Smart Doll

Interactive Doll with Remote Control and Monitoring Capabilities for Enhanced Child-Parent Interaction

PRESENTED
BY
Reem Dalab, Ali Yassin
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1. Acknowledgment

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2. Disclaimer

We have written this report for an educational purpose and it may contain some errors Therefore, An-Najah National University does not bear responsibility for any errors in this report.

3. Abstract

This project presents the development of an innovative interactive doll equipped with a camera and microphone, aiming to strengthen the bond between parents and their children. The doll incorporates cutting-edge technology to facilitate real-time remote monitoring and control through a dedicated website, enabling parents to observe and interact with their child from a different room.

The interactive doll offers a two-way communication channel, allowing the child to engage in play while the doll captures their words and repeats them back, fostering a sense of companionship and entertainment. The camera module embedded within the doll provides a live video feed, enabling parents to visually monitor their child's activities in real-time.

This project demonstrates the successful integration of hardware components, software development, and web-based communication to create an interactive doll that enhances child-parent interaction. The system's intuitive interface and remote monitoring capabilities make it an ideal tool for busy parents seeking to actively participate in their child's daily activities and provide them with a supportive, interactive playmate.

4. Introduction

In today's fast-paced world, maintaining a strong connection between parents and their children is of utmost importance, particularly for children with autism. However, busy schedules and physical separation can often pose even greater challenges to this vital bond for autistic individuals. To address this issue, this project introduces an innovative solution in the form of an interactive doll equipped with advanced features such as a camera and microphone. This interactive doll aims to bridge the gap between parents and their children, including those with autism, by enabling remote monitoring and control, allowing parents to actively participate in their child's playtime, even from a different room.

For children with autism, the interactive doll serves as more than just a means of communication and play. It becomes a valuable tool for therapy and development. Through its built-in microphone, the doll captures the child's words, creating an interactive experience where the doll repeats the child's words back to them. This feature not only provides entertainment but also supports language development and cognitive growth, which are crucial areas of focus for children with autism.

In the following sections, we will delve into the design, implementation, and evaluation of this interactive doll, discussing the technical aspects, user interface, and the potential impact on child-parent relationships.

5. Constraints / Earlier Coursework

5.1 Constraints

During the work on our project, we faced several constraints that may impactIn addition to the innovative features and benefits of the interactive doll, the project encountered the following constraints:

- High Cost: The project faced financial constraints due to the high cost of components, such as the Raspberry Pi. Careful budgeting and resource allocation were necessary to manage expenses effectively.
- Time Constraints: Procuring specific components, like the Raspberry Pi, proved time-consuming due to limited availability. Efficient time management and adaptability were required to overcome delays.
- Integration Challenges: Connecting the Raspberry Pi with the Arduino posed technical difficulties, requiring extensive troubleshooting and experimentation to achieve seamless communication and synchronization.

- Lack of Peripherals: The Raspberry Pi's need for a screen and keyboard presented a challenge due to their unavailability.

5.2 Earlier Coursework

In preparation for my current hardware project, we have completed a number of relevant coursework and experiences. These include

- **Microcontroller course:** This gave us an entry into how to use microcontrollers like Arduino.
- **CPU Lap:** Helped with debugging the hardware, and finding when and where it is faulty.
- **A course in computer programming**, which taught us the fundamentals of coding and debugging especially HTML, CSS and python.

6. Literature Review

This project helps parents to monitor their children during their busy times, in addition to enhancing children's language skills, through the doll's repetition of the child's speech.

At the beginning of our work on this paper, we started searching for similar ideas and projects related to our idea, with the aim of adding more features to this project.

After our study of these research papers, we noticed that they are studying the impact of smart dolls on children and their behaviors, with a special focus on children between the ages of 4 to 10 years. ("My doll says it's ok": a study of children's conformity to a talking doll)

In another study, we found that it examined the effects of video modeling on generalized independent game play for two children with autism. Appropriate and repetitive verbal and motor play was measured, and the relationships between the measures were examined. Two individual trials with multiple baselines and withdrawals were used across play. One child was presented with three toys that were not physically related, while the other was presented with three related toys. Video modeling produced increases in relevant play and decreases in repetitive play, but general play was only observed with related games. The generalization may be due to variables including shared physical properties of toys, natural reinforcement properties, and increased correspondence between verbal and motor play. (Using Video Modeling for Generalizing Toy Play in Children With Autism, First published September 2007)

In another research paper, we noted that they designed an interactive doll to interact with elderly people with dementia. This research paper says: Our approach stimulates their imagination and then facilitates positive interaction with the robot by expressing only the basic elements of human-like features.

Based on this approach, we developed HIRO, a child-sized robot with an abstract representation of the body and no facial features. The recorded voice of a real human infant emitted by the robots enhances the robot's human likeness and facilitates positive interaction between the elderly and the robot. Although they found no significant difference between HIRO and an infant-like robot with a smiling face, a field study showed that HIRO was accepted by elderly people with dementia and facilitated positive interaction by stimulating their imagination. (Front. Robot. AI)

7. Methodology

In this chapter, we are going to talk about the design of the system, the components that were used to accomplish it, and discuss the development process and the outcome at the end of that process afterward.

7.1 Overview of The System

In this research, a smart doll was developed. To achieve such results Raspberry Pi and Arduino were used as controllers. They were utilized together to add a challenge in learning new things. Establishing serial communications between them (Krauss, 2016)[4].

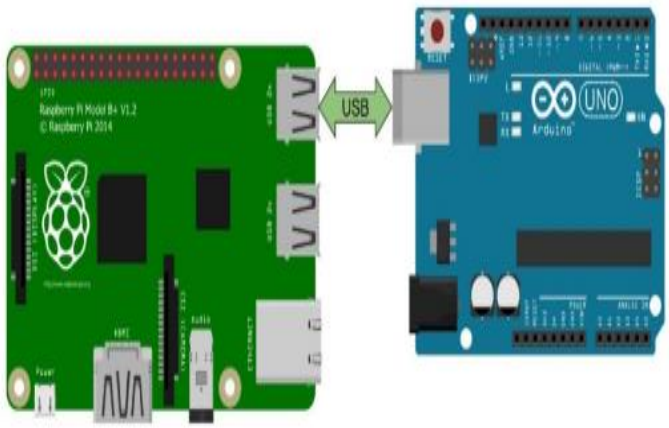

Figure 1 , Serial communication between Raspberry pi and Arduino

In the automated mode and the speech repetition and video streaming the Raspberry Pi served as the doll's brain while Arduino served as its muscles. The user can control the car through the control buttons on the website, which allows parents to watch their children through it, as it contains five control buttons to move the game in all directions (right, left, forward, backward, in addition to the stop button). Then it will send commands to the Arduino to control the doll movement using four Direct Current Motors (DC) connected with wheels.

7.2 Hardware Components

In this section, the used design and tools are described to show the whole process of parental observation of their child as well as the interaction of the doll with the child

7.2.1 Car Structure

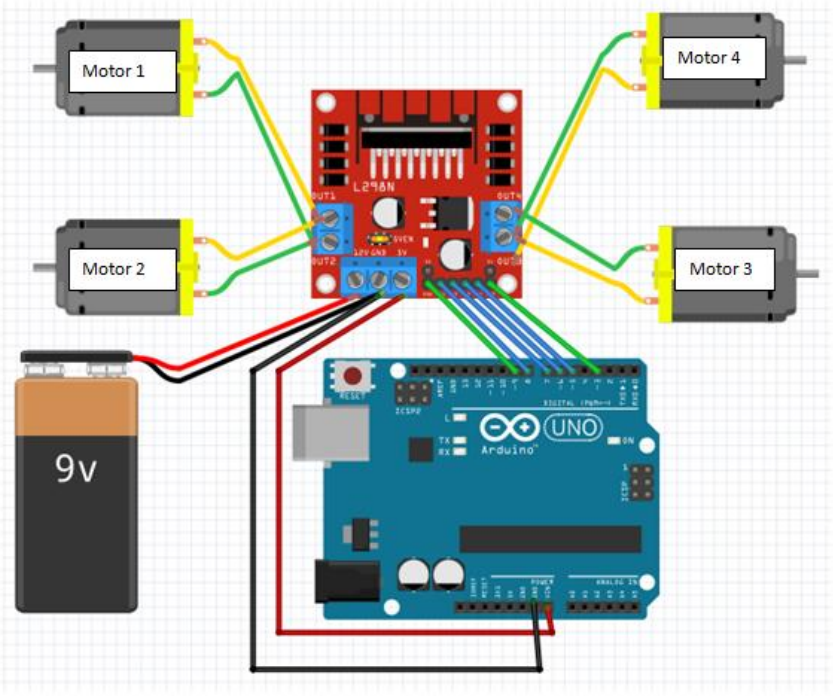

Figure 2 , Car Structure

- Arduino Uno: The Arduino Uno board was chosen as the primary microcontroller for controlling the doll's movements. Arduino Uno is widely recognized as a standard in the industry for its versatility, ease of use, and compatibility with various sensors and actuators.

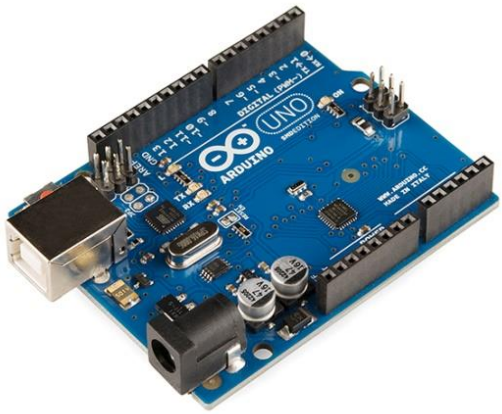

Figure 3 , Arduino Uno

- H-bridge Driver: Was used to control the direction of the spin of DC motor, without changing the way the leads are connected. An H bridge is an electronic circuit that can drive the motor in both directions. H-bridges are used in many different applications, one of the most common being to control motors in robots. It is called an H-bridge because it uses four transistors connected in such a way that the schematic diagram looks like an “H”.

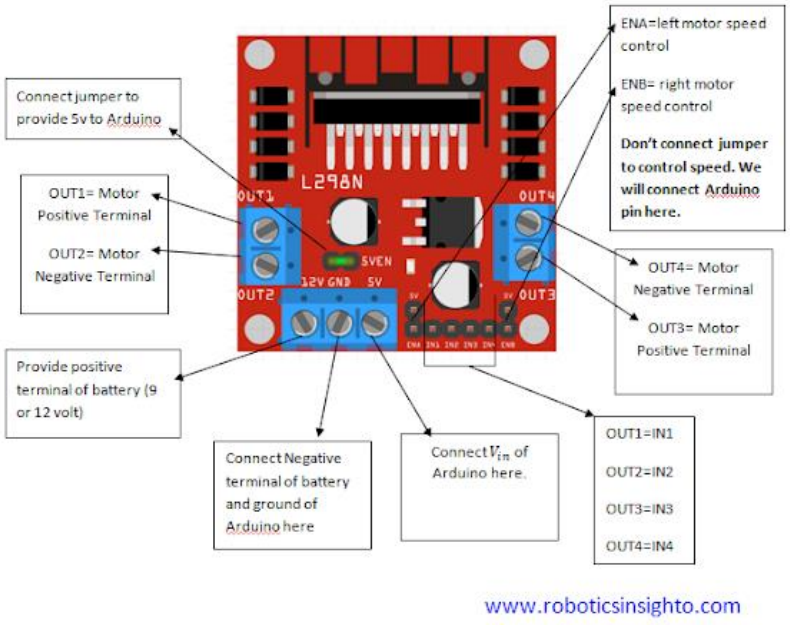

Figure 4 , Driver

Figure 5 , H-bridge Driver

- DC Motors: DC motors are the most common type of motor to move wheels of cars. DC motors normally have just two leads, one positive and one negative. If the two leads were connected directly to a battery, the motor will rotate. If the leads are switched, the motor will rotate in the opposite direction.

Figure 6 , DC Motor

Figure 7 , wheels

Figure 8

7.2.2. The Doll: the doll contains the camera module, Voice Recognition Module and the Raspberry Pi.

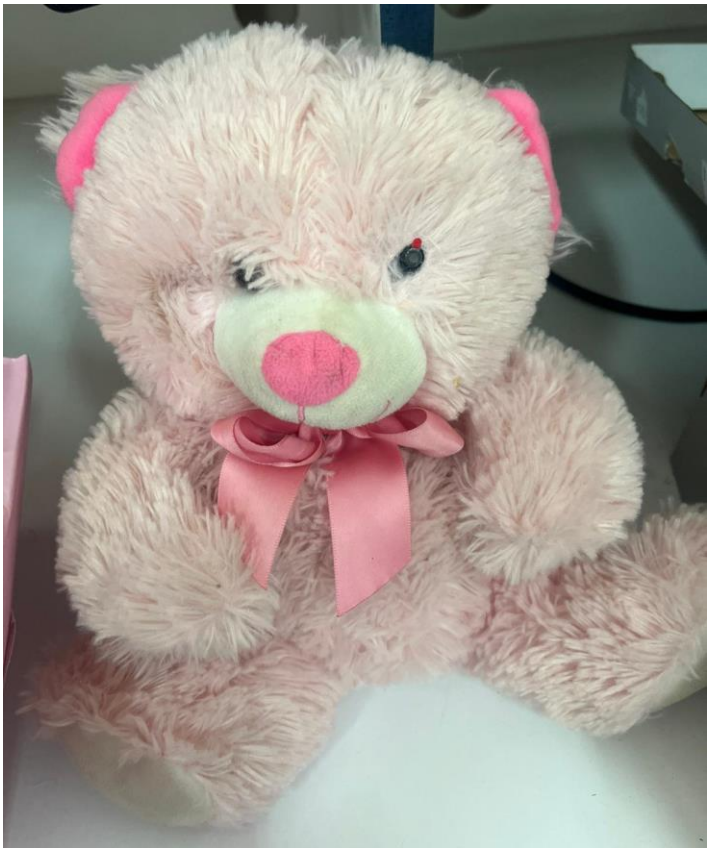

Figure 9

- Raspberry Pi 3B+: The Raspberry Pi 3B+ model was chosen as the central component for camera and microphone functionalities. The selection of Raspberry Pi adhered to the industry standards for its reliable performance and compatibility with various software applications.

Figure 10 , Raspberry Pi

- Camera Module: A camera module compatible with the Raspberry Pi was integrated into the project.

Figure 11 , Camera Module connected to Raspberry

- Voice Recognition module: to store the voice to be outputted later via speaker.

Figure 12

- Servo motor: We used a servo motor and placed it inside the hands of the doll so that it could move and interact with the child while repeating the words.

Figure 13

- Power supply: A power bank was used to supply the Raspberry Pi and Arduino mega with 9 Volts.

Figure 14, power bank

- Li battery: battery was used to supply the driver with 3.7v

Figure 15

- Speaker: We added a speaker to output the input sound through the microphone.

Figure 16

7.2.3. Website: We built a webpage in html and css, the page contains a screen showing a live video of what is being filmed through the camera on the doll, and it also contains 5 buttons to control the movement of the doll in all directions (forward, behind, right, left, stop button)

- Video Streaming: The web page displays the video that is being filmed through the camera on the doll, so the web page is the client that communicates with the server, which in turn displays the video on the web page.
- Control buttons : The web page contains control buttons, when you press a button, it communicates with the server in the Raspberry Pi, then it sends commands to the Arduino, to control the movement of the doll, Arduino sends the signal to the motors connected to the wheels to move them in the desired direction

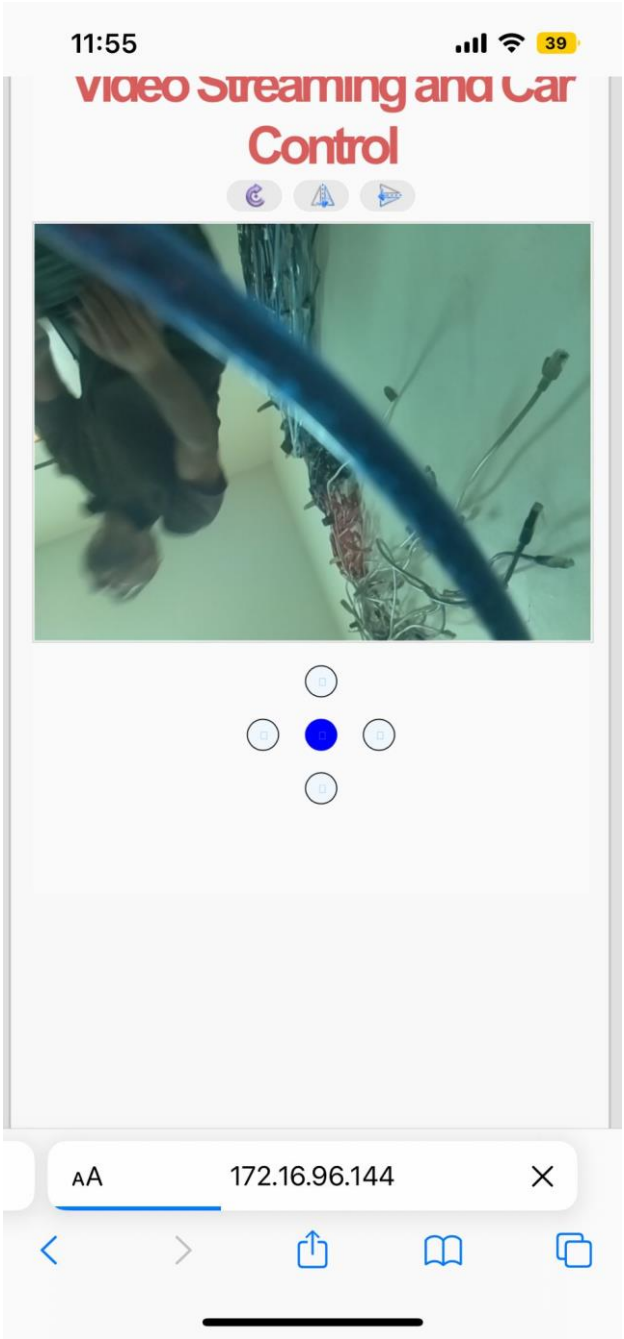

Figure 17

7.3 Implementation

The doll's movement is controlled by a web page that contains control buttons, if someone clicks the button it will communicate with the server in Raspberry, then it sends commands to Arduino, to control the movement of the doll, Arduino sends the signal to the motors connected to the wheels to move them.

We put the camera in the middle of the doll so that it works to photograph the place where the child is and to work to cover and photograph the largest possible area.

In addition, we have placed a microphone inside the doll so that the child can interact with it, so when he presses the button inside it and speaks to it, the doll will repeat the speech and it comes out through the speaker.

Also, we have added a servo motor inside the hands so that the toy can move and interact with the child in conjunction with its repetition of his words.

8 Results

- Seamless Communication and Control: The integration of a camera, microphone, and remote control capabilities in the interactive doll enabled seamless communication and control for parents. The dedicated website served as an intuitive interface, allowing parents to remotely control the doll's movements and listen to their child's conversations. The system demonstrated reliable performance and responsiveness, providing parents with a sense of presence and active participation in their child's playtime.
- Language Development and Cognitive Growth: The interactive feature of the doll, which repeated the child's words back to them, proved to be effective in fostering language development and cognitive growth. Children engaged in interactive conversations with the doll, leading to increased vocabulary, improved speech patterns, and enhanced cognitive abilities. This result highlights the potential educational benefits of the interactive doll in facilitating language acquisition and cognitive stimulation.
- Emotional Bond and Connection: The project successfully emphasized the emotional bond and connection between parents and children. By enabling remote monitoring and control, the interactive doll allowed parents to actively engage with their child's play and exploration, irrespective of physical distance. The ability to listen to the child's conversations and provide responses through the doll fostered a sense of connection and parental presence, enhancing the emotional well-being of both parents and children.

9 Discussion

9.2 Learning Curve:

It is undeniable that some things needed additional research and some extra trial, but with a great set of documents, plenty of online tutorials, and a community of supportive people, the learning mission was not as challenging or steep as it initially seemed. Our system required learning about new hardware parts that we were not familiar with before and had to learn from scratch while developing it. We learned about Raspberry Pi, having knowledge about this hardware part was

important to us because It helped us with the ability to remotely shoot a video and display it on a web screen, in addition to recording and repeating sounds.

9.3 Testing:

- The Arduino Uno was connected directly to the Raspberry pi via serial port and the Raspberry was powered by a power bank. The car is controlled through a website on the Raspberry pi, where it communicates with the server to give it commands that are sent to the Arduino to move the wheels of the car.
- The sound is repeated through the Raspberry pi, which receives the sound through the microphone and outputs it via the web site. In addition, the servo motor was connected to the Raspberry pi and placed inside the hands of the doll, so that it moves in sync with the doll's repetition of speech.
- A video streaming has been added to the web page by connecting the camera with the Raspberry pi, where the web page communicates with the server on the Raspberry to display the video.

9.4 challenged faced:

- The absence of hardware parts in the local market and the high price, it was difficult to find parts, such as Raspberry Pi and lithium batteries. H-bridges, servo motors got burned while testing the project, which caused a delay in completion.
- The difficulty of dealing with the Raspberry is a very sensitive piece and must be handled with care.

10 Conclusion

In conclusion, this hardware project introduced an innovative solution in the form of an interactive doll equipped with advanced features to bridge the gap between parents and their children. By incorporating a camera, microphone, and remote control capabilities, the interactive doll served as a dynamic medium for communication and play, fostering engagement and nurturing the emotional well-being of the child.

Throughout the project, we emphasized the importance of maintaining a strong connection between parents and children in today's fast-paced world. The interactive doll provided a means for parents to actively participate in their child's playtime, even when physically separated.

The project successfully integrated hardware and software components to create a seamless user experience. The dedicated website served as a central hub for remote access to the doll, allowing parents to control its movements and listen to their child's conversations through the integrated microphone. This not only

fostered a sense of connection and parental presence but also encouraged language development and cognitive growth in the child.

Overall, the implementation of the interactive doll demonstrated its potential to enhance child-parent relationships. By combining the functionalities of a doll, camera, and microphone, this project offered a unique and engaging experience for both parents and children, strengthening the emotional bond between them and promoting active participation in the child's daily activities.
Through further evaluation and user feedback, future improvements and refinements can be made to enhance the functionality and user interface of the interactive doll. Nonetheless, the project serves as a proof-of-concept for the integration of interactive and remote technologies in facilitating meaningful parent-child interactions.

In conclusion, the interactive doll project showcased the possibilities of leveraging technology to overcome the challenges of busy schedules and physical separation, enabling parents to actively engage with their children and strengthen the parent-child bond.

- **Future work:**

Future work includes the ability to ask the doll many questions that will be able to answer, with the aim of benefiting from it in teaching children, developing their languages, and social communication.

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