Senior Project

Final Report for

Mrs. Quacker: An IoT Integrated Duck

in the partial fulfillment of

TECH 4945

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Executive Summary

Today's technology keeps expanding into newer and better products for humans. As adults get new technology 'toys' to play with e.g., phones, cars, watches, etc., kid toys have not made a huge leap into the technology world. Toys now a days have moving parts, make noises, or even have a microphone to repeat words a child might say. These toys may be fun at first but can get boring after a while. Kids need toys that are more stimulating and more likely to grab their attention. Mrs. Quackers, an IoT (Internet of Things) integrated duck, will grab ahold of kids' attention while keeping their interest.

Mrs. Quackers connects to a smart phone for interaction and play. Kids can use an app on their parent's phone to manually move Mrs. Quackers, make her quack, do silly dances, and more. Mrs. Quackers will use IoT technology to connect to an app on the phone and react to commands that is pressed on the app. Mrs. Quackers will be able to move with motors, quack with a speaker, react to loud noise using a microphone, express emotions with her eyes using LCD (Liquid Crystal Display) screens, and be able to avoid collisions using a proximity sensor.

Table of Contents

Table of Figures

Introduction

Today's technology keeps expanding into newer and better products for humans. Ring doorbell has been made to pair to smartphones and let customers see and talk to people at their front door from a remote location. Smart watches can be used to talk to other people and be used to track one's own personal health, such as "blood pressure, heart rate, and other concerns in real time." (Foote, 2022). Kid toys have also upgraded from handheld toys to digital and robotic toys. Lego has made apps to control and program their products while other companies, such as leapfrog and vetch, have products with cameras. It is only a matter of time before a lot of kid's toys will start to connect to phones to use with apps.

Mrs. Quackers, an IoT integrated duck, takes what most everyday devices do, but as a kid's toy. There are not many kids' toys out on the market today that do IoT besides tablets and phones made specifically for kids. Lego created a product called Technic™ where once the Lego set is built, an app can be used on a phone to control the Lego creation. The app, Lego® Technic™ Control+, lets consumers move their Lego creations by driving and moving different parts of the creation along with sound effects. Mrs. Quackers will be handled in a similar manner to Lego's Technic™ Control+ app as she will be able to be controlled by using an app as well. She will be able to move, quack, avoid collisions, detect loud sounds, and express emotions with her eyes. Mrs. Quackers, an IoT integrated duck, will soon join the select few that are out on the market today.

Review of Objectives

The objective for this project was to control Mrs. Quackers with a phone app via a Wifi connection. This was accomplished by using an Arduino to host a simple Wifi server and using a phone app to make 'GET' requests to the server to control Mrs. Quackers.

Review of Deliverables

The deliverables for this project were to make Mrs. Quackers move with motors, quack with a speaker, have eye movement using OLED (Organic Light-Emitting Diode) screens, record the user's voice with a microphone to play back to the user, and use a proximity sensor to avoid collisions. Not all deliverables were met as the round OLED screens were not able to be obtained and the function of the microphone had to change due to a lack of library support for the speaker. The round OLED screens were replaced with round LCD screens and the function of the microphone changed to detecting loud noises.

With these changes, Mrs. Quackers can move with motors by pressing a button on the phone app, which sends a 'GET' request from the phone app to the Arduino which then sends a signal to the motors. Mrs. Quackers can speak with a speaker by detecting a loud noise with a microphone, detecting a potential collision with a proximity sensor, or when a button on the phone app is pressed. Mrs. Quackers can move her eyes when a loud noise is detected or when she is rotated left or right using the buttons on the phone app. Mrs. Quackers can detect loud noises if the noise meets or exceeds the programmed threshold. Mrs. Quackers can avoid collisions by moving backwards if the proximity sensor detects an obstruction of movement within 5 inches.

Technical Implementation

An Arduino Uno Wifi Rev2 is used as the master controller for this project. It houses the program used to control Mrs. Quackers and acts as the main hub for power for other components used in this project. The components used for Mrs. Quackers include two round LCD screens, a microphone, a speaker, an infrared proximity sensor, two right angle DC (Direct Current) motors, a motor driver, and a base shield. The base shield was placed on top of the Arduino and provided extra connections. The motor driver and proximity sensor were plugged into the base shield using JST (Japan Solderless Terminal) connections while the rest of the components used jumper wires. When programming, the Arduino IDE (Integrated Development Environment) was used to program all the components used for Mrs. Quackers. One component was programmed at a time with no other components connected for efficient testing and error resolution, when needed. Once each component was programmed and was in working order, all components were connected to the Arduino and all the induvial programs used for each component were put into one main program and edited to make sure the program flows as intended. After this, an Android phone app was programmed using Android Studio and Flutter's language Dart. The app screen can be seen in Figure 1.

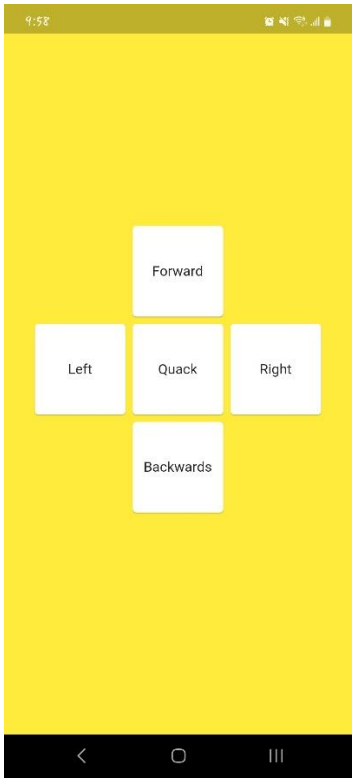

Figure 1 - Phone App Screen

The phone app has five buttons which can be pressed or held, depending on the action. For the 'Quack' button, when it is tapped, Mrs. Quackers will make a quack noise. The other four buttons can be tapped or held for movement. If a movement button is tapped, Mrs. Quackers will move for about one second and stop. If a movement button is held, Mrs. Quackers will move until the button is released. The 'Forward' button moves Mrs. Quackers forward while the 'Backwards' button moves her backwards. The buttons labeled 'Left' and 'Right' will rotate Mrs. Quackers in that direction. Testing between the

phone app and the Arduino code occurred during programming and errors were fixed during this time. The following block diagram shows how each component interacts with one another.

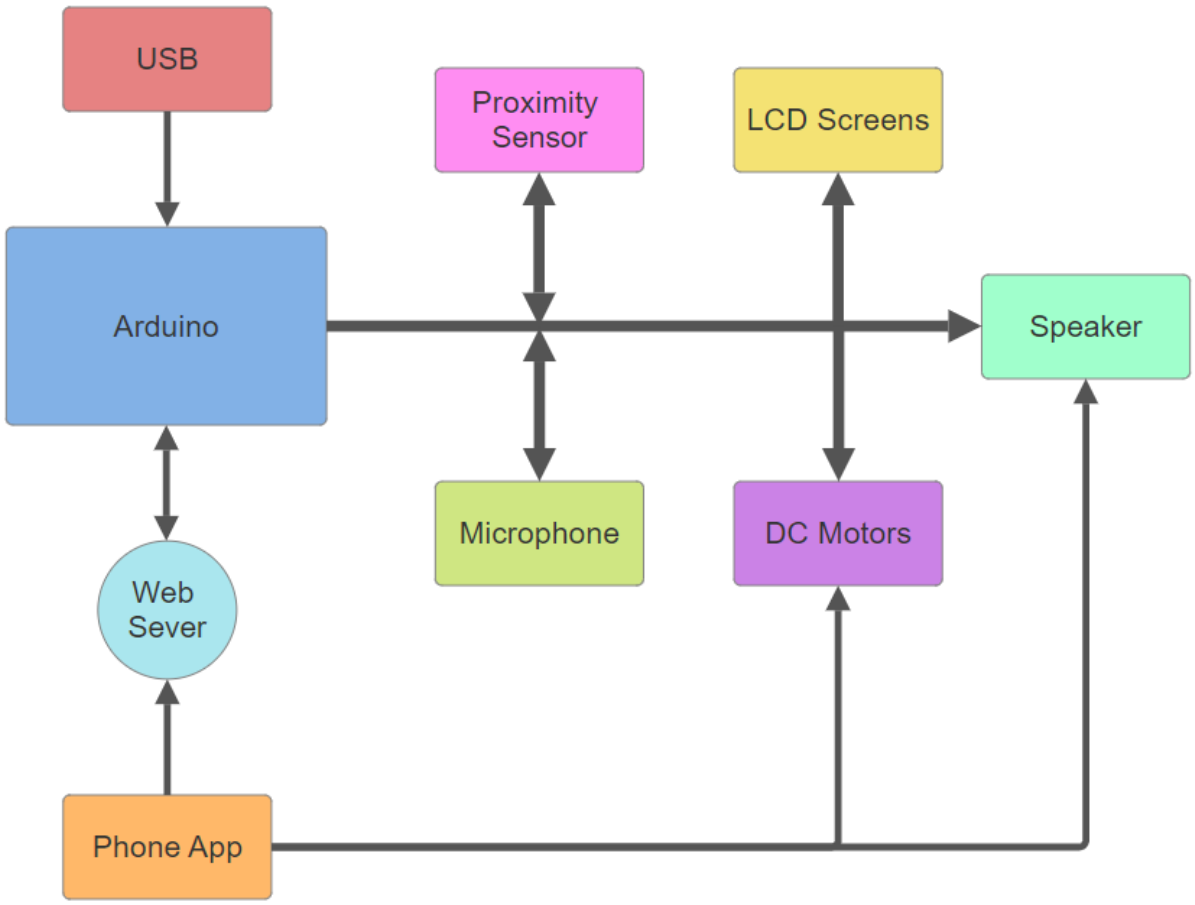

Figure 2 - Block Diagram

A USB connects the Arduino to the computer to power the Arduino which then powers the proximity sensor, LCD screens, speaker, DC motors, and microphone. The proximity sensor and microphone send data back to the Arduino. The Arduino creates a simple web server which can be accessed from the phone app. With the phone app, when a button is pressed, it sends a 'GET' request to the simple web server which then controls the DC motors and the speaker.

Once finished, a hollow push-and-play plastic duck toy, with a rubber head, was used to house all the components. The head of the duck toy was removed from the body to remove the eyes and drill seven holes under the top of the duck's lip. The LCD screens were put into the newly made eye holes and were adjusted to the desired location. The speaker was slotted in the top lip of the duck, positioned downwards so the sound would come out of the seven drilled holes. Polyester fiber filling was inserted into the head to make sure the two round LCDs would not move during the operation of the duck.

Figure 3 - Mrs. Quackers' Head

Before insertion, research was conducted to make sure the heat from the LCDs did not meet or exceed the polyester fiber filling's heat threshold. The polyester fiber filling can with stand heat up to 295° C and the maximum heat the LCD screens produce is 80° C.

To make sure all the components fit into the duck's body, a rotary tool was used to remove excess plastic inside of the body that obstructed the full enclosure of the components. As each section was removed, the components were put into the duck's body and was evaluated if more plastic needed to be removed. Once the desired amount of plastic was removed from the inside of the duck's body, the wires from the components were zipped tied together to make the inside of the duck's body cleaner and more organized. The components were then put into the duck's body and screwed shut with the original screws from the toy and the head reattached. Figure 4 shows the components inside of Mrs. Quackers, minus one side of the body.

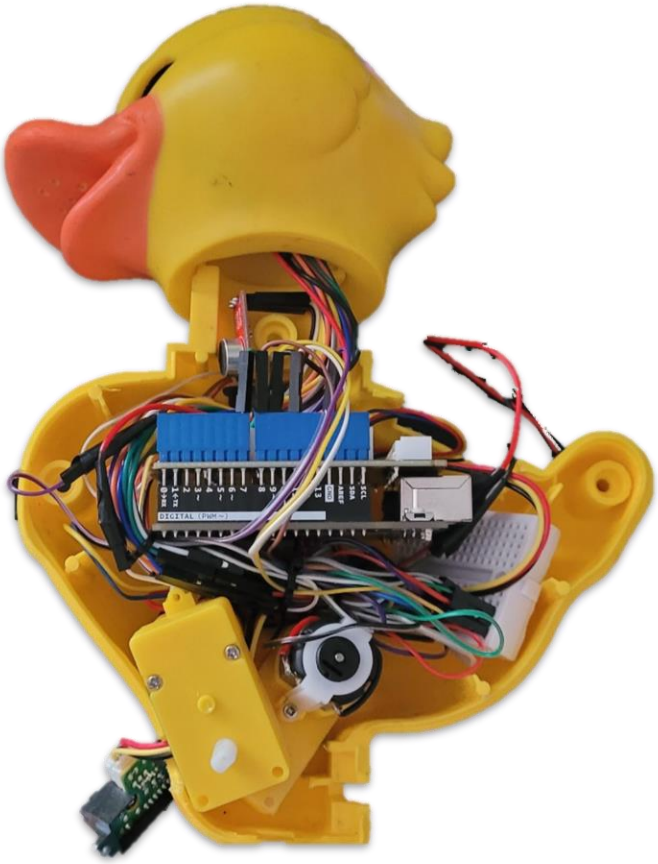

Figure 4 - Components inside Mrs. Quackers

The programs from the phone app and Arduino were used to test if the components were working properly once Mrs. Quackers was put together completely and if a problem(s) arose, the body and head of the duck were taken apart for readjustments of components.

Once Mrs. Quackers was working as desired, she was taken to the University of Memphis to get the IP address of the Arduino when it connects to the Sandbox_207 Wifi. Once the IP address was obtained, the IP address was added to the phone app and Arduino code. The phone app was then downloaded onto an Android phone and was able to control Mrs. Quackers via Wifi when both the phone and Mrs. Quackers were connected to the Sandbox_207 Wifi. **Error! Reference source not found.** shows what Mrs. Quackers looks like when put together and connected to the Wifi.

Figure 5 - Completed Project

When Mrs. Quackers is first plugged into the computer, her eyes will remain dark until she is connected to the Wifi. Once connected, her eyes will glow yellow and display her eye along with pupils. She will automatically be using the microphone to detect loud noises and the proximity sensor to detect distance.

Evaluation of Plan of Work

The project timeline deviated from the original plan discussed in the proposal. The original plan stated that the start of the project would start in the month of March, but the actual start date was pushed to the month of September. Testing and fixing of each component while programming Mrs. Quackers stayed the same.

Evaluation Results

The testing of Mrs. Quackers consisted of the following: microphone and proximity sensor. To test the proximity sensor, a tape measure was laid flat onto a table with a bright light overhead and Mrs. Quackers was placed at 0 inches. A white glasses case was used as the object of obstruction and was placed about 35 inches away from the proximity sensor as the proximity sensor's maximum range is about 32 inches. The program containing the proximity sensor code was sent to the Arduino and with a serial monitor from PuTTY open, the glasses case was moved from about 35 inches to in front of the proximity sensor, at about 0 inches, at a consistent and moderate speed. The serial monitor from PuTTY displayed values for voltage and distance obtained during the movement of the glasses case. The data from the serial monitor was then copied and pasted into an excel sheet then turned into a graph, as seen below.

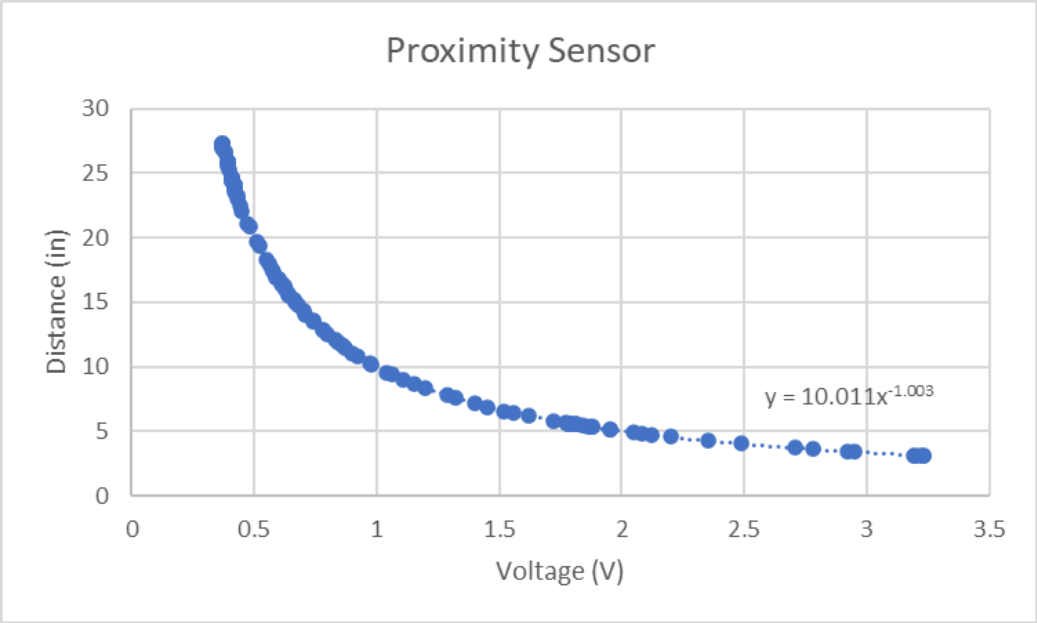

Figure 6 - Proximity Sensor Test

Figure 6 shows the graph produced by the proximity sensor. The graph demonstrates that as the distance in inches decreases, the voltage the proximity sensor reads also decreases. The power trendline was used in the graph instead of the exponential trendline due to the power trendline fitting the curvature of the data more than the exponential trendline.

The test for the microphone consisted of changing a value in a conditional statement in the Arduino program. The conditional statement used in the program is an 'if statement' which acts as the noise threshold for the microphone. Figure 7 shows the conditional 'if statement' that is used in the Arduino program.

```
if (volts >=0.05)
```

Figure 7 - Microphone Test

The value in the 'if statement' was changed during testing to find the desired threshold. The sound measured by the microphone is measured in voltage and when the sound level meets or exceeds 0.05 volts, Mrs. Quackers reacts. To test the sound level of the microphone, the following sound tests were performed: banging on the table, yelling, tapping on the body of Mrs. Quackers, talking normally, and talking loudly. The two most effective tests were talking loudly and tapping on the body.

Conclusions

IoT technology is used in a range of applications and industries. Health care, smart homes, and smart vehicles are few examples of major IoT applications being used in the last few years (Kumar et al., 2019). As technology grows more advanced, it is only a matter of time before more advanced toys will land on the market. There are only a select few toys out there on the market today that use IoT

technology, and it is inevitable that the future of kid's toys will use more advanced technology, such as IoT, in their products.

Mr. Quackers, the IoT integrated duck, uses IoT to communicate between a phone app and Mrs. Quackers to make her come 'alive'. Mrs. Quackers uses motors, a proximity sensor, LCD screens, a microphone, and a speaker. The completion of the project took about a month and a half. If more time were allocated to the project, more features could have been completed. Overall, the IoT portion of the project was a success.

References

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