Ukulele Instrument Tutor

Project Proposal
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ECE 445- Senior Design

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I. Introduction

1. Title: Ukulele Instrument tutor:

There are not many musical instruments in the market today which provide direct assistance to a musician in playing a new instrument. Our idea is to utilize our experience in the field of electrical engineering to build a ukulele with integrated LEDs in it which will help the musician figure out which fret to press and then strum it for the required sound. We will program various notes, chords, and songs into the microprocessor for the musician to play as well as utilizing force resistance sensors to ensure the proper notes are played. An LCD display will act as a user interface and allow the user to determine what is going to be played. The project will be unique if it has inputs like note detection or finger position sensing, LED outputs, as well as stand alone operation.

2. Objectives:

The goal of this project is to develop a tutor that will allow the user to play a ukulele proficiently. This will help them develop the skills needed to play without the aid of a tutor in the future. The project will be accomplished by using LEDs to direct the user on where his fingers need to be placed. After that the sensors will determine if the note played matches the correct note in the song upon which it will display the next note to play. This will be an easier alternative to learning to play an instrument in a class where attention to individuals might not be emphasized.

<u>Benefits:</u>

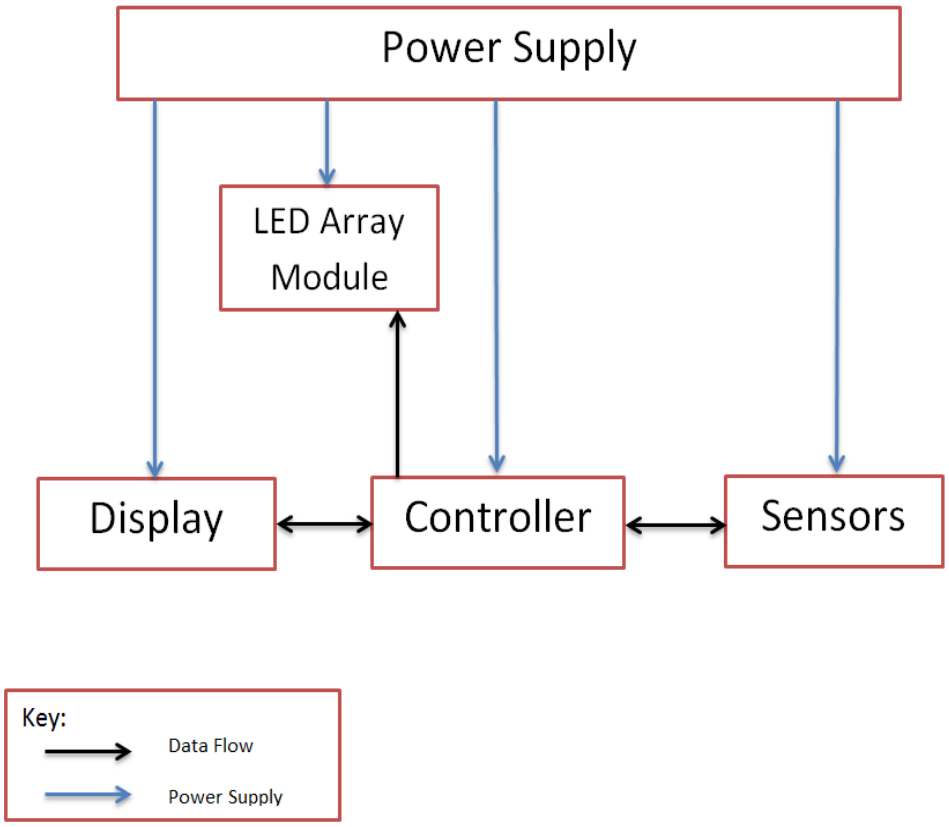
- Helps the user learn how to play the correct note quicker than conventional methods.
- It is a portable system and can be taken wherever desired.
- LEDs display system undermines the need for a musical score sheet.
- Cheaper than other products available on the market, such as Fretlight.
- Its fun!

<u>Features:</u>

- LEDs to direct proper finger placement.
- Import songs to device which can be viewed on the LCD screen.
- Displays the note being played on the LCD screen.
- Portable and easy to use.

II. Design

Block



Diagram

Block Descriptions

Sensing Unit

The sensing unit consists of pressure sensors that would be placed behind the LEDs on the fretboard. They will register a pressure value when the user presses the desired note. This data will be sent to the microcontroller which then determines whether the correct note was played or not based on the amount of pressure that was exerted.

Power Supply

A 9V battery would be the source of power for all the major components. It would be attached in parallel with all the other units and provide the desired voltage to each component. For example, the microcontroller requires a power input of 3.3V for it to function. hence the battery would be attached in parallel to the controller with a resistor to regulate the incoming voltage.

Microcontroller

A PIC microcontroller is going to at the center of the whole system. A music file, that has been converted manually into notes and chords, will be stored in the memory of the microcontroller and will be programmed so that it is passed to the LED array module to light up the note that is

supposed to be played. The pressure sensors also send data back to the microcontroller and from those information, we can determine whether the note that was pressed was the correct note or not. Another feature controlled by the microcontroller is the LCD display that displays the song selection screen at the beginning and once the song is selected, it displays the note that is being played.

LCD Display

The LCD display has two functions, one, at the start, it shows the user the list of songs that are saved in the memory of the microcontroller. Second, the display is used to display the note of that is being played, so that as well learning how to play the note, the user will also be able to learn the name of the note played.

LED Array Module

16 red LEDs will be placed on the fretboard, that cover the first 4 frets on the Ukulele. This is because almost all the songs can be played with the notes represented by the first 4 frets. Under each of these LEDs, pressure sensors would be placed that measure the amount of pressure applied. The LEDs light up to show the user what note he needs to play and it stays until the user plays the correct note. Once the user plays the correct note, the next note to be played immediately lights up.

III. Block Level Requirements and Verification

Requirements:

Hardware

- Force-Sensing Resistors detect 100g to 10kg
- Refresh rate for the data loaded into the monitor great enough so there is no noticeable flickering
- LED lights light up correctly in response to the note/chord being displayed

Software

- Code perform accurately with no noticeable delay to human interaction
- Able to detect change in resistance to finger pressure
- PIC Microcontroller recognizes correct note being played

Verification:

1. Testing Procedures

i. Pressure Sensors: The first step for testing our circuit design would be to create a simulation in PSPICE which will have our inputs and outputs in order to determine circuit parameter values. This will allow us to verify our circuit design and make sure we are not short circuiting any inputs or outputs to prevent equipment damage. It will also help in debugging the circuit design to ensure proper functionality. Once proper operation is achieved by simulation, we will start connecting the sensors to the microcontroller and start the implementation phase of the ukulele instrument tutor.

ii. Microcontroller: The microcontroller is one of the most critical parts of our system because it will control the LEDs, get inputs from the sensors as well as display data to the LCD. Therefore it is a significant part which will make the device more user friendly by providing visual interface through the LCD. One of the requirements of the microcontroller is to take the sensor inputs and display the output note to the LEDs in a timely manner. We will test the microcontroller by incorporating it in a design in our breadboard to ensure that the output from the LEDs are correct. In addition to that we will test the inputs to the microcontroller to make sure that proper signals are coming in.

iii. LEDs: The LEDs will be used to display the locations where the user must place his fingers. We will simulate the LEDs in PSPICE to determine proper functionality for a note that will be played to ensure that they light up in the correct places.

iv. LCD: The LCD will be tested by visual confirmation upon having user inputs from the buttons. If it functions improperly we will test it using a logic analyzer or an oscilloscope to see the data coming into it.

Tolerance Analysis:

The focus of the tolerance analysis will be on the force sensitive resistors. Initially we will test an individual pressure sensor and use that as our reference pressure. When the rest of the sensors are positioned in our array, they may detect unintentional pressure from playing the desired note. From there we will determine the minimum pressure required to detect the accurate note being played.

- Force accuracy ranges from approximately± 5% to ± 25% depending on the consistency of the measurement and actuation system, the repeatability tolerance held in manufacturing, and the use of part calibration.
- The force resolution of FSR devices is better than ± 0.5% of full use force.

IV. Cost and Schedule

1. Cost Analysis

i. Labor

Name	Hourly Rate	Total Hours Invested	Total= Hourly Rate * 2.5 * Total Hours Invested
Ammar Faiz	$35	150	$13,125
Udit Sharma	$35	150	$13,125
Matt DiLiberto	$35	150	$13,125
TOTAL	$105	450	$39,375

ii. Parts

Part	Part Number	Unit Cost	Quantity	Total
LED	5050 SMD	$3.29	16	$52.64
Force-Sensitive Resistor	Pololu #1695	$5.26	16	$84.16
Push Button	COM-0097	$0.35	4	$1.40
PIC Microcontroller	PIC32MX795F512L	$6.62	1	$6.62
LCD Display	SainSmart 1.8 SPI LCD Module	$13.99	1	$13.99
Battery- 9V	PC16049V	$1.46	1	$1.46

9VOLT BATTERY CLIP	233	$0.21	1	$0.21
TOTAL				$160.48

2. Schedule

	Ammar Faiz	Matt DiLiberto	Udit Sharma
9/16-9/23	Order parts, work on schematics for system, research ways to build Ukulele tutor	Order parts, work on schematics for system, research ways to build Ukulele tutor	Order parts, work on schematics for system, research ways to build Ukulele tutor
9/24-10/1	Design schematics. Order parts. Simulate designed circuits.	Design schematics. Order parts. Simulate designed circuits.	Design schematics. Order parts. Simulate designed circuits.
10/2-10/14	Microcontroller-Program and test sensors inputs	Microcontroller- Program and test LED outputs	Microcontroller-Program and test LCD functionality
10/15-10/21	Design sensor arrangement on ukulele	Design LED arrangement on ukulele	Design LCD arrangement on ukulele
10/22-10/28	Power system- See requirements for power, test circuit without battery	Power system- Calculate power requirement, test circuit without battery	Power system - See power requirement, test circuit without batteries

10/29-11/2	Power System- Design PCB, run circuit on battery power	Power System- Design PCB, run circuit on battery power	Power System - Design PCB, run circuit on battery power
11/3-11/4	Get ready for Mock Up demo with the circuit on protoboard	Get ready for Mock Up demo with the circuit on protoboard	Get ready for Mock Up demo with the circuit on protoboard
11/5-11/18	Final Debugging and testing	Final Debugging and testing	Final Debugging and testing
11/19-11/25	Thanksgiving Vacation	Thanksgiving Vacation	Thanksgiving Vacation
11/26-12/2	Final paper write up	Final paper write up	Final paper write up
12/3-12/16	Perform Demos and Presentation	Perform Demos and Presentation	Perform Demos and Presentation
12/17-12/23	Finish final paper and lab notebook	Finish final paper and lab notebook	Finish final paper and lab notebook