Color Sensing Infinity Mirror

Practicum for ECE 411

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CONTENTS

|  |  |  |
| --- | --- | --- |
| 1. INTRODUCTION | |  |
|  | 1.1 Practicum Requirement | 3 |
|  | 1.2 Overview | 3 |
|  | 1.3 Project Scope | 3 |
|  |  |  |
| 2. PROJECT DESCRIPTION | |  |
|  | 2.1 Product Summary | 3 |
|  | 2.2 Product Requirements | 4 |
|  |  |  |
|  | |  |
| 3. USER REQUIREMENTS | |  |
|  | 3.1 User Interface | 6 |
|  | 3.2 User Manual | 6 |
|  |  |  |
| 4. DELETED REQUIREMENTS | | 6 |
|  |  |  |
| 5. APPENDICES | | 6 |
|  |  |  |
| 6. REVISIONS | | 6 |
|  | 6.1 Revision Marking | 6 |
|  | 6.2 Revision History | 6 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
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**1. INTRODUCTION**

1.1 Practicum Requirement

A major portion of ECE 411 is the practicum project, which requires teams of students to design, build, and test a device that uses, at a minimum, a sensor, microcontroller, and an actuator. Additional requirements were specified to teams as well. These requirements shall henceforth be referred to as “marketing requirements.” The purpose of the product (henceforth referred to as “the product”) described in this document is to fulfill all marketing requirements.

1.2 Overview

LED art is popular and marketable, with interesting pieces going for hundreds of dollars. Our project decision was made with the intention to explore this attractive market. The product will be a tabletop infinity mirror that will respond to an object placed in the proximity of the mirror based on the object’s color.

The basic concept for the product was constrained and particularized by the skills of the individual team members as well as a desire for simplicity without sacrificing the demonstration of the technical acumen of the team.

1.3 Project Scope

It is the intention of the team to fulfill all of the “Must” requirements, some of the “Should” requirements, and some of the “May” requirements provided to the team by demonstrating competency through the design and construction of the product with particular interest in the following areas: bare-metal driver and software coding, use of digital and analog actuators, and creative power solutions.

The team will research and comply with best practices and standards of engineering throughout the process of creating the product.

**2. PRODUCT DESCRIPTION**

2.1 Product Summary

The product will be capable of sensing color. Based on the input, the product will adjust the output of an electric light array to match the detected color and it will also output a generated audio tone ~~corresponding to the color of the object~~. The product will be powered from a wall outlet and may also be powered by a rechargeable battery.

In order to make the product affordable to build and to increase the viability of the product as a commercial item, it is the intention of the team to design the product such that the total cost of components is no more that $80.

2.2 Product Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| **System** | **Marketing**  **Requirements** | **Engineering Requirements** | **Justification** |
| Physical | 4 | 1. The microcontroller will be mounted to a two layer PCB. A sensor may be mounted to a daughter board. | The given marketing requirements specify use of a two layer PCB for the microcontroller. Based on the color sensors researched and depending upon the physical configuration of the product, a daughter board may be required for the sensor. |
| 7,11 | 2. All electronics should be enclosed within the product. | This is in keeping with the desired aesthetic of the product (a tabletop novelty) and fulfills the additional marketing requirement of being enclosed. This also helps ensure the safety of the product by enclosing any exposed electrical conductors. |
| Power | 2,3,9 | 1. The product should be powered by a wall outlet. | This is a simple and cost effective solution that allows the team to procure an over the counter power adapter and also grants the team the flexibility not afforded by some other solutions (USB) to power more complex outputs. |
| 6,10 | 2. The product may be powered by a rechargeable battery in addition to a wall outlet. | This increases the novelty of the product while allowing the team also to demonstrate proficiency with more complex power solutions. |
| 6,10 | 3. The product may be capable of being turned on and off without de-powering the product. | This increases the novelty of the product while allowing the team also to demonstrate proficiency with more complex power solutions. |
| 11 | 4. The power supply should be able to supply at least 12W of power under both wall power and battery power. | Based on team research, 12W should be sufficient to supply all of the product’s power requirements. This also ensures the safety of the product by ensuring that the waste heat can de dissipated without damage to the enclosure. |
| Microcontroller | 3,5,8,10 | 1. The product should use a microcontroller such as the Atmel AVR ATMega328 or similar to interpret the input and control the outputs. | Use of this type of microcontroller fulfills several of the marketing requirements while also allowing the team to demonstrate proficiency in writing bare metal code. In addition, this type of microcontroller provides enough GPIO pins to give the team flexibility in choosing inputs and outputs. |
| Input | 1,6,8,9,10 | 1. The product should use a sensor that can detect color even when no additional source of light is present and be able to transfer this data to a microcontroller. The sensor may be a TCS34725 or similar. | This is necessary for fulfilling marketing requirements and will also allow for the demonstration of proficiency in writing device drivers. |
| Output | 2,5,6,8,9,10 | 1. The product should have a luminescent output that can be controlled by a microcontroller and is capable of producing a range of RGB outputs. The output should also be constrained by output of the power supply. The output may be a digital LED array or similar. | This is necessary for fulfilling marketing requirements and the overall aesthetic of the product. Research has indicated that a strand of digital LED pixels will meet these various requirements. This will also allow for demonstration of proficiency in writing device drivers. |
| 2,7 | 2. The light output should have a max power rating of no greater than 10W. | Based on research of available power supplies and LED outputs, 10W should be sufficiently low power to allow for battery operation and to be safely enclosed. |
| 2,6,9,10 | 3. The product should output a tone controlled by PWM that corresponds to the detected color on the input. | This adds novelty to the product and also allows for demonstration of the team’s ability to manage increased complexity. |
| 2 | 4. The audio output should require no more than 2W of power. | Based on research of available power supplies, 2W should be sufficiently low power to allow for battery operation. |
| Software | 8,10 | 1. The product will be programmed with bare metal drivers such as I2C and SPI or similar. | This fulfills marketing requirements and allows for demonstration of team proficiency. |
| **Base Marketing Requirements (These are MUST requirements.)**  1—Have one or more inputs or sensors  2—Have one or more outputs or transducers  3—Have one or more processing modules that control some of the outputs based on the inputs  4—Use two layer PCB that is between 1 and 16 in2  5—Use components that can be hand soldered  11—The product must be safe.  **Additional Marketing Requirements (These are SHOULD requirements.)**  6—Be novel and interesting  7—Be packaged in an enclosure  8—Be “bare metal”  9—Have more advanced sensors and actuators  10—Demonstrate proficiencies of team members | | | |

**3. USER REQUIREMENTS**

3.1 User Interface

The product should be sufficiently simple that the user can operate it under normal conditions with no outside instruction. The device should be coded and constructed in such a way as to be fun for the user and rugged enough to stand up to prolonged use.

3.2 User Manual

This space shall be filled with user instruction for all conditions including those that might reasonably be encountered, but that are outside the ordinary.

**4. DELETED REQUIREMENTS**

|  |  |  |  |
| --- | --- | --- | --- |
| **System** | **Deletion Date** | **Engineering Requirements** | **Justification** |
| None | None | None | None |

**5. APPENDICES**

None.

**6. REVISIONS**

6.1 Revision Marking

Changes to the previous revision will be marked in the current revision. Additions and changes will be highlighted in yellow (Example) while deletions will be struck through and colored red (~~Example~~).

6.2 Revision History

Revision 1—10/23/2014: Original revision.

Revision 2—10/27/2014: Made additions and one deletion from the Product Description.