**OBJECTIVE**

Design and construct a robust a robust project to further our understanding different electrical engineering disciplines: power supply design, sensor implementation and control, circuit design, microprocessor programming, and CAD.

**DESIGN**

We began by putting together a basic outline **Fig. 1** of our project which was subject to change as we advanced through the design process

Diagram

Description automatically generated

**Fig 1. Hypothesized design for Midi Laser Light Harp**

**INTRODUCTION**

* In order to pursue this project we needed to build a power supply to power the system, a microcontroller to control take I/O signals and generate an output, lasers and sensors to generate I/O signals, and two knobs encoders for pitch selection and to select between single notes or chord transposition.

**POWER SUPPLY**

The intended purpose of this power supply was to serve as a bus for multiple projects. Therefore, our power supply needed to have three outputs: +12 and -12 volts for our analog synthesizer and +5V for our midi laser light harp.

Input taken from data sheet

Diagram, schematic

Description automatically generated **Figure 2. Options for power supply configurations based on datasheet, dual output was selected**

Output filter based off a basic LC filter that is 10x below the frequency of a converter

**CODE FOR TEENSY**

The code for our teensy used the Arduino programming language. This language was chosen because it has pre-built midi libraries. The purpose of the code is to monitor the pins hooked up to the sensors to monitor for a note being played. Stored in memory is a set of configurations (major scale/minor scale/chord) for each supported base note (C, D, etc.). The configuration is chosen by the input from the rotary encoders. Once the code determines that a note has been played (beam of light has been interrupted), it outputs the desired note. The output is done via midi. Midi output includes which note is being played, as well as when to start and stop the note.

**TEENSY**

We chose to use a Teensy for this project because it supports the pre-built midi libraries available for Arduino. We used a teensy instead of Arduino because it offered the same functionality at a lower cost. Requirements for the microprocessor were enough GPIO pins to read the input from the 7 laser sensors. In addition, it needed to support the input from two encoding knobs. We also needed a small amount of memory to hold the different harp configurations (major scale/minor scale/chord for each base note).

**ENCODERS**

In addition to input for the strings, we needed a way to select which notes would be controlled by which string. To do this, we implanted two rotary encoders. For this project, we chose to use [absolute/incremental] encoders. These allowed us to scroll through a set of note configurations for the harp (i.e. whether the strings compromise the notes of a scale or notes of a chord) as well as the base note for the scale/chord (e.g. C major, D minor, etc.).

**LASERS**

The lasers work with the sensors to provide input to the laser harp. The lasers form the “strings” of the harp, and notes are played by interrupting the beam between the laser and the sensor. For safety reasons, we chose lasers with output less than 5mW. Green lasers were chosen as they allow for a more easily visible beam. For this design, we chose to implement 7 lasers, allowing for a full octave major scale.

**SENSORS**

The sensors work with the lasers to provide input to the microcontroller. We chose phototransistors as they were cheaper and easier to integrate with GPIO. As part of the sensor design, we chose to embed the sensors in the case and cover them with wax paper in order to filter out ambient light. The sensors expect a constant laser beam light source when no note is being played. In order to play a note, the beam of light between the sensor and laser emitter is interrupted. The microcontroller constantly monitors the input, and when the beam is interrupted it outpus a signal to being playing the note. The note remains played until the beam of light is restored.

**CASE DESIGN**

**The encloser must hold the components, including the teensy and power supply. It also houses the lasers and sensors with a gap between them for the laser beams. The gap allows for the strumming of the laser “strings” emulating how one would play a traditional harp. The primary structure was composed of [wood/plastic] due to the lower cost. The enclosure was designed using the CAD software SolidWorks.**