DESIGN AND DEVELOPMENT OF ARDUINO BASED ELECTRONIC HARP USING LASER

[1]Namrata Kataki, [2]Nishanta Gogoi, [3]Sarfarhaz Nawaz, [4]Jyoti Prakash Talukdar, [5]Akshoy Deep Gogoi
[1]Assistant Professor, [2,3,4,5] B.Tech Final Year Student
[1]ECE Department,
[1]Girijananda Chowdhury Institute of Management and Technology, Guwahati, India

Abstract: This paper presents an electronic musical instrument which is capable of creating new sound synthesis methods and will replace the functionality of the conventional methods used in commonly available HARPs. The system consists of a laser module where laser collaborates to produce beams and each beam represents a note. The laser beam replaces the strings of a traditional HARP to avoid bruising of the user's hand. The beam is created with the help of stepper motor, mirror and the laser source. LDRs are used as detectors to identify which beam is cut. The Arduino microcontroller is configured so as to produce a different tone whenever a different beam is cut [1], [2].

***Index Terms* - LASER, Stepper Motor, Arduino, LDR, harp**

I. INTRODUCTION

The electronic Harp is a new musical instrument where laser beams are used instead of conventional strings. The user will be able to play notes by cutting the beams with his/her hands instead of plucking the strings in a conventional harp. Different laser beams are used for different notes. Various tones could be created by hitting proper laser beams as every beam is intercepted differently. Each laser beam is pointed to a LDR and each LDR circuit is fed into arduino microcontroller. The arduino microcontroller is programmed to assign different tones to different laser beams. When the user breaks a particular beam by placing the hand on it, the corresponding LDR detects this cut. The LDR sends this information to the microcontroller and the corresponding note is played out through external speakers. [1], [2], [5],[6].

II. PROPOSED SYSTEM

The designing of the proposed harp can be divided into three sections. In the first part, the strings of the harp are designed with laser. In The second part, different musical notes are assigned to different laser beams which act as the strings of the harp. In the final section the musical notes are played by detecting the cut in the correct laser beam or string is done. [3], [4]

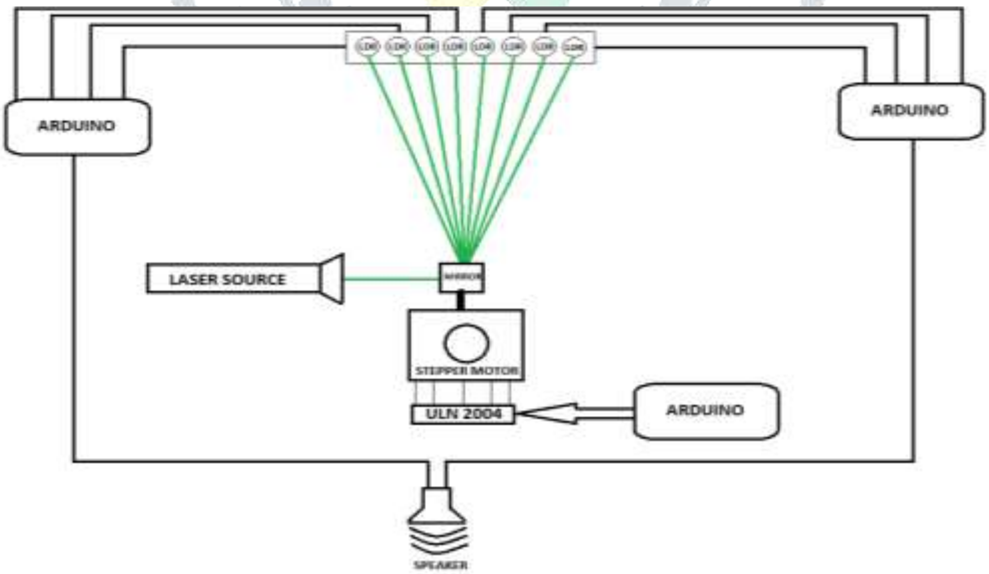

Fig 1: Block Diagram of the system

The generation of the strings for the laser harp

The laser system consists of a single green laser module of visible wavelength (650nm), with a power output of 50mW. The laser provides the light source for each LDR, which acts like switches when the beams are blocked. Since this is a non-contact instrument they also provide a visual guide to the user, of where they should place their hands to play the instrument.

The first and foremost thing to be done while developing a laser harp is the production of the laser beams. Here this is done using a stepper motor. A mirror is connected to the shaft of the stepper motor and the stepper motor is rotated into 8 steps. The number of steps and the speed of the motor can be controlled by the Arduino operating it. Now, when the beam is incident upon the mirror from the laser source, the motor deflects the beam into 8 different steps. As the speed of rotation of the motor is very high, all the deflected light rays appear simultaneously at the same time and we obtain the strings for our harp.

Producing musical note for each beam

Musical notes are being assigned to each deflected beam once the strings are generated. Light dependent resistors (LDR) are placed against each laser string of the harp. The laser light continuously falls on the LDR. When a particular beam is cut, it blocks the light falling on to the LDR. There is an instant change in the resistance of the LDR and it triggers a change in the voltage output. The LDR sends this information to the arduino connected to it. Based on this the Arduino senses which LDR is triggered and it plays the particular note assigned to that.

Generation of different tones for different beams

Each LDR is assigned a specific tone through the microcontroller and each tone is fed with different frequency. The same frequency is not assigned to two different LDRs. It is due to these frequency changes that we are able to hear different musical notes being played at different strings of the harp.

III. System Design

Interface between arduino and stepper motor

Figure 2 shows the connection between arduino to ULN2004 driver and from the driver to the stepper. Here P8, P9, P10, P11 are taken as input pins from the arduino to IN1, IN2, IN3, IN4 of the ULN2004 driver. The 4 coils COIL1, COIL2, COIL3, and COIL4 are connected to the output pins of the driver OUT1, OUT2, OUT3, OUT 4 respectively. The common wire of the stepper is connected to the pin 9. 5V supply is given via the arduino.

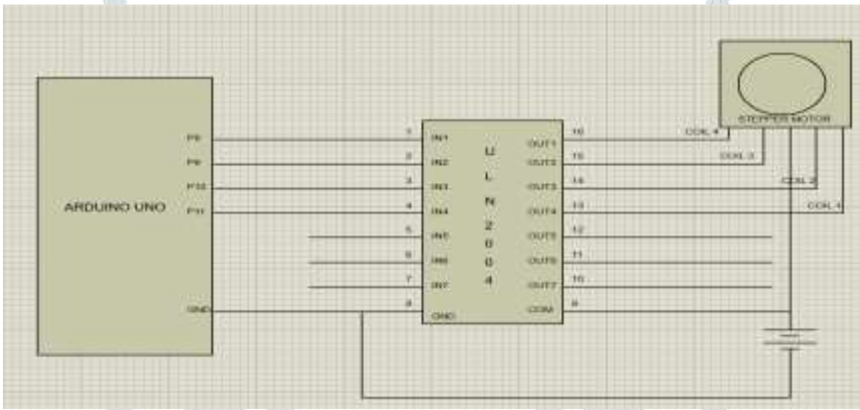

Fig 2: The circuit diagram for arduino to stepper motor connection

Interconnection of LDRs and Arduino

Figure 3 shows that four LDRs are connected in series and one point is connected to the 5V pin of the Arduino and the other is connected to the ground. Similarly the rest of the four LDRs are connected in series and are the connected to the 5V pin and the ground pin in the same way. Also potentiometer is used to calibrate the resistance of the LDRs. Two different potentiometers are used for either side of the LDRs. The positive and negative pins of the potentiometers are connected to the 5V and ground pins of both the Arduinos' respectively and the calibration pin of the potentiometers are connected to the A5 pin of both the chips. Also one speaker is used for the generation of the musical note. The positive pin of the speaker is connected to the D9 pin of the Arduino and the negative pin is connected to the GND pin of the Arduino.

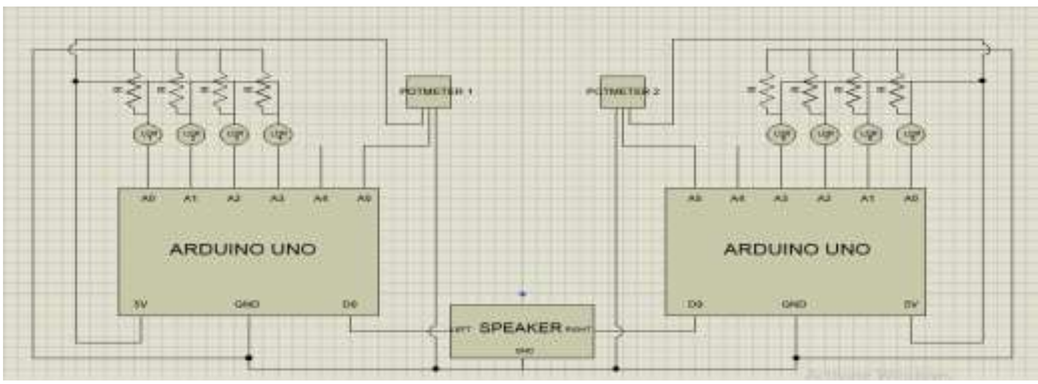

Fig 3: Circuit connection between the LDRs and the arduino board

IV. SOFTWARE IMPLEMENTATION

The process begins with the stepper motor rotating in 8steps. When the laser is shone on to the mirror, the 8 strips of line show up. If continuous tone from the speaker is heard, we calibrate the circuit with the help of potentiometer. After calibration, the process moves to the next step and the ray 1 is checked. If ray 1 is cut, the first musical tone is played. If not, then it moves ahead and checks the second ray. If second ray is cut, the corresponding note is played. This process is continued until all the eight rays are checked. If the eight ray also isn't cut, it moves back again to the first ray and the entire process is repeated again.

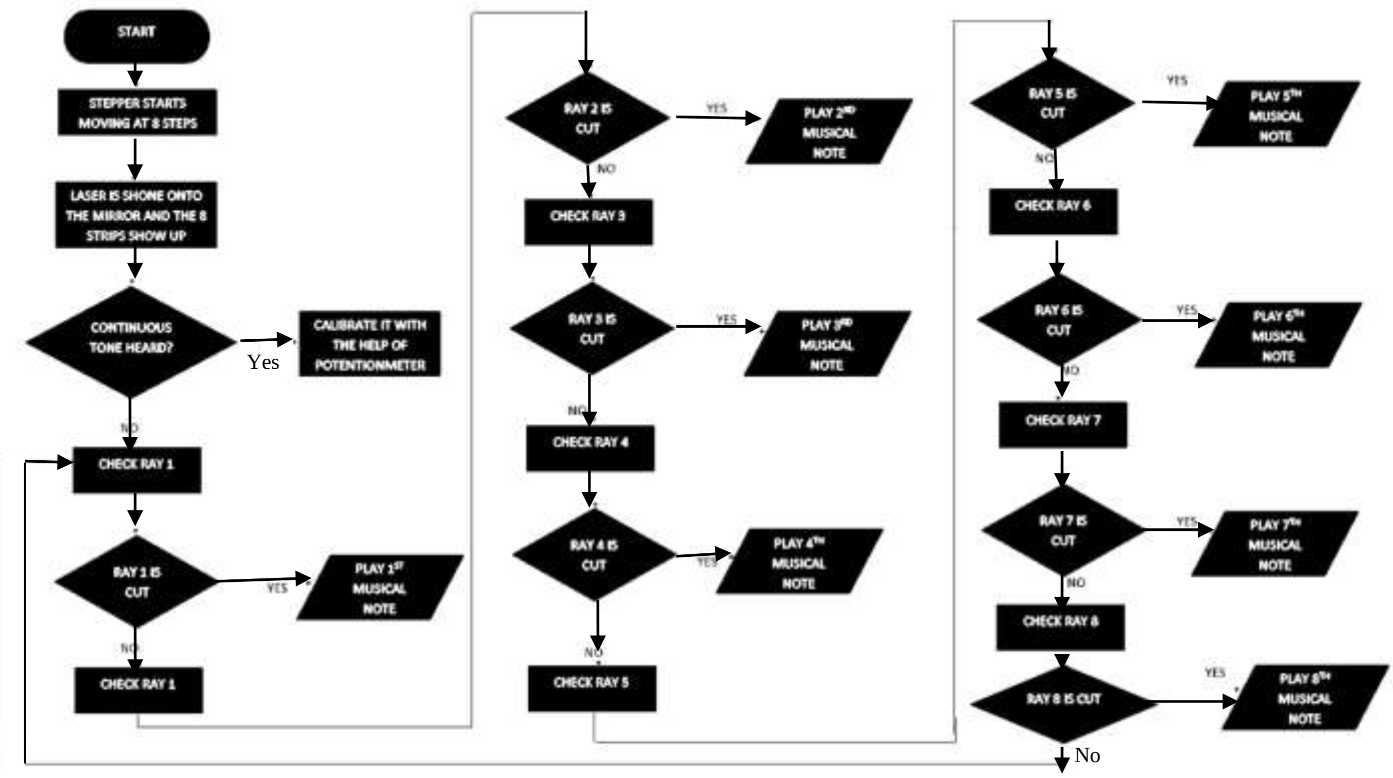

Fig 4: Flow Chart

V. RESULTS AND DISCUSSION

1. ***The LASER system:*** Figure 4 shows how the single laser beam is divided into 8 different steps.

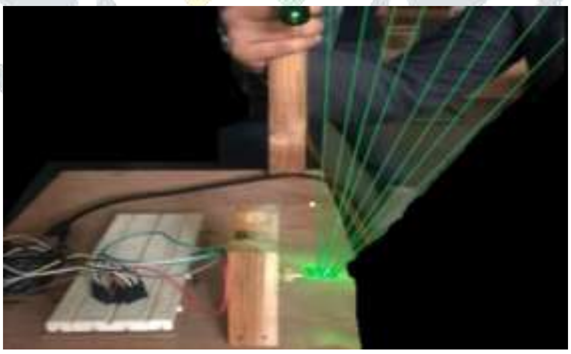

Fig 5: Generation of laser strings a from a laser source

2. ***Detector System***

The LDR combines with the detector circuits complete the laser system. The LDRs detect when an object is blocking the light. When the light is absent the resistance of the LDR increases which causes a voltage change on the inputs to the comparator on the detector board. This causes the comparator to change from a low to high output. The response of the LDR is fast, the lag time is negligible. The detector circuit works by using a comparator that compares two input voltages. One voltage is called the reference voltage (V_{ref}) and the other is called the input voltage (V_{in}). When V_{in} rises above or falls below V_{ref} the output changes polarity (LOW to HIGH). V_{in} changes due to the light or absence of light falling on the photocell. The resulting output is digital.

Table 1: Resistances of LDRs for arduino 1 & 2 and reference voltages

Sl no.	Parameters	
1.Resistances of LDRs for Arduino 1	(for L1, L2, L3, L4)	2.6KΩ -3.3KΩ

2. Resistances of LDRs for Arduino 2	(for L5,L6,L7,L8)	2.4 KΩ -3 KΩ
3.Reference voltage for Arduino 1	V_{ref} (for L1,L2,L3,L4)	6.5V
4. Reference voltage for Arduino 2	V_{ref}(for L5,L6,L7,L8)	6.5V

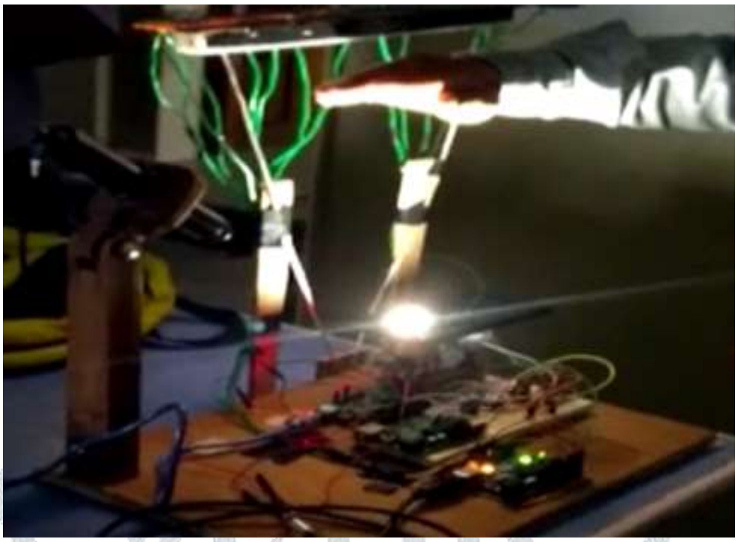

Fig 6: LASER strings has been cut to produce musical tone

3. Calibration

The LDRs behave differently depending on various ambient lighting conditions. So, the sensors must be calibrated. This is done manually by using a potentiometer as an input. The potentiometer also acts as a voltage divider and will be hooked up to one of the analog input pins. Turning the potentiometer sends a value from 0 to 1023 to the Arduino. This will be used to dial in the calibration.

Table 2: Calibration table

Sl no	LDR no	Voltage (V)
1	L1	3.8
2	L2	4.2
3	L3	4.0
4	L4	4.1
5	L5	4.2
6	L6	4.2
7	L7	3.9
8	L8	4.0

4. Frequency addition

The outputs of the LDRs are connected the Arduino Uno in the following way:

- The outputs of the first four LDRs are connected to the analog pins A0-A3 of the Arduino. Similarly the other four are connected to A0-A3 of the other Arduino.
- The output is obtained at the D9 pin of each Arduino are connected to the speaker using a 3.5mm female and male jack.

The frequencies assigned to each tone are shown in table 3.

Table 3: Frequencies fed to LDR

Sl no.	LDR no.	Frequency(Hz)
1.	L1	329.63
2.	L2	246.94
3.	L3	196
4.	L4	146
5.	L5	830.6
6.	L6	932.3
7.	L7	311.1
8.	L8	1047

Difficulties

The biggest issue throughout the project was with the laser diode. Initially a 5mw laser diode was used. During testing the lasers seemed to work as expected. The laser was supplied with a 3V DC power supply and it drew a typical current of 250mA. The problem started occurring when the laser was powered on for a few minutes. After a few minutes the output began to drop and finally disappear. This was due to the increase in temperature of the laser. This increase in temperature causes the reduction of the laser output. A number of methods were used to try and solve this problem, but none were successful. A current limiter circuit was built to reduce the current to the diode by 20% - 30%. After a number of minutes the same problem occurred. Another method of keeping the lasers cool using freeze spray and a fan proved unsuccessful as the power output drops if the lasers are too cold. The only solution was to use a new laser diode which was stable. Although the laser employed in our harp is still powerful (50mW) than the earlier one (5mW), the harp requires a little bit of smoke effect and dark conditions to be properly visible to the user. Also the light is the prime most factors in our project. So the light factor acts as both boon and bane in our project. With the correct amount of light exposure, we can play the harp properly but with light exposure more than necessary, the harp starts to misbehave.

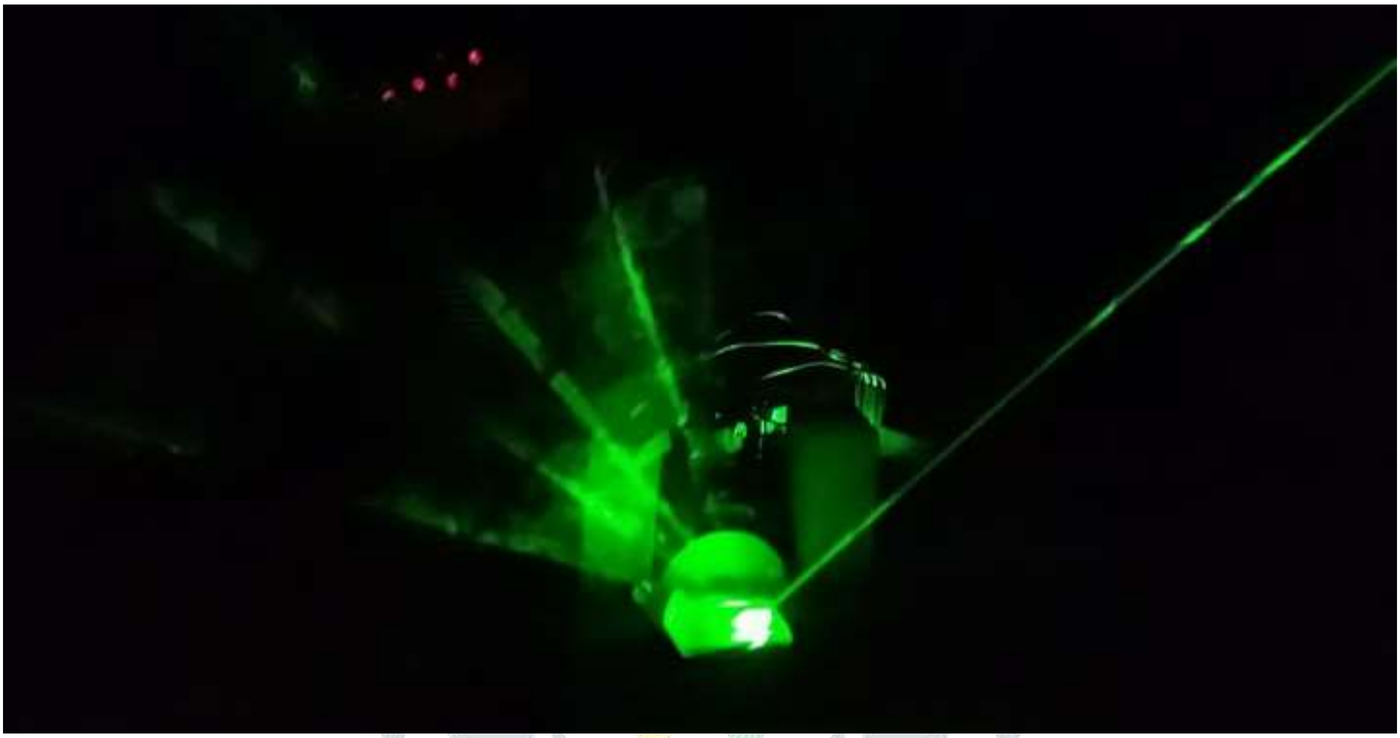

Fig 7: Final view of the designed electronic HARP in smoky air (only 6 strings out of 8 strings are visible due to smoke)

VI. CONCLUSION AND FUTURE SCOPE

As with growing demand for electronic musical instruments, the prices of them are increasing at an exponential rate. This creates a lot of hardships for music enthusiasts who belong to middle class and most of the time end up leaving their passion because of such price hikes. In this project, the design and implementation of a new kind of electronic musical device was explored. From the results, it is evident that this kind of device is both practical and relatively inexpensive to construct and operate. The result is a hybrid non- contact electronic musical instrument. The laser harp is USB powered with total power consumption less than 2.5W, hence having the feature of minimum power consumption. The fundamentals of this system are formed, but the overall design, precision and effectiveness can be improved. With further adaption and improved methods, the possibilities of this device are endless. It opens up a whole new area to the electronic musical industry. [3]

VII. ACKNOWLEDGMENT

We wish to express our heartfelt thanks and appreciations to the department of ECE, Girijananda Chowdhury Institute of Management & Technology, Guwahati for providing the necessary support in completing the project.

REFERENCES

[1] Ravichandra, A., Kirtivasan, K., Mahesh, A. and Savanth, A. Non-Contact Digital Music Instrument Using Light Sensing Technology. World Academy of Science, Engineering and Technology International Journal of Electronics and Communication Engineering Vol:11, No:10.

[2] Dawda,M., Kadam, S., Sushrut, K., Raina, N., Annadate, P. 2015. LASER HARP. International Journal of Advance Research In Science And Engineering IJARSE, Vol. No.4, Issue 05. ISSN-2319-8354(E)
[3] Woodruff, A. and Gormez, B. 2012. Laser Music System. Bachelor thesis.
[4] Ferenc, G. and Popovic-bozovic, J. 2015. Infinite Beam Laser Harp. IEEE
[5] Paradiso, J. A. 1997. Electronic Music Interfaces: New Ways to Play. IEEE Spectrum. ISSN 0018-9235
[6] Magun, I., Guerrero, F. and Jimenez, E.J. 2006. *Gestural Control using Laser Harp*", IEEE