# Holiday Arboreal Light Project

PROJECT PLAN

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# List of Definitions

PWM - Pulse width modulation

RGB - Red Green Blue

LED - Light emitting diode

# 1 Introductory Material

## 1.1 Acknowledgement

We would like to thank Dr. Tom Daniels for the assistance in researching and developing the plan for the project thus far.

## 1.2 Problem Statement (2 paragraphs +)

Christmas is a time for celebration and with celebration comes the arrival of holiday displays. Many people decorate their homes and other objects like trees with sets of lights. However many products on the market are limited to individual design and creativity by not being customizable. For instance, in order to decorate an arboreal display in a pattern you would have first visualize that display and then lay the lights accordingly. The complexity changes when the person wants the patterns displayed to change. Thus, our team has decided to tackle this problem of being able to create complicated displays in a simple manner.

In order to provide more customization, our team wants to utilize technology in the form of smart phones and web apps. Our idea is for users to set up their lights on a tree and then upload patterns to that string of lights. Smartphone cameras will be used to record the position of LED's within the display. The data will be sent to our web app/android app where a 3d model of the display with LED's will be created. Users are then able to decorate their display through the web app/android app. Thus, the ability for customization is far greater than your average string of lights.

## 1.3 Operating Environment

The operating environment for our final product is focused around use on a standard pagan holiday arboreal display. This display can either be inside or outside. The RGB lights are waterproof and the controller box will also be weather-resistant.

## 1.4 Intended Users and Intended Uses

The intended users for our holiday lights are people who are interested in programmable LED lights, but are also interested in arts and gadgets. Our end goal is to create a product that can be used by anyone, even those who are not familiar with technology.

Although our project is mainly focused on creating programmable LED for standard pagan holiday arboreal displays, our final product can be used with anything in mind. Some other uses include displaying the programmable LED lights on stairs, desks, bed frames, hangers, etc.

### 1.5 Assumptions and Limitations

Assumptions:

- User will only have one controller per house
- The user has a working WiFi connection
- User owns a smartphone with video functionality

Limitations:

- Keep cost at a minimum for components
- Have to use specific string of lights that are either individually addressable or use PWM

### 1.6 Expected End Product and Other Deliverables

Mobile Application - An Android Application for the user to perform set up. The user takes video from different points around the display, and the app will process the video to determine the location of each LED on the string. This will create a 3d representation of the display for the user, and they will be able to select a pattern to displayed. This information will be sent to a web server on the Raspberry Pi.

LED lights w/ Raspberry Pi Controller -The Raspberry Pi will have two modes: set-up and display. For set-up, the Raspberry Pi will send PWM signals to the string of lights so as to only have a certain amount lit up for a set of frames in the video that the Android app is capturing. After the location of each LED has been found and the user has selected a pattern, the Raspberry Pi will send the PWM signal for that pattern.

## 2 Proposed Approach and Statement of Work

### 2.1 Objective of the Task

The objective of this project is to engineer a product that will provide our intended audience the ability to program their own holiday arboreal light display. This will include components such as led light strands, a raspberry pi controller and custom driver, as well as a mobile android application. The mobile application will be used to calibrate the light display through the use of computer vision by use of the phone camera. Then the user can create a custom pattern to be displayed, as well as send their pattern through a web server to the hardware components which in turn, will display the users desired pattern.

### 2.2 Functional Requirements

- A PWM controller will send a byte-stream through the lights via shift-registers that will illuminate each individual RGB light.
- The Raspberry Pi will host the web server that will receive the buffer of bytes from the mobile application, as well as drive the PWM controller

- The mobile application will use smartphones camera and 24-bit color sensor to detect the location of the individual lights on the display.
- The mobile app will handle all of the creation of the byte-stream for illuminating the lights.
- The mobile app will send the byte stream via wifi to the web server.
- The mobile app will construct a graphical image of the tree in a custom coordinate plane to map the placement of each light.

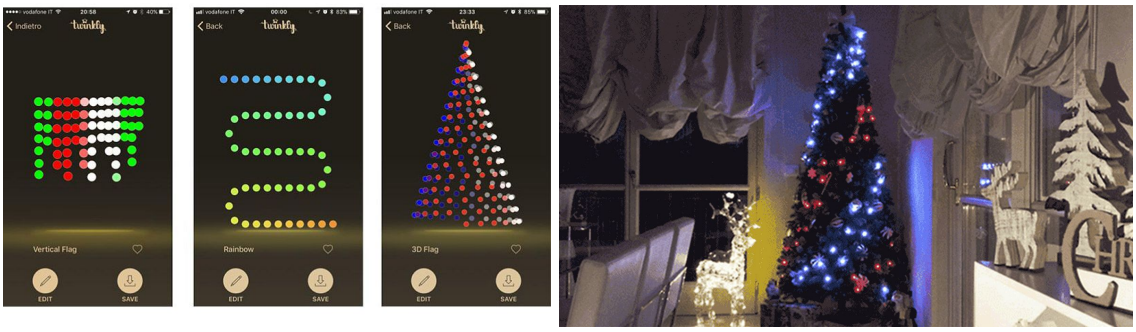
### 2.3 Constraints Considerations

The byte stream should refresh fast enough such that it should not be detectable by the human eye.

Code should be commented and easily readable: e.g., variable names should not be too complex and should correlate with the functions they are being used for. Comments above a function should summarize what it is and how it is to be used while comments within should go into more specifics.

### 2.4 Previous Work And Literature

There are a couple different products out on the market currently that are similar to our projects goal. Most of these products include a LED light strand, with a controller and then are interacted with by an external device. Twinky for example uses an LED strand and controller, with communication to an android/iphone app. The application takes into account that the LED's were placed in specific locations on the tree. Calibration is decided by how the strand of lights is laid onto the tree.




*Figures 1 & 2*

All photos were taken from the twinkly website. https://www.twinkly.com/

### 2.5 Proposed Design

Discuss possible solutions and design alternatives.

### 2.6 Technology Considerations

Our strengths in this project come from our use of a camera to capture a 3D model of the holiday display, which very few other products offer. However, in doing so, the setup of the display becomes more complex and may result in the user having issues on initial setup. Another issue is that it requires the user to use a mobile device in tandem with the LED controller, which introduces more room for error.

### 2.7 Safety Considerations

- There is a risk of electric shock via the outlet
- Long strands of lights may present a risk for strangulation
- Electrical components may be a fire hazard through incorrect use
- Long cords might present a tripping hazard if set up improperly

### 2.8 Task Approach

Use knowledge of Android Studio to design an Android application to facilitate the setup of the lights and to send control signals to the Raspberry Pi. Code will need to be written for the Raspberry Pi to control the light string using PWM, after receiving a signal from the Android Application via WiFi.

### 2.9 Possible Risks And Risk Management

-Feature creep

-Unrealistic goals

-Lack of communication and inability to meet regularly

### 2.10 Project Proposed Milestones and Evaluation Criteria

1. Sending a signal from RasPi to Lights
2. Scanning tree LEDs with application
3. Changing LED color using application

### 2.11 Project Tracking Procedures

Our team will utilize the following applications to track project progress over the next two semesters:

-Github: We will use Github to save and share software that is written over the course of the project. This will give use a form of version control in order to revert to an older version if necessary.

-Trello: We will use Trello boards to efficiently plan both short and long term goals as well as track the progress of teams and individuals over the course of the project.

-Slack: We will use Slack as our primary form of communication with team members for the course of the project.

### 2.12 Expected Results and Validation

What is the desired outcome?

The desired outcome of our project is to be able to control programmable RGB LEDs through our application. This includes changing the color of the lights, and determining which lights light up.

How will you confirm that your solutions work at a **High level**?

TBD.

### 2.13 Test Plan

N/A

# 3 Project Timeline, Estimated Resources, and Challenges

### 3.1 Project Timeline

Our roles have not been officially set as of this time so work is not delegated to individuals. The timeline of the project is not official

| | |
|---|---|
| **WEEK 3** | Research & Meetings |
| **WEEK 4** | Research & Meetings |
| **WEEK 5** | Research & Meetings |
| **WEEK 6** | Ordering Parts & Research<br>Android application development |

| | |
|---|---|
| | Software selection for visual diagnostics |
| **WEEK 7** | Android application development<br>Testing visual software outside of application<br>Web server/web application setup |
| **WEEK 8** | Android application development |
| **WEEK 9** | Android application development |
| **WEEK 10** | Android application development<br>Visual software integrated into android |
| **WEEK 11** | Android application development<br>Visual software integrated into android |
| **WEEK 12** | Android application development<br>Web server/web application with android device |
| **WEEK 13** | Android application development |
| **WEEK 14** | Android application development |
| **WEEK 15** | Android application development |

*Table 1.*

The project plan needs to be actually thought out and planned. The issue currently is we are unsure of our plans and therefore it is kind of challenging to make plans for the future. In the upcoming weeks the project plan will be filled out as we understand what tools and applications we are using. This is allow for better planning of progress and integration of a timeline for things to be completed.

For V1.

### 3.2 Feasibility Assessment

The project will consist of an Android application and a Raspberry Pi controller connected to a string of PWM LEDs. A challenge we may have is ensuring that there is no current drop along the string of LEDs, such that each light is powered the same. Another issue may be identifying the lights through the android application; the camera must have a high enough resolution to be able to differentiate between multiple lights. The other challenge is putting the found lights within a coordinate system (either 3 dimensional or cylindrical coordinates).

### 3.3 Personnel Effort Requirements

As things currently stand, all group members will be required to attend all weekly meetings with the client and advisor. In addition, members of the app development team can begin work on the proposed mobile android application.

### 3.4 Other Resource Requirements

- Raspberry Pi
- RGB Lights
- Op Amp
- 12V power source
- Smartphone
- PWM controller
- Android Studio/XCode
- Linux web server

### 3.5 Financial Requirements

We will require funding from our client and the department to purchase the required resources referenced above in section 4.3 (Sans smartphone, web server and software development tools such as Android Studio/XCode).

## 4 Closure Materials

### 4.1 Conclusion

Our goal is to provide a customizable LED holiday display for a user to interact with. This will be accomplished using an Android application to set-up the lights and allow the user to select patterns, as well as a Raspberry Pi receiving information from the app and controlling the string of lights with PWM. The Raspberry Pi will be running a web server to receive this information.

### 4.2 References

None as of yet.

### 4.3 Appendices

None as of yet.