Laser Harp

- Team Light Music -

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Design Document Rev. 1

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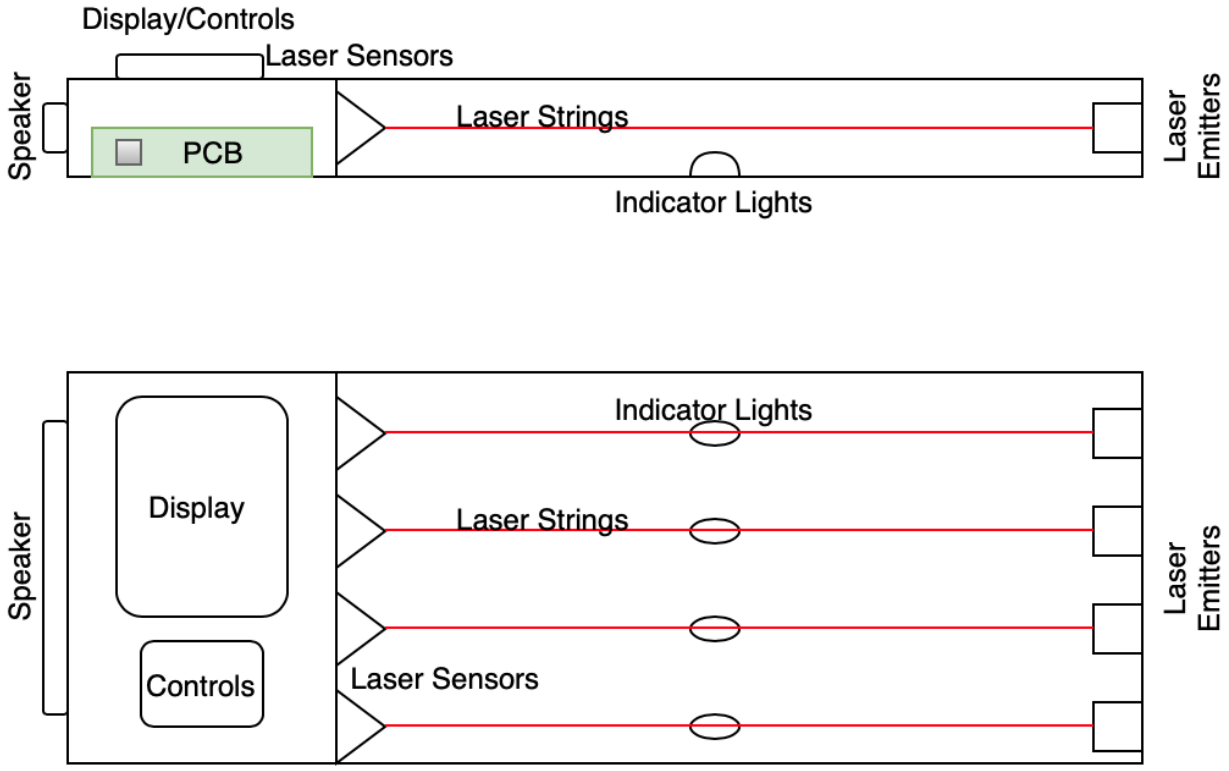

Figure 0.1: Product Sketch

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Revision Log

Date	Revision	Changes
01/12/2023	0	• Document Creation
01/19/2023	1	• Initial Proposal Ready

Table 0.1: Revision Log

Glossary

Strings: Emitted beams of light that mimic the “strings” of the harp.

Laser: Light Amplification by Stimulated Emission of Radiation. A device that emits a focused beam of light.

Microcontroller: An Integrated Circuit that includes a microprocessor that controls the functions of an electronic device.

Microprocessor: An Integrated Circuit that contains the components of a computer processing unit on a single chip.

PCB: Printed Circuit Board. A thin board where circuits are etched onto.

Pitch: A quality of sound describing the frequency of vibrations of the sound waves.

Timbre: A quality of sound distinctive from pitch or volume that describes how something sounds.

1 Introduction

1.1 Executive Description

The aim of the project is to design a laser harp: a musical instrument which emits lasers in place of strings and allows a user to play musical tones by making physical contact with one of the beams. Plucking of the string is achieved by breaking the beam of light emitted by the laser.

To design the laser harp, a microcontroller, an array of lasers, light sensors, a power source, a speaker/buzzer, and some form of data storage are needed. When the beam of light is broken, the light sensor indicates to the microcontroller to play a tone at a pitch depending on which string was plucked. The laser harp will consist of eight separate strings in order to play a complete Western scale and will visually indicate which note was plucked. The user also has the ability to change the octave/voice of the harp so that bass, mid-range, and treble tones can all be reached easily.

In order to make the device interactive and educational, a function for storing and playing back sequences of notes will be needed. This will allow for the user to learn simple built-in melodies or riffs as well as create and store simple sequences of tones. Other factors are outlined in Section 2.2.

1.2 User Story

Matt the Musician is interested in a beginner instrument that teaches him some basic musical concepts such as pitch and melody. He needs a simple, intuitive interface that can convey to him basic riffs or songs without prior knowledge of music theory. Matt would like to create his own melodies or songs when inspiration strikes his mind. He also thinks lasers are cool, and would like to show off his instrument and songs to his friends.

Harriet the Harpist is looking for a new way to express herself musically. She already has experience as a harpist, and would like to transfer her skills to an electronic instrument. She wants this device to look awesome while performing and incorporate lasers as well.

Based on these user stories, the high-level design requirements for the laser harp are described below.

2 Design Requirements

2.1 Requirements

1. The device must be able to emit beams (strings) of light.
2. The device will detect if a string has been broken.
3. The device must have the ability to output audio/sound.
4. The output tone will correspond to a given string.
5. The device will store sequences of tones.
6. The device must be able to playback stored sequences of tones.
7. The device will indicate which string to pluck when teaching a sequence of tones.
8. The device must be able to switch between different octaves/voices.
9. The device will indicate to the user the current octave/voice range.
10. The triggered note/pitch will be visually displayed.
11. The selected key/scale will be visually displayed.
12. The strings will have the Western scale sequence of “Do Re Mi Fa So La Ti Do”
13. The strings have the ability to be changed to different scales/keys.

2.2 Factors influencing requirements

1. Safety factor
    a) Laser emission must not result in tissue damage
    b) Other things needed to indicate when device has some problem
2. Reality Usage Factors
    a) LED light needed to show when sting is broken
    b) Lasers to be in a color which is obvious to be seen
3. Music define factor
    a) Eight tones (Do Re Mi Fa So La Ti Do) require eight stings, one for each note in a scale
    b) Ability to change between bass, mid-range, and treble
4. Reality requirement Factors
    a) Can store song patterns
    b) Better if we design a function for people to store the song they create
5. Environmental Factors
    a) Utilize environmentally friendly material if possible.
    b) Avoid wasting too much material during design.
6. Economic Factors
    a) The team has an overall budget of $425.
    b) Use cheaper material (while still ensuring device quality) if possible

3 System Overview

3.1 System Block Diagram

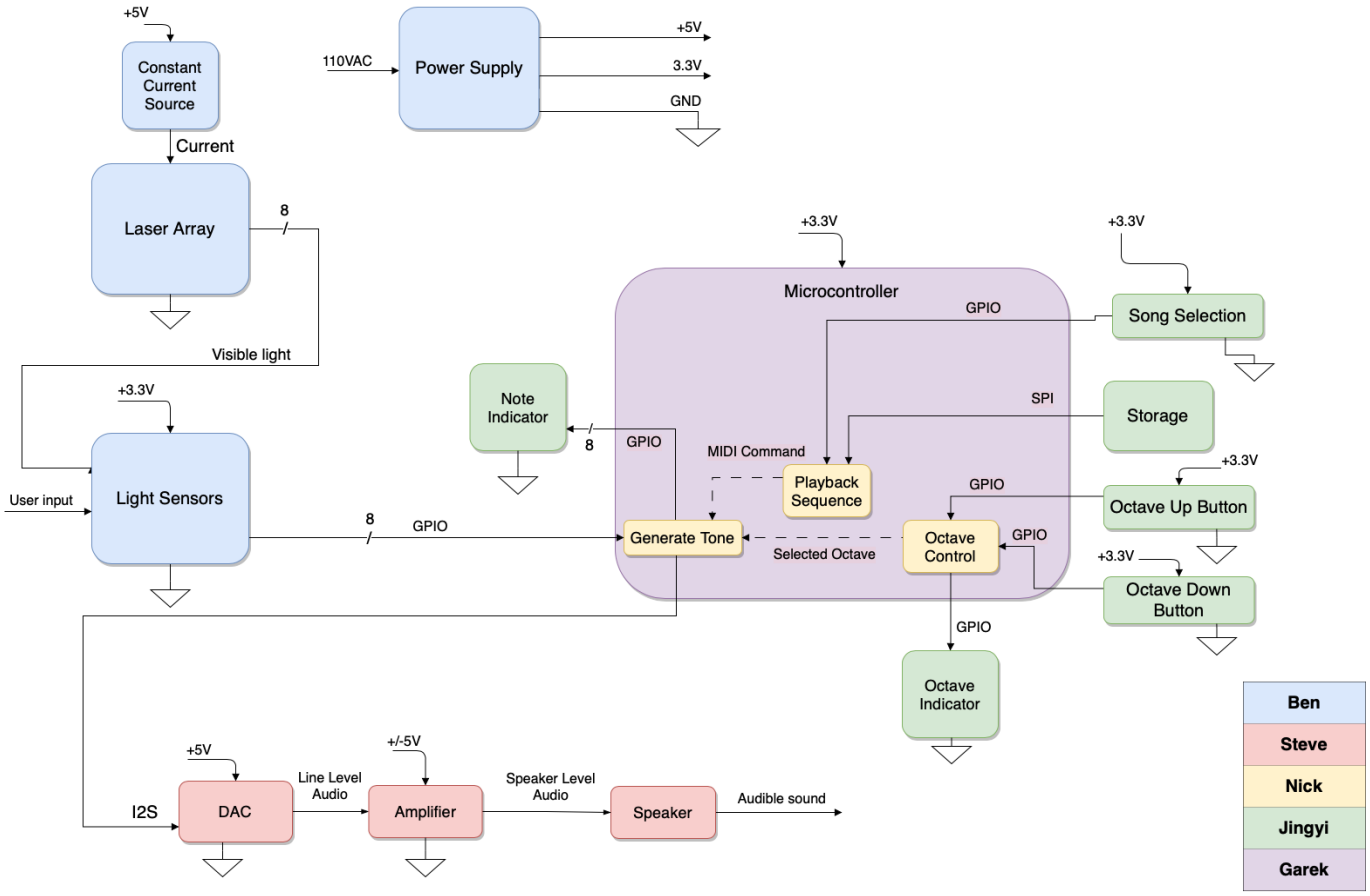

Figure 3.1.1 System Block Diagram

3.2 System Activity Diagram

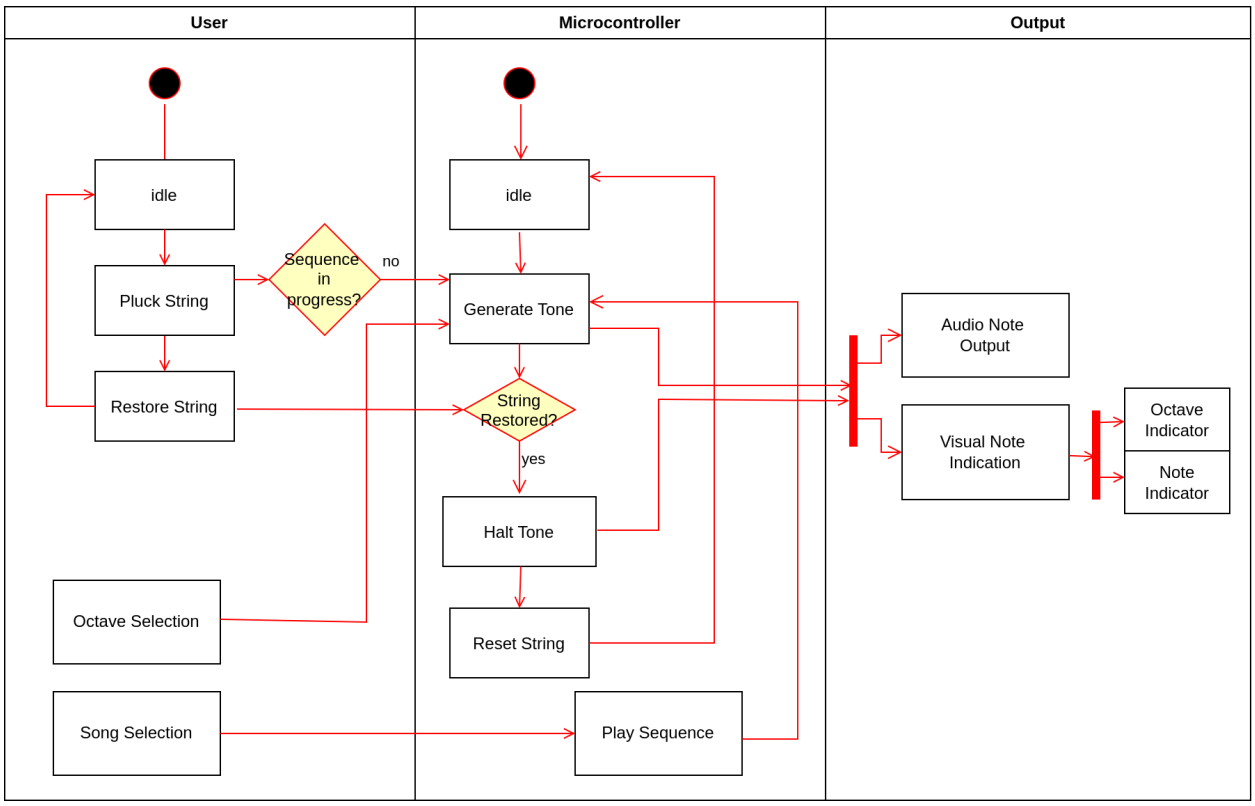

Figure 3.2.1 System Activity Diagram

4 Team Structure

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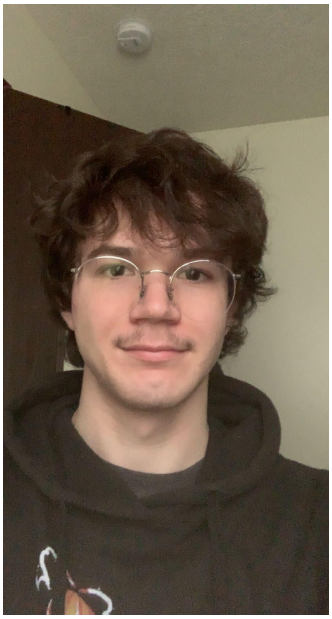

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