1 Introduction

1.1 Objective

Solving a Rubik's Cube can be a daunting task to those that are not familiar with the puzzle. One of the main drawbacks of learning how to solve a Rubik's cube is that there is no way to reset it if the user cannot solve the cube. Additionally if the user is stuck on one puzzle and does not want to reset the cube, the cube will provide guidance about possible next moves.

1.2 Background

Futuro Cube and Magic Cube are two examples of LED Rubik's cubes that are on the market. The Futuro Cube is a cube backlit by 54 color changing LEDs that senses rotation, orientation, and tapping. The user taps the side to rotate clockwise, taps the bottom to rotate counterclockwise, and shakes the cube to scramble the puzzle. The cube has other games that use these features as well. The Magic Cube is a cube also backlit by 54 color changing LEDs, but in order to complete a move in a Rubik's cube puzzle the user pushes a button corresponding to the move they want to make. In addition, the cube has other games that the user can play. What neither of these LED Rubik's cubes is the ability for the user to physically rotate each face of the cube like the original Rubik's cube.

Our LED Rubik's cube is a teaching tool for individuals new to solving the puzzles and those that want to master solving them. The cube, therefore, must be able to physically rotate to allow the user to practice moves the same way he normally would implement them on a standard Rubik's cube. This feature is driving the implementation component of the design.

1.3 High-Level Requirements

- The cube must be able to physically rotate with the implementation of color changing LEDS.
- The cube must allow the user to reset each face to the solved state of the Rubik's cube.
- The cube must be able to provide feedback to the user about possible next moves for a puzzle at the user's command.

2 Design

Add description… and block diagram

2.1 Control Unit

The control unit is responsible for ensuring each circuit node is powered and grounded and the user has the ability to turn the cube on and off and to reset the cube. The control unit is comprised of a microcontroller, a reset button, and a power button. The control unit is powered by a USB connection to a computer and has inputs from the color display module and the rotation module.

2.1.1 Microcontroller

The microcontroller is powered by a computer through a USB. The microcontroller is responsible for powering and grounding all of the circuit components. In addition, it provides the necessary inputs for the digital potentiometers in the color display module and receives inputs from the reset button, the power button, and the rotation module.
Requirements: The microcontroller must have 54 output pins that control 54 digital potentiometers. The microcontroller must have six input pins for the rotational sensors one input pin for a reset button.

2.1.2 Reset button

The reset button allows the user to reset the cube to the original state, and it is an input to the microcontroller.
Requirement: Must be easily pressable

2.1.3 Power button

The power button allows the user to turn on the cube, and it is an input to the microcontroller.
Requirement: Must be easily pressable

2.1.4 Computer

The computer powers the microcontroller through a USB connection.
Requirement: Must be able to provide 5V to power the microcontroller

2.2 Color Display Module

The color display module is the circuitry necessary to individually light each square with a color changing LED. This module is comprised of 54 RGB LEDs each connected to one of 54 digital potentiometers.
Requirements: Needs to contain 54 multi-color LEDs to represent each face of the Cube. Needs to be able to easily identify which LED represents which square on the Cube

2.2.1 RGB LEDs

54 RGB LEDs will display the proper color of the square each is in based on the voltage across them.
Requirement

2.2.2 Digital Potentiometers

54 digital potentiometers will control the voltage across each LED. They will be controlled by the microcontroller in the control unit.
Requirement: Must be able to control voltage within .2V to give the proper color for each LED that corresponds to a potentiometer.

2.3 Rotation Module

The rotational module is responsible for providing feedback about the orientation of each face. It is important to know the orientation of each face each time the power to the cube is turned on and each time the user makes a move on the cube. The rotation module is comprised of six rotational sensors each connected to a decoder. The decoder is then used to output a signal to the microcontroller in the control unit.

2.3.1 Rotation Sensors

Six rotational sensors will be used to determine the orientation of each face. Each sensor will be located inside the center square on each face since the center square can only rotate and will not change location. They will provide feedback about orientation to a decoder.
Requirements: Must be able to read the input rotations so that the microcontroller can determine what move the user made.

2.3.2 Decoders

Each decoder will take input from a rotational sensor and select an output to provide a signal on to the microcontroller in the control unit about the quadrant of rotation the face is in.
Requirement: Must be able to properly read the output signal of the rotation sensor to feed information to the microcontroller.

2.4 Physical Implementation

The shell of the device will be a large size Rubik's cube made out of 26 smaller cubes. Inside the center cube on each face there will be a rotational sensor. The center of the device contains a mechanism that allows each face to rotate individually. Additionally, the center will contain the LEDS in an orientation that allows the correct spot of the cube to be lit up. There will be fiber optic cables directing LEDs in the center of the device to the edges of the smaller cubes to display the color.

2.5 Risk Analysis

The part of our project that poses the greatest risk to successful completion of the project is delivering power to each of the LEDs. We would not be able to use wires to power the cube internally since they would get caught on any rotation of the cube. This is a problem that will

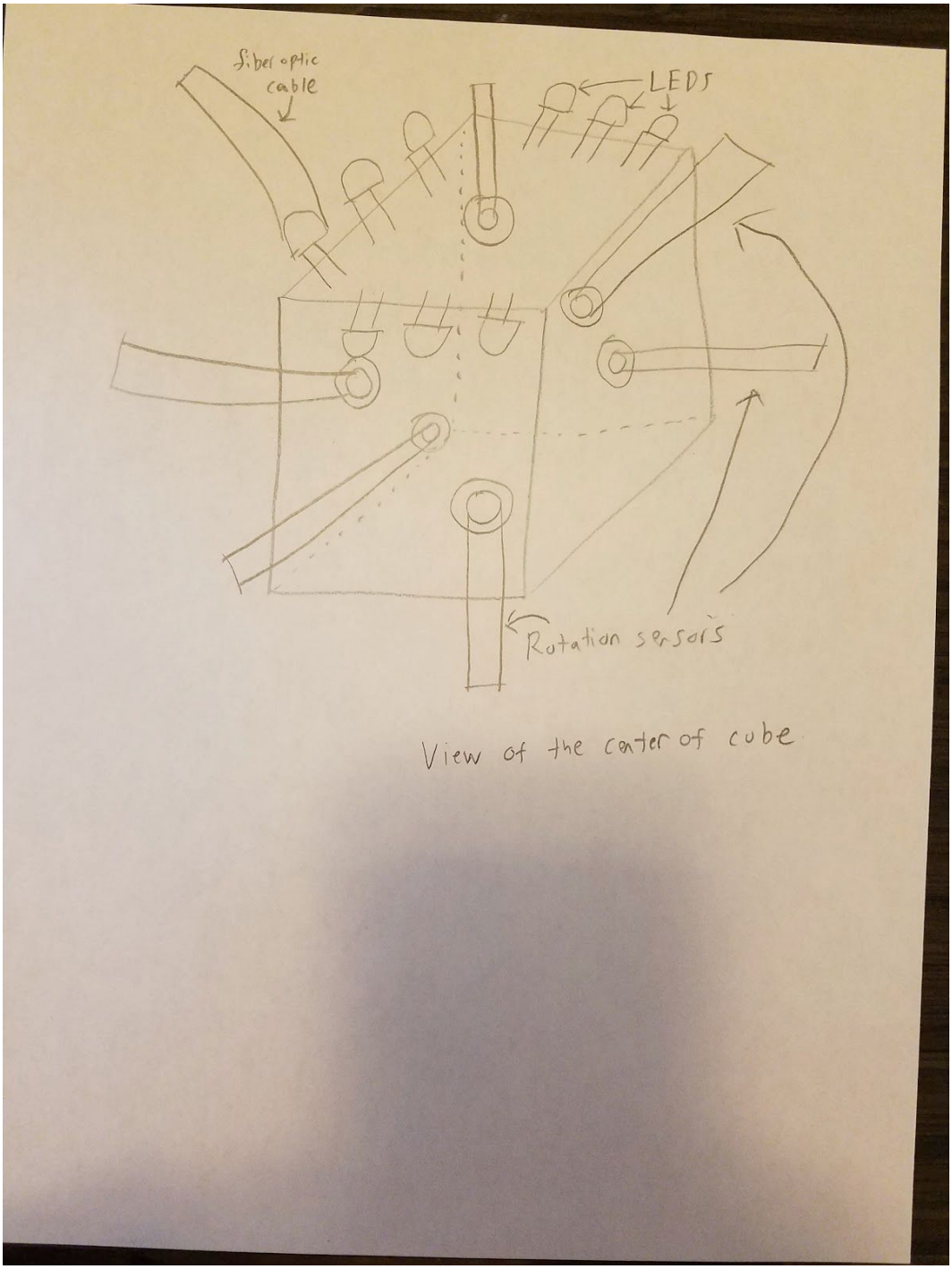
require careful engineering techniques to make sure that each face of the cube is properly represented.

3 Safety and Ethics

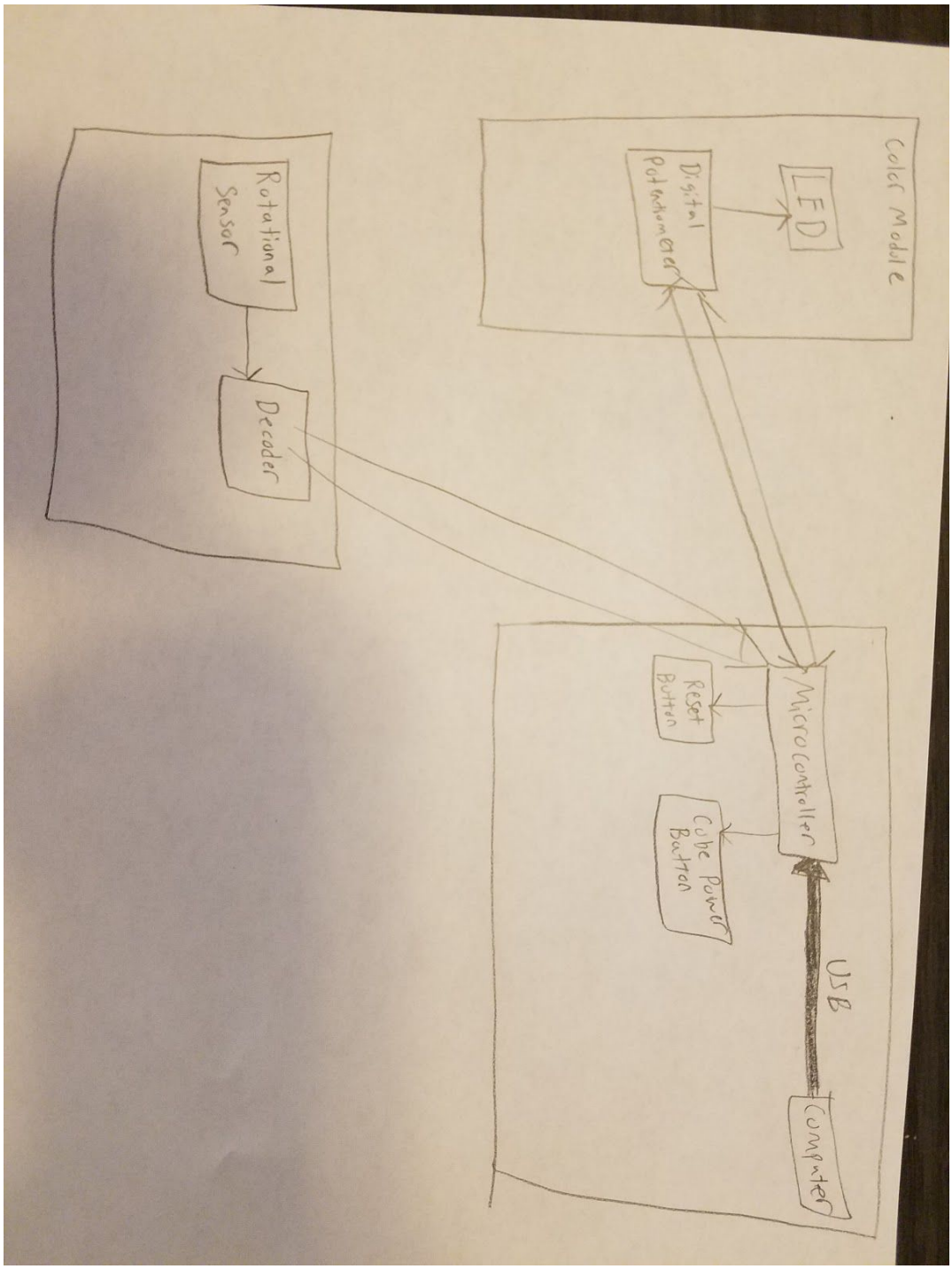
We have done some research on similar products, and we believe that our product is different from other LED Rubik's Cube because ours will feature physical rotation and rotation sensors. We plan on holding our project to the highest standard and on following the IEEE code of ethics. If we use any ideas from an external source, we will make sure to properly cite them.

The only safety issue in our project would be the LEDs. These need to be powered by a current which could potentially be dangerous, particularly to infants or small children who may try to stick small parts of the Cube in their mouth. This product should be kept away from small children. In an attempt to reduce the risk of a small child being injured, we will make sure to not have any live loose wires in any part of our project.

Physical Design: This drawing shows what the center of our Cube will look like. Shown is rotation sensors that will sense a rotation input, LEDs with fiber optic cables directing out the light to each face of the Cube



Block Diagram: Using these modules, we should be able to build our design properly. The rotation sensors should be sufficient to determine what input the user gives. We then will be able to design control logic to output the proper colors to each of the LEDs and direct the light outside the Cube.



4 References

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