AN ASSISTIVE HUMAN-ROBOT SYSTEM WITH MULTIPLE SOCIAL ROBOTS FOR AUTISTIC CHILDREN

BMCC

CUNY RESEARCH SCHOLARS PROGRAM

Weida Jiang, Dr. Mohammad Azhar

Abstract

Autism Spectrum Disorder(ASD) is a lifelong developmental disability characterized by difficulty in social interaction, repetitive behaviors, both verbal and nonverbal communication. According to a recent Centers for Disease Control And Prevention (CDC) report, about 1 in 54 children in the United States will be affected by ASD in 2020[3]. The biggest challenge we have faced is the difficulty of establishing effective communication with autistic children; moreover, treatment for autism requires a long period of time. Current robots can provide curiosity and more likely to increase the interest in autistic children to participate. Recently, researchers have deployed humanoid robots to assist autistic children and overcome their mental disorder[1, 2]. Current robots can provide curiosity and more likely to increase the interest in autistic children to participate. Hence, we hypothesize that multiple robots may be deployed as an essential therapeutic tool to improve autistic children's social interaction and collaborative skills.

Approach

- Design and develop human-robot social interactions (HRI) and collaborative scenarios to help autistic children(**PreK-6 up to 12 years old**) engage in regular communication to improve their social skills and collaborative skills.
- Develop an intelligent web interface dashboard to collect applicable data extracted from the robots and mobile HRI software for therapists/parents/caregivers.
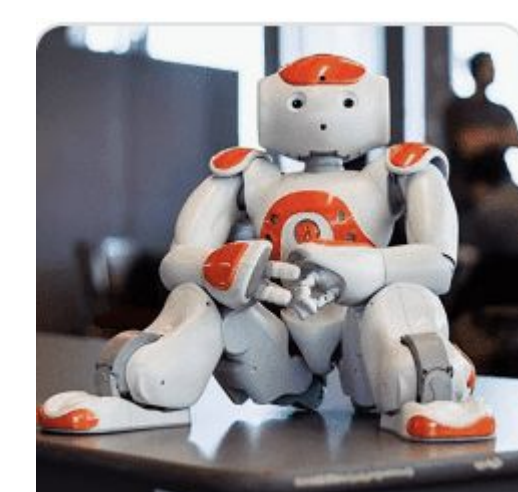

Fig.1 Cozmo   Fig.2 IOS APP   Fig.3 NAO

Human - Robot Interaction Design

- **Social Interaction Skill**
  - Greeting exercise with **NAO Humanoid Robot** to motivate autistic children to practice traditional greeting with the robot
  - **Communication involves with verbal (voice) and nonverbal (mobile interface) skills.**
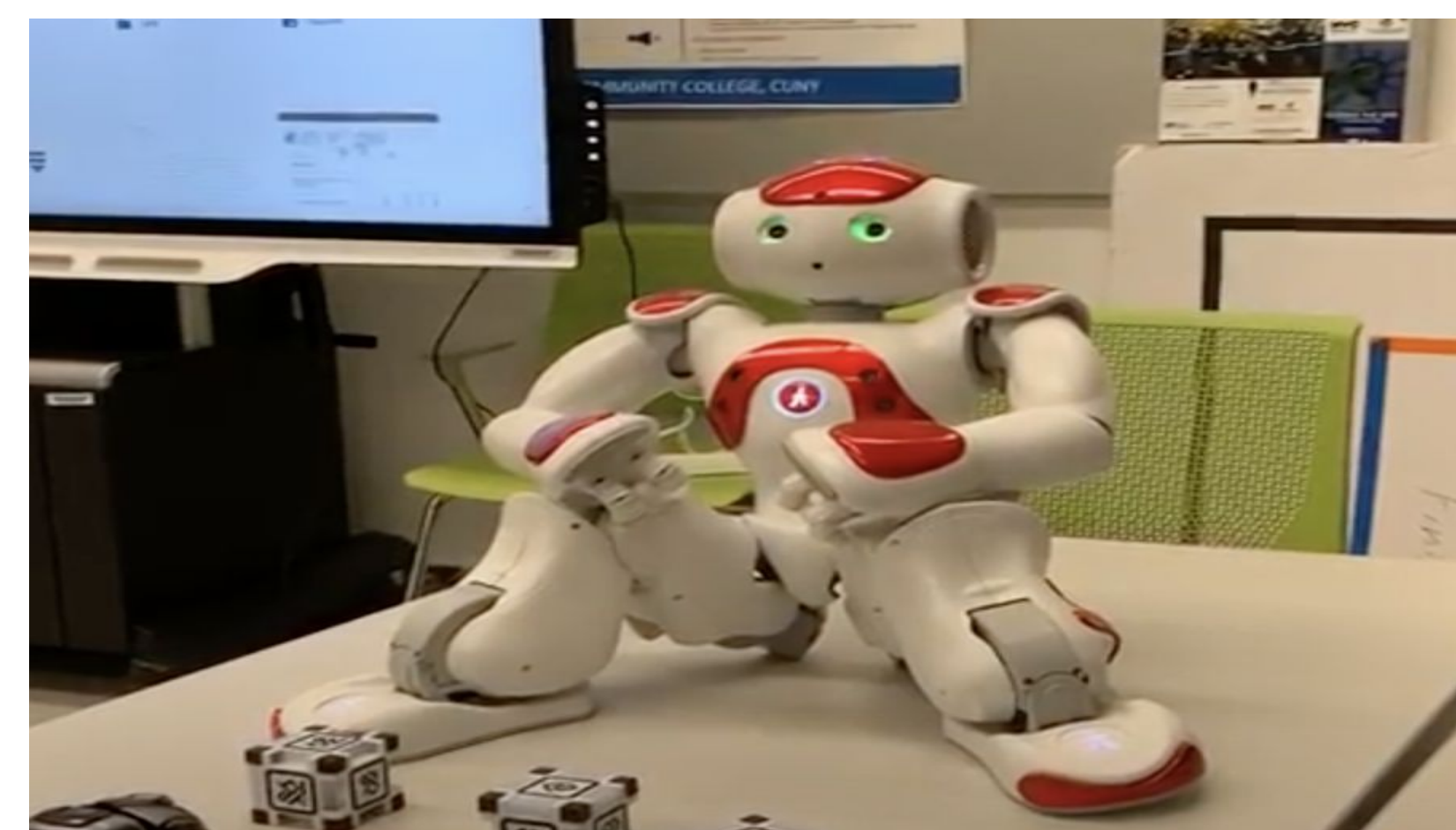

Fig.4 Make friend with NAO diagram

- **Collaborative Skill**
  - **Joint task exercises with NAO Humanoid Robot, Cozmo Robot, and Mobile IOS Application** will control the movement of the robot to complete specific assigned tasks (i.e., find the cube) to improve cooperative and collaborative skills.
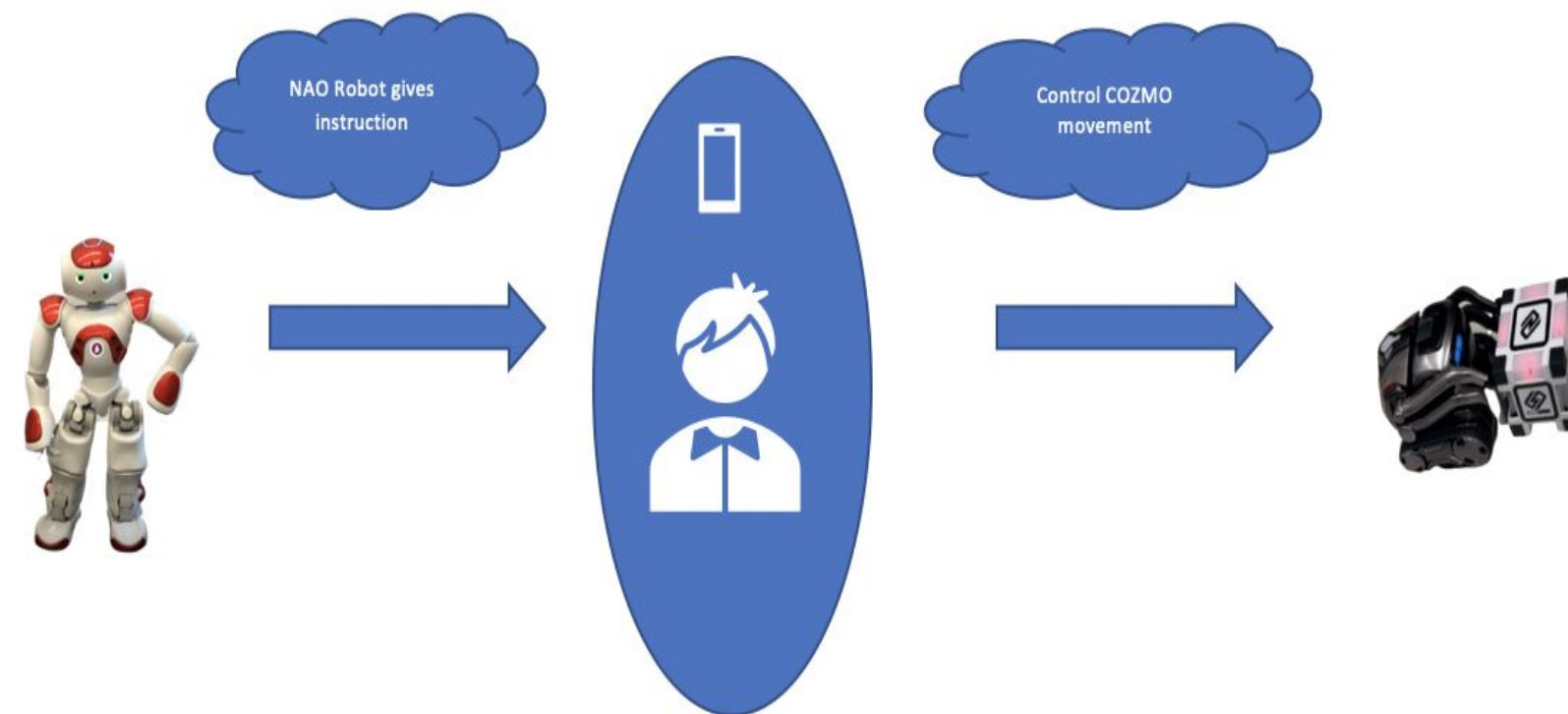 - **Communication involves with verbal (voice) and nonverbal (mobile interface) skills.**

Fig.5 Collaborative skill model diagram

Development

- Project is developed in four different phases
  - Phase 1 : Choregraphe for front - end and Java back - end development to control the NAO Humanoid Robot.
  - Phase 2: IOS development for mobile application development.
  - Phase 3: Calypso software to control the Cozmo Robot.
  - Phase 4: Cross-platform communication among NAO Humanoid Robot, Cozmo Robot and Mobile Application.
- IOS App: integrate speech to text library, analyze the language and make requests to the Python and Java back - end via the HTTP protocol.

Fig.6 Swift cross-platform request demo code

- Java, Python and Calypso: develop web service interface to accept the request, process the information and send response back.

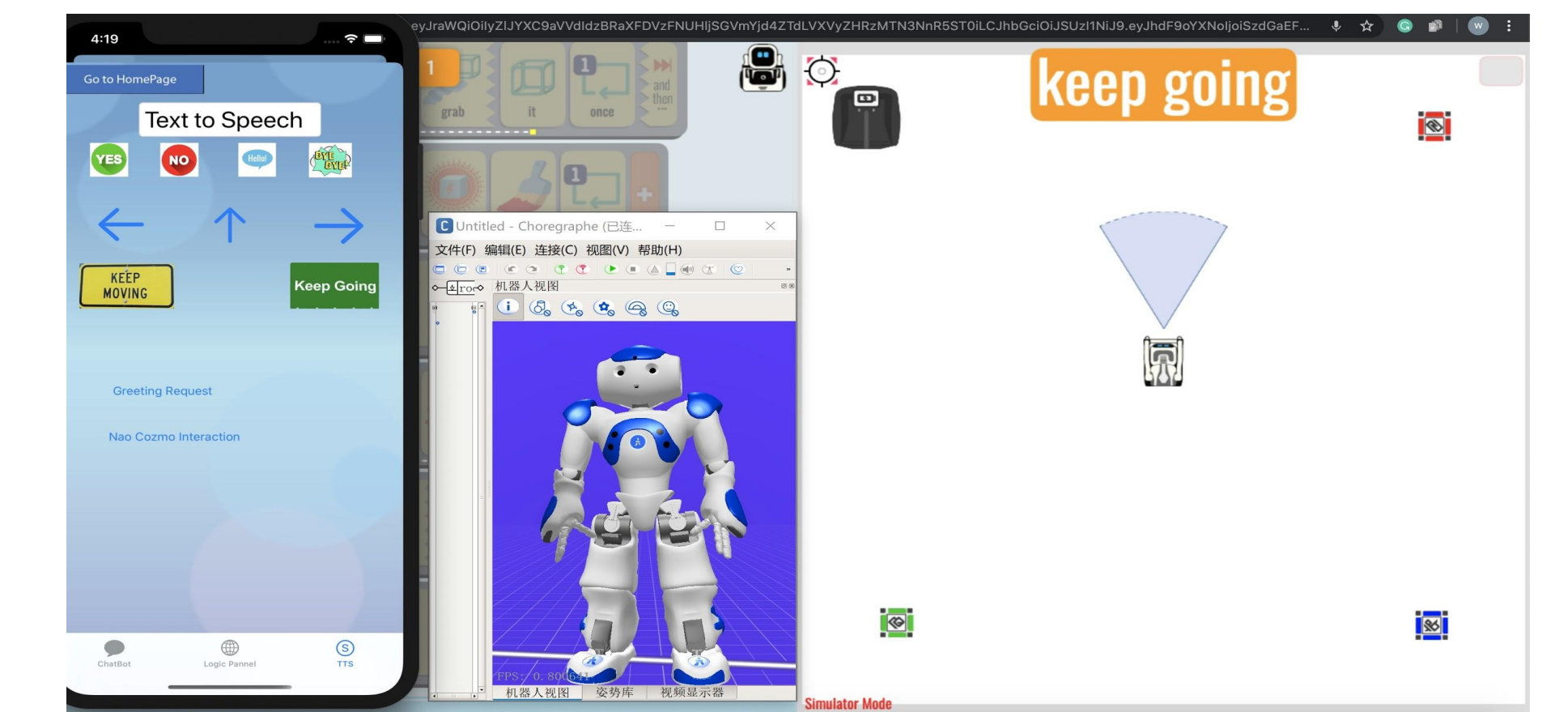Fig.7 Java back - end web service interface demo code

Fig. 8 Test cross-platform In virtual environment

Conclusion and Future Work

- In this research, we implemented:
  - an HRI assistive solution employing NAO Humanoid Robot, Cozmo Robot, and a Mobile Interface to improve autistic children's social interaction and collaborative skills
  - a software system architecture prototype that enables cross-robot and mobile interface communication.
- We are currently working towards:
  - conducting expert user study,
  - developing more Human-Robot Interaction and collaborative modules
  - developing a web interface dashboard to collect applicable information for therapists and parents, which can help them monitor and understand children with autism.
  - Our long-term goal is to conduct official human-robot interaction user study with autistic children to further validate our hypothesis employing our proposed HRI solutions.

Reference

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2. Billing,Erik.Ziemke, Tom. "Robot-Enhanced Therapy for Children with Autism." SweCog 2018: 14th National Conference of the Swedish Cognitive Science Society, Linköping, October 11 and 12, 2018
3. Centers for Disease Control And Prevention (CDC). Data & Statistics on Autism Spectrum Disorder. Retrieved from https://www.cdc.gov/ncbddd/autism/data.html

Acknowledgement