Interactive Robotic Therapy Toy for Children with Autism Spectrum Disorder

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Abstract*— This paper presents a low-cost, interactive robotic tool designed to support speech therapy for children with Autism Spectrum Disorder (ASD). The prototype integrates voice recognition, dynamic visual feedback, and gamified learning to create an engaging, human-interaction-minimized environment. By combining off-the-shelf Meccano robotics with a custom Android app, the system encourages speech production through repetitive exercises while providing real-time feedback. Initial surveys and pilot testing indicate strong potential for cost-effective, home-based therapy, with 95% of respondents expressing willingness to adopt such a device.

I. Introduction / Background

About 3.2% American children aged 8 have autism whereas in the Arab world some studies represent values as low as 0.18% percent. Amongst many factors, economic and cultural regional differences play a big role is this disparity. Traditional speech therapy often requires expensive, in-person sessions, creating accessibility barriers. Robotic interventions have shown promise in ASD therapy due to their predictability and engagement potential, yet cost remains prohibitive.

II. Related work

Several studies have demonstrated the efficacy of multimedia tools and social robots in ASD interventions. For example, the Keepon robot elicits spontaneous communication in children with ASD, while tablet-based flashcards support vocabulary acquisition. Commercial Meccanoid platforms have been used in informal STEM education but have not been evaluated for therapeutic applications. My prototype combines proven elements such as robotic embodiment, voice feedback, and gamified flashcards to deliver a low-cost therapeutic tool to be used in developing countries.

III. Photos

Figure 1 Twelve year-old me at the Intel International Science and Engineering Fair in Jordan

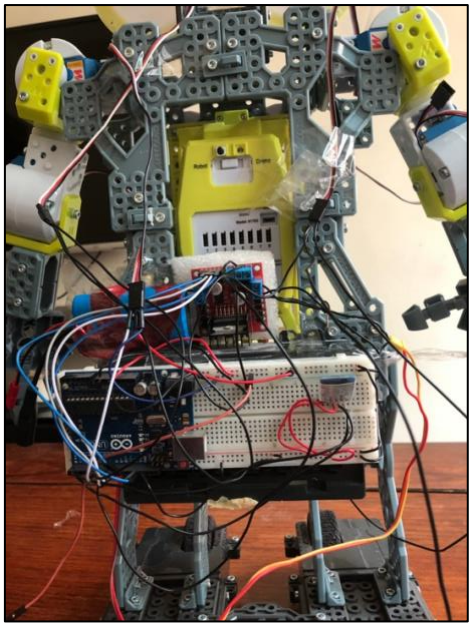

Figure 2 Robot from the back

Figure 2 shows how I connected the motors of the Meccanoid to the Arduino. Additionally, the module on the right-hand side of the breadboard is the Bluetooth receiver to be able to accept commands from the mobile application.

A. Hardware and Electronics

The Meccanoid G15 was bought at a nearby toy store. I ended up using all the disconnecting the motors from the supplied driver and connecting them to Arduino Uno. Additionally, I connected a researchable battery and a Bluetooth module to receive the messages from the mobile app.

B. Software

The application as made with a free online tool called the MIT App Inventor. This tool allows users with very little application development experience to create android apps. The app starts off by giving the user the choice to select a type of quiz. Upon that selection it then connects to the Arduino using BLE and instructs it to move the robot based on some preprogrammed actions. These actions reflect what the robot feels after the user inputs a correct or incorrect answer.

These lesson sequences comprise of flashcards (colours, shapes, nouns, verbs) and prompts pronunciation tasks. Correct responses trigger celebratory robot gestures;

incorrect attempts prompt repetition. App displays a flashcard and speaks the target word.

IV. Responsible innovation

My design prioritizes accessibility and sustainability:

- **Cost Efficiency:** Parts total under £100, enabling broader deployment.
- **Privacy:** No cloud storage of audio; all processing occurs locally on the device.
- **Environmental Impact:** Reusable plastic components and upgradeable firmware extend device lifespan.
- **Inclusivity:** Interface designed for non-verbal and minimally verbal children through intuitive LEDs and gestures.

V. Author bio(s) / experiences

I began my making journey at the age of 13, driven by a desire to build things that could make a difference in people's lives. At the time of writing, I am an undergraduate Software Engineering student and a prospective master's student.

A significant motivator for my work was witnessing the stigma and systemic challenges faced by neurodivergent individuals, particularly in the Arab world. While volunteering at Al-Masar School for children with disabilities, I observed a clear disparity in the progress of students based on their families' financial backgrounds. Children whose parents could afford to spend extra time and resources on home support progressed much faster than those whose families, due to economic or cultural reasons, were unable to do the same.

One of my other early prototypes was a custom Braille keyboard that allowed visually impaired individuals to interact with a standard computer keyboard. I developed this while still in school and won first place for it, and it remains a project close to my heart. The aim was to provide an affordable and intuitive alternative to expensive accessibility equipment.

VI. Acknowledgements

This work is dedicated to children with ASD and their families. Special thanks to supervisors Mr Odeh Tawfeek Mr. Hazem Hamdan, Mrs. Farah Hourani, Masar School, and Dr. Amera al Masri for their invaluable support and insights.

VII. References

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