Holographic LED Display

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ECE 445 Project Proposal - Fall 2020

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1. Introduction

1.1 Objective

We want to make devices in our own homes much cooler looking that can be used as an alternative for looking at your own phone for notifications, time, etc. We want to create a display of LEDs and sensors that are rotating in some fashion such that it can appear holographic and we want to display the current time and/or message from a phone such that a person can look at something with appealing visual cues while refraining from viewing their phones. Essentially, we would like to be able to program whatever we want such as letters, numbers, or animations and view it on our 3-D display.

1.2 Background

Currently, LED lights are extremely useful in homes and buildings and give us more diversity in terms of aesthetic purposes. Ever since it was created in the 1960s, LED lights have started to serve as a multi-purposed function and presents us with the chance to use them for different design opportunities in our home. The LEDs themselves are extremely advantageous in that it is possible for the light to reach full intensity when immediately switched on, as well as being able to have low power consumption (higher efficiency in comparison to a lamp).

For holographic displays, there is current research that is being done around the world in order to make this possible. For the scope of our project, we are trying to mimic the holographic effect as there are advantages to doing so such as increasing realism. Using the LEDs in a synced fashion for a 3-D display makes it possible for there to be an interesting effect come into play. The refresh rate of these LED lights is also really important in terms of generating our display; by being able to make our refresh rate faster, we are able to get a clearer image as there is less downtime between a flicker of light.

1.3 Physical Design

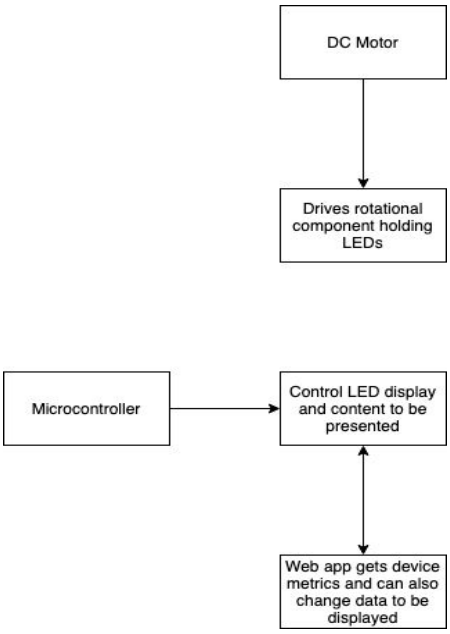

Figure 1.1

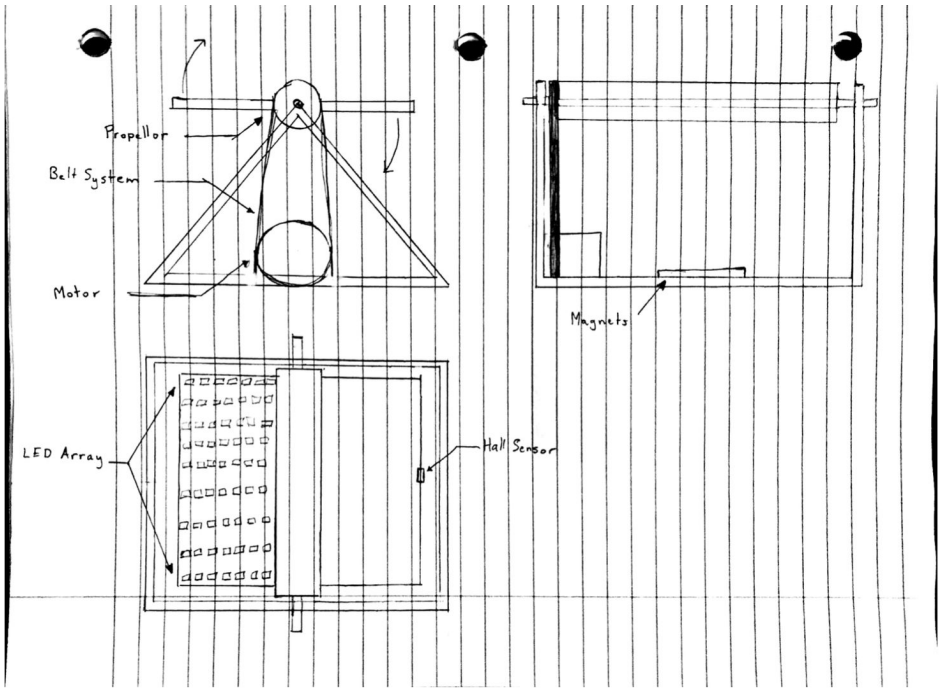

Figure 1.2

Figure 1.1 shows the design features of the main modules we'd like to incorporate in our project. The microcontroller will be part of a control unit as well as an SD card that will be used for a control unit - to control the LED display. Figure 1.2 shows what our overall product will look like in terms of a final solution.

1.3.1 High Level Requirements

We want our device to be able to mimic our holographic display as mentioned above. The criterion that can be used for our success if we are able to display the time and the text at a frequency of at least **400 Hz** and should be seen in place and have a clean look. We want to be able to give the user functionality directly from a web app such as be able to have a text box that can take in input for letters such that they can be displayed directly (synced to Arduino) as well as time. We also want to be able to calculate certain metrics and display them to the user at all times as well as be able to change the color of the display per discretion and to increase/decrease the RPM speed directly from the web app itself. As a stretch goal, we would like to be able to sync our microcontroller with our phone directly for notifications or calls and be able to signal the user. For example, if a user is being called, our device can immediately blink green and maybe even play some music in the background.

2. Design

2.1 Block Diagram

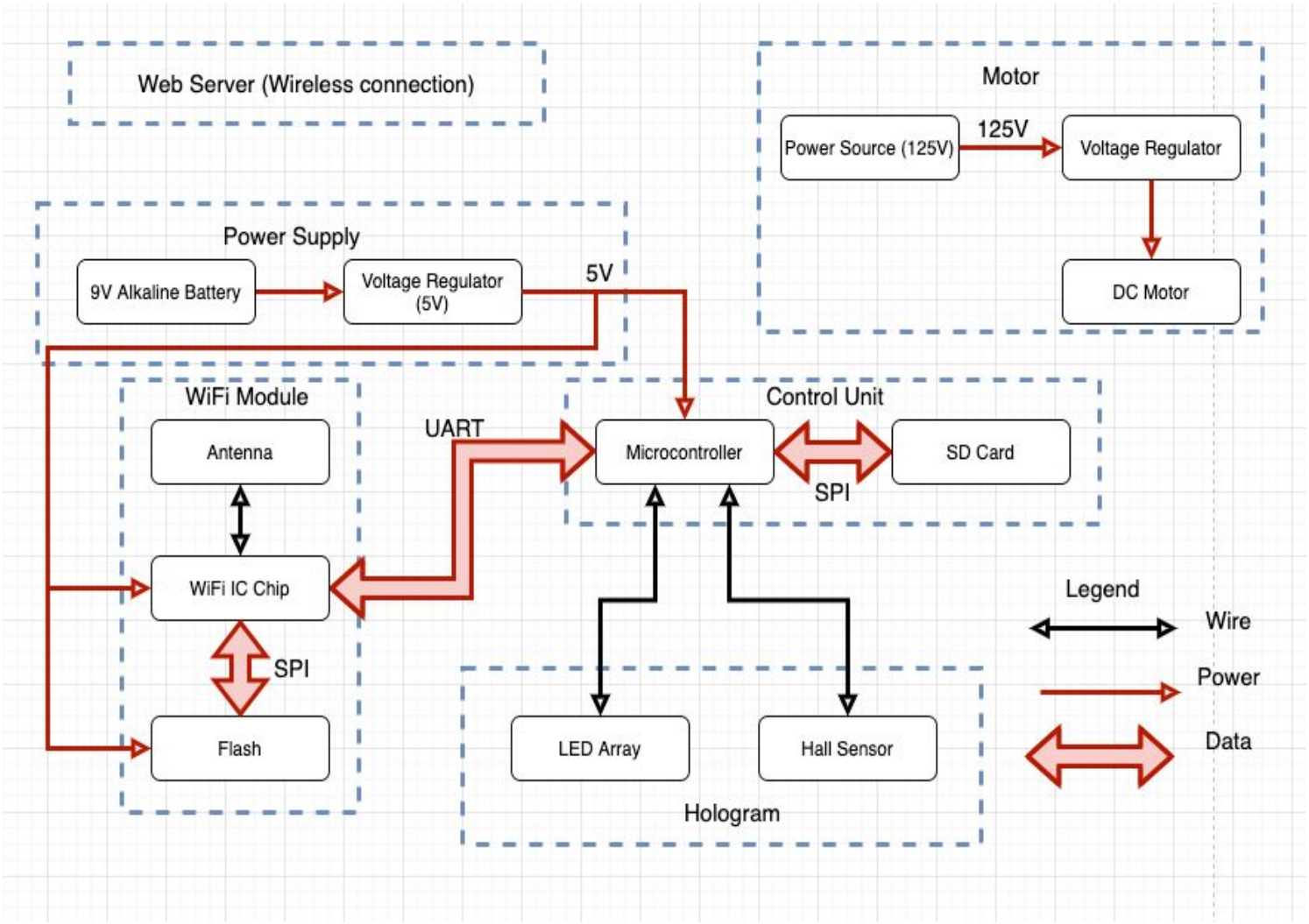

Figure 2.1 shows the block diagram that we intend to create for our project. We have several types of connections - wire, power, and data. We have a motor that is sourced from a power source of preferably 125V that will help power our DC motor. We will be utilizing UART and SPI as our protocols between the microcontroller and the WiFi IC chip and between the WiFi chip and flash. Our microcontroller will serve as the crux of our control unit and will dictate what is shown on our LED array and to keep the hall sensor in coordination to our system.

2.2 Functional Overview

2.2.1 Power Supply (Alkaline Battery, Voltage Regulator)

The power supply will consist of an alkaline battery and a voltage regulator that will help us make sure that we are within our limits for how much power we supply for our hardware. The alkaline battery will be a standard 9V battery, and we are going to use a voltage regulator to get us 5V.

2.2.2 WiFi Module (Antenna, WiFi IC Chip, Flash)

The WiFi module will be our main communication device from the web server to the microcontroller. This will include an Antenna that will be a component used to get a good connection for the WiFi, as used in lots of smart devices. The WiFi Chip is the transceiver that then sends data to the microcontroller. The WiFi unit also has in house memory which is why flash is needed.

2.2.3 Control Unit (Microcontroller, SD Card)

The microcontroller we are using is the ATmega328 chip that is commonly used in Arduino Nano.The SD Card will be used to store memory and information in regards to the microcontroller.

2.2.4 Hologram (LED Array, Hall Sensor)

The LED array and the hall sensor will be used for the actual “holographic” effects that we are trying to create. The hall sensor is used for motion detection of an LED light array that is spinning.

2.2.5 Motor (Power Source, Voltage Regulator, DC Motor)

Since the motor is not directly connected to the propeller, a separate power source is needed to run the motor. This is good, since we would need a lor more voltage anyway. The motor will be connected to a 120 Volt power source, an outlet. A switch can be toggled to turn the motor on and off. The motor will vary in speeds based off of confounding variables, but that is the whole point of the hall sensor.

2.3 Risk Analysis

The largest potential error is going to be the functionality of the microcontroller in conjunction with the WiFi module. Getting a clear signal as well as sending data over to the microcontroller can result in a lot of potential issues, and can be problematic in terms of setting everything up correctly. It is important that this is established properly and within range such that we are not having errors when debugging other parts of the project. There is also the risk at which the rate at which the LEDs spin at and how well the hall sensors can detect and report back to us in terms of every rotation that is done and if we are able to correctly modify our actions based on that. This leads to a potential loss in our animations and what we try to display so it is absolutely crucial that we can make our LEDs' refresh rate small enough such that the rotations are done properly. There is also the extra layer in that we have to animate as well as create the 3 dimensional illusion. Using multicolored LEDs is a big priority for us, but they can also be slower in the way that they refresh. This is also a lot more data that our microcontroller has to compute at once and it is important we have enough memory that is present such that it can incorporate these changes.

3. Safety and Ethics

There are a variety of ethical guidelines and safety measures we will have to take into account for the design and functionality of this project. With regards to safety, we will need to take into account two main attributes of our physical design. Since our LED design will be rotating at a very high RPM, it will be important to disclose to users that they should not touch the holographic display while it is in operation. We may need to implement certain safety measures as well to ensure that younger children and less attentive audiences will not injure themselves or others. Additionally, the flashing LED lights at full brightness may have the potential to trigger symptoms in people with epilepsy or seizure risk. We will also need to disclose to avoid usage in people with any of the prior mentioned health risks. Our project also needs to uphold engineering ethical standards and address the safety, health and welfare of the public as mentioned in [1] and [2]. This would include designing the rotational component in a manner that upholds safety of all users. We would also like to improve the understanding and design of our device. Obviously, as technology improves, we would like for our device to have that goal in mind, and utilize whatever safety cues are most appropriate.

From an ethical standpoint, we will need to ensure privacy of information for our device. Since we essentially aim to display information from a cell phone on our display, there will potentially be private and/or sensitive information present on the holographic display at any times. We will need to take the appropriate measures to mitigate any security risks that seem inherent especially since there will be a WiFi module through which data may be communicated to the web.

4. References

[1] IEEE Code of Ethics. (n.d.). Retrieved September 15, 2020, from https://www.ieee.org/about/corporate/governance/p7-8.html

[2] ACM Code of Ethics and Professional Conduct. (n.d.). Retrieved September 15, 2020, from https://www.acm.org/code-of-ethics