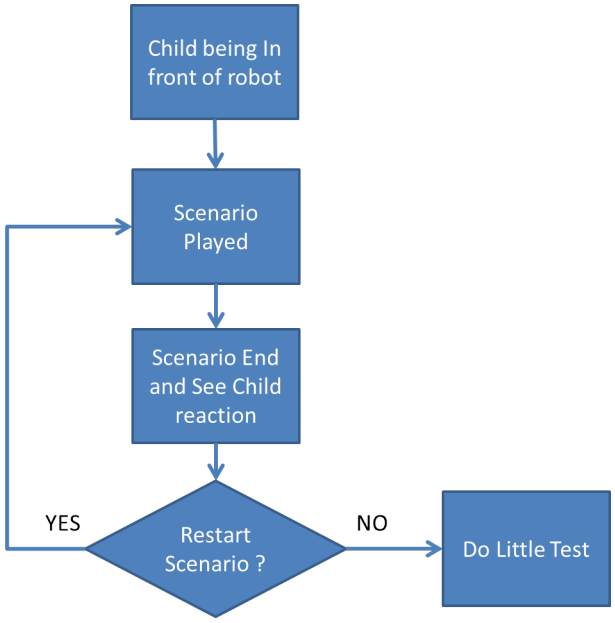

Fig. 1. Flow chart of the humanoid robot scenario-playing method.

Fig. 2. Stickers used on humanoid robot's hands.

III. Implementation

A. Hardware and environment

We build the overall experiment environment with the following hardware: Humanoid robot, laptop, projector, speakers, and wireless access point. The hardwares each other's relation are shown in Fig.5.

Humanoid robot : Here we chose Darwin-OP as our humanoid robot and also our mediator with the autistic children. Darwin-OP is made by ROBOTIS, it has a camera, two microphones, a speaker, a gyroscope sensor, 3 buttons and 20 DOF. Motions are designed in sequences: The robot plays a series of actions of a role and is controlled by the commands received from console (laptop). It sends back the finished signal when the actions was done.

Laptop : A GUI serves as console of the overall environment. It plays the background of scenario with projector and speakers, it also sends commands to Darwin-OP itself for role playing.

Projector and Speakers : An assistant tool to help console (laptop) shows the screen and plays the sound to children.

Wireless Access Point : A communication bridge between console (laptop) and Darwin-OP.

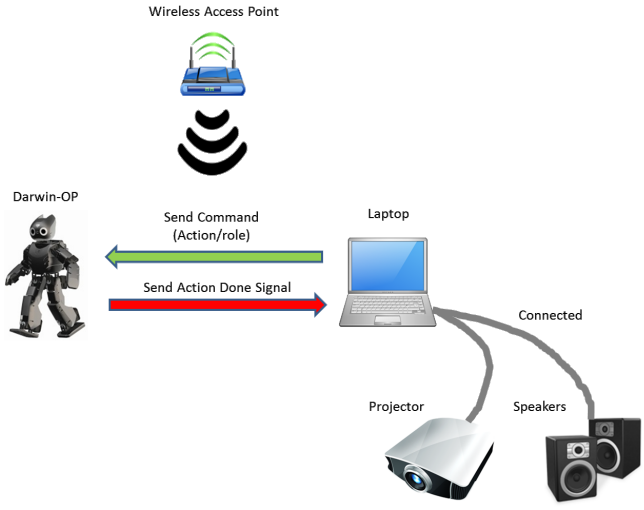

Fig. 5. Enviroment overall architecture

These hardwares are set down like this in Fig.6, and the dash-line is projected range of projector. Autistic child will be inside the projected range seeing robot play scenario; Assistant will control the console from laptop at side.

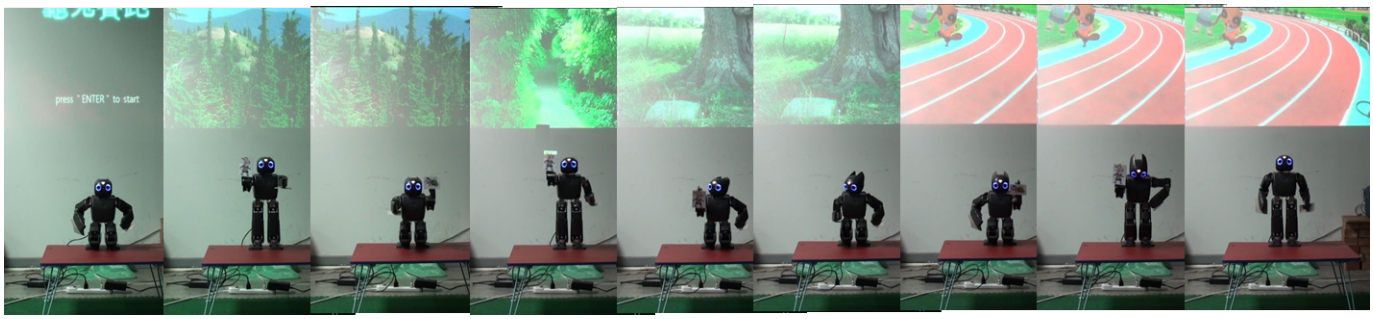

Fig. 3. Projector displayed the background and Darwin-OP played "Turtle beats Hare"scenario when system start running. Storyline from begin to end is depicted from left to right. The most left photo shows the begining screen, it said "press ENTER to start (the program)".

Fig. 4. Background used in the fairy-tale. Forest is used in intro; race circuit is used when start racing; path and stone under a tree is used when hare sleeps; the final circuit appeared the other animals which hurray for turtle's victory.

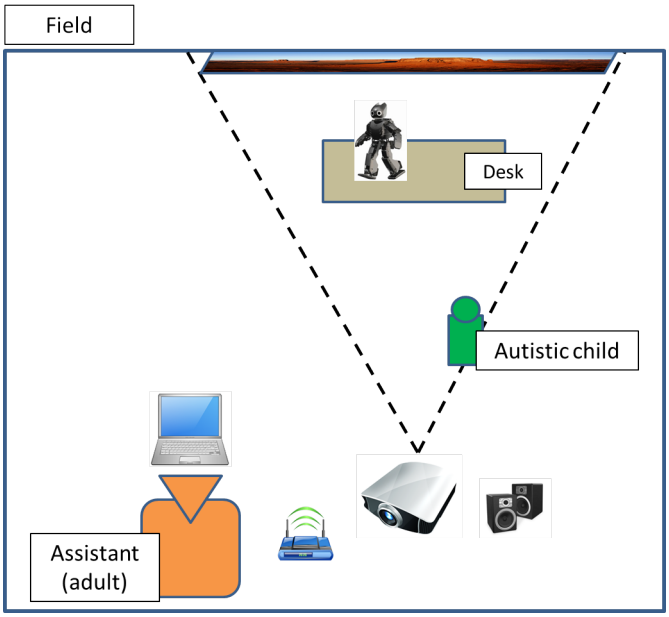

Fig. 6. Hardwares' location in the field.

B. Console system

Console system is programed in C++. We use the SFML library [2] to handle background changed events and the background sound. The UDP-based Data Transfer Protocol (UDT) [3] handles wireless communication between the console and Darwin-OP. Darwin-OP uses the official API for controlling the motion (action).

Laptop is connected with the projector and speakers. The screen from projector plays the background of a scenario, speakers plays the sounds that belong to the background, and Darwin-OP plays the specific role when specific background being played according to commands received through broadcast from laptop (see Fig.5).

C. Overall system running

During preparation, Darwin-OP takes two stickers in the way depicted in Fig.7. During the turtle's or rabbit's lines, the robot raises up the turtle sticker or rabbit sticker, respectively (see Fig.8). Other roles and backgorund effects are played by console (see Fig.4). Fig.3 gives and overview of the overall system.

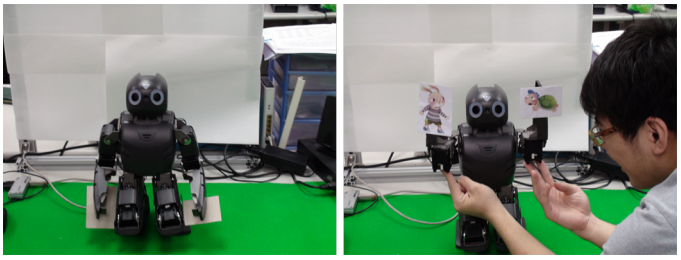

Fig. 7. How Darwin-OP takes turtle and hare, hands down (right), hands up (left).

IV. Conclusion and Outlook

We presented method that is specifically designed to attract the autistic children's attention and discuss methods to measure the rate of this attention.

As further steps, we intent to check to what extent the autistic children are capable to distinguish the role that is played by the humanoid robot. Currently, we use the character stickers to imply and guide child to know robot's role, but the role representation in such way may be ambiguous. To resolve the problem, we raise an idea that is using a head-changed humanoid robot, take "Turtle beats Hare" in example: The head

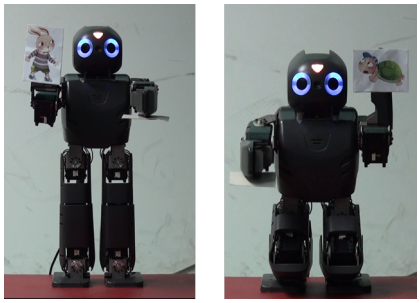

Fig. 8. Darwin-OP raise up hare (right) and turtle (left) stickers with their role action.

turns to turtle when turtle turns talk and vice versa. However, in more simple and brief way, we could prepare more robots, every role played by one robot, this should be distinguished clearly. We will consider it as our next topic.

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