Project Summary

This project entailed making a three-dimensional display of LEDs. As required, it was to be capable of displaying at least ten distinct colors, as well as to be large enough in resolution to display alphanumeric messages. Alongside having three selectable, pre-programmed animations, the user was supposed to be able to create additional animations of their own within a custom GUI. Finally, as a self-imposed challenge, a cursor was to be implemented that the user could manipulate in real-time via the GUI.
This presented a number of logistical challenges, due to the scale of the display: in order to attain ten colors, RGB LEDs were to be used and individually addressed, meaning that hundreds of LED anodes and cathodes were to be manipulated at a high enough speed to appear as images to the human eye. To be exact, since the dimensions of our display is an even 8x8x8, there are 512 LEDs, each with three colors to address at once.
This posed a problem, due to the limited memory and USB buffer size of the utilized microcontroller. To overcome this, a communication protocol was implemented on a standard time interval to send user commands to the microcontroller in "chunks." These commands, on the user end, take the form of a screen in which predefined animations can be selected, as well as drawing colors with the cursor, all inside of the stylized GUI. This information then had to be processed into position and brightness data before being routed out from only four pins of the microcontroller to the hundreds of LED cathodes. In order to neatly organize the slew of data, it was decided that it was necessary to send it out as a serialized bitstream into a line of shift registers as memory. In order to apply current evenly throughout the system, transistors were applied as buffers between the high-current power supply, activated as switches by the shift registers.
Finally, the individual cathode and anode controls create a vertical "scanning" effect through the cube that pulses through the display at a high enough frequency to look like a still image to the eye. In order to actualize this, the cathodes had to be attached as vertical rails, with the anodes forming horizontal planes, effectively creating eight layers of two-dimensional screens. The team underwent a series of challenges, each of which were overcome by deconstructing them and tackling each one at a time.