Pomelo, a Collaborative Education Technology Interaction Robot

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***Abstract*—We have designed "Pomelo", an interactive robot that teaches children basic algorithmic skills and enhances classroom collaboration through games. Pomelo looks like a friendly dog with a screen displaying its eyes and cooperates with the students through vision and speech. Pomelo becomes a part of the class instead of merely being a second teacher by interacting with children in the same way children interact with each other, like "Robovie" [1]. Ultimately, Pomelo will encourage kids to use technology as an interactive learning tool instead of a form of addictive entertainment while creating a more cooperative and social classroom environment.**

***Keywords*—Education, Visual Programming, Speech recognition and synthesis, Collaborative learning, Computer assisted instruction, Computer-supported cooperative work**

I. Introduction

Millennial children are exposed to technology at a very young age, but aren't shown how to properly use this self-driven learning tool. The wrong use of technology decreases the quality of interaction between kids and robots, shifting the positive role of technology from education to addiction while also facilitating cooperative activities between kids.

To tackle this issue we designed Pomelo, a friendly robot that interacts with children in classroom settings, acting as a helper that creates a learner-centered environment. Through Pomelo, we aim to promote positive technology habits and strong algorithmic skills in students while creating a high quality learning atmosphere.

II. Design Goals

A. Inducing Good Technological Habits

The major cause of technology addiction, especially in young demographics, is fueled through their excessive use starting at early ages. The problem stems from their wrong perception of technology caused by their monotonous use of it for entertainment purposes. As we aim to help enhance education through interactive and collaborative learning, we have designed Pomelo to interact with kids in two different ways that induce self-driven educational motivation. Students will no longer use technology as a way to escape the boring aspects of their lives, but rather as an educative interactive tool that simultaneously induces social interaction with their peers. This will ultimately heighten their understanding of technology and guide them into forming beneficial technological habits in the future.

B. Enhancing the Effectiveness of Clasroom Learning Enviorments

The modern elementary school classroom contains an average of 24 students with a single teacher responsible. This results in an overwhelming abundance of unanswered questions in which kids aren't able to receive the attention required for them to reach their full capacity. As a way to address this, we integrated a natural language processing functionality to Pomelo that answers some of the simpler questions the students might have like simple math calculations during class while the teacher focuses on the overall class goals. This way students no longer have to wait for the teacher to answer their questions and move forward in their learning.

C. Teaching the Basis of Algorithmic Thinking

Besides increasing the efficiency of the classroom, Pomelo also creates a learning opportunity for break-time and after-school environments through collaborative and interactive programming exercises. Pomelo can be programmed to move in desired patterns and directions through physical code-blocks.

In order to draw the bridge between classroom learning and self-driven learning, we have designed a feature through which teachers can create and assign puzzles or mazes to the

students using the aforementioned code blocks. These assignments will encourage collaboration both within the student groups and with Pomelo, who will assist the kids in solving the more difficult challenges.

III. Functionality

As we intend to integrate Pomelo into elementary school classrooms, we have designed a child-friendly and entertaining user interface that will become part of the collaborative classroom environment. We have transposed the software code blocks normally used in visual programming languages to the physical world and have made our robot responsive to these physical blocks. This allows for more inherent cooperation between the kids and Pomelo, while also reaching the parts of our user demographic that is less familiar with computer interaction.

IV. Project Development

Based on the design goals and functionality, we have developed our first prototype (Figure 1). The first version is a simplistic robot composed of a custom plexiglass base with the electronics on top and is powered through a battery pack. In the second prototype, we aim to implement our pet dog design (Figure 2, 3) which will be 3D printed and assembled on top of the current design. We also plan to add a face detection and emotion recognition program that will produce student specific output and respond to different emotional states.

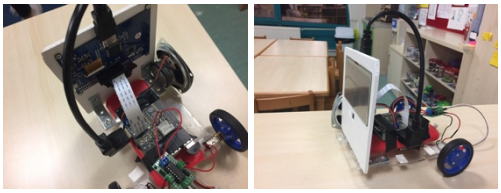
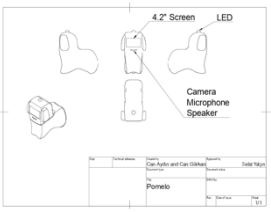


Fig. 1. First Prototype

A. Prototype-1

We used Raspberry Pi 3 as our main processor and the Pololu DRV8835 motor driver to control our two back Micro DC Motor wheels. Pomelo has a rear-wheel drive and a caster wheel in front, providing the movement needed for completing the code-block tasks. In order to process the code-block images, we installed a RasPi Camera and used the OpenCV ArUco library. We also used XPT2046, a 4.3'' LCD screen, to display Pomelo's eyes which are responsive to different student input. The speech processing was done through the Voice HAT Board and the Google Assistant API along with a microphone and speaker. With this system, Pomelo is able to answer students' questions, respond to them and engage in conversations through the API.



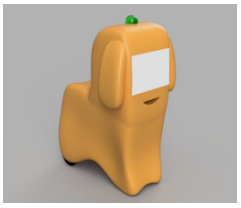


Fig. 2. Blueprint of Outer Frame Fig. 3. 3D Render of Outer Frame

Conclusion

We have designed a collaborative robot capable of interacting and cooperating with kids in school settings, improving their social and algorithmic skills while creating a more efficient school environment. We have accomplished the first step of our process by producing our initial prototype, processing speech, correctly reading the ArUco code-blocks, and responding according to our visual and audio input. We will proceed with improving the personalized response ability of Pomelo through face and emotion detection, integrating a learning mechanism which is applicable to sensory/perceptual information [2] into our code to train Pomelo to perform more accurately over time. We will also further the group interaction ability by adding a dance functionality which will play music and dance in response to the kids, and will also engage in storytelling sessions that customize stories according to kids' collaborative input.

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