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Introduction

This essay will detail the progress and development of my visual interactive live music project 'The Lazykit'. I will be going through the research which led me to make the decisions I did as well as discussing the troubleshooting and problems encountered along the way, and how I could improve the project in preparation for a commercial market. As well as the aforementioned I shall also discuss the similarities between my project and other products and the inspirations behind my decisions as well as the potential viability to release such a product within the commercial market.

Project Overview

The idea behind my project was to create a portable and compact rhythm based light show which can be used to accompany Musicians and DJs in smaller, more intimate venues, for live streams or even as a visual toy to keep in the studio. The current model consists of a rectangular box which holds a laser that emits a beam in parallel to two horizontal mirrors, one above and below. The laser reflects off of a mirror placed vertically at the opposite end of the box which is being pivoted by a motor. The laser then reflects off to the horizontal mirrors creating angular patterns which can be seen through the emissions of a smoke machine (see Appendix A for example).

The original concept has been developed from a personal use live show element for my own productions and work and slowly over the course of developing the idea as well as looking at potential fixes as well as market research evolved into a product which could hold a unique place within the larger commercial market and especially for up and coming musicians who do not have the budget or team behind them to create an interesting live show.

Process and Development

The initial thought which sparked the creation of this project started when looking at various instances of total internal reflection and how lasers reflect inside water and other materials such as acrylic (Freudenrich 2001). This then brought me to pursue the idea further and look at any ways in which this could be adapted to become an interesting visual element for a live performance. After researching the idea and looking at various laser based light shows and some home made DIY projects I found myself inspired to create something similar which could be manufactured and sold without the hassle of a client having to code and build something themselves. When looking at which materials would best display these effects it was apparent that any clear materials would emit ambient light when exposed to a laser meaning that I would have to adjust the project to utilize other forms of reflection (Sandlin 2019).

The process of acquiring the laser took a bit of research, as going into this project I had no clue or prior knowledge of what laser I would need nor the means to acquire them. The options I had available to me were quite various, looking at class 3 lasers which are the strongest

commercially sold lasers to acquire were typically sold as full laser pointers (Electronics Hub 2018). I was also able to acquire laser diodes which could then be linked up through an Arduino. But due to budgetary restraints I found it cheaper and safer to purchase a laser pointer and work around that instead of a custom laser diode and Arduino. For building and testing out a prototype the laser pointer turned out more useful as its mobility and ease of use proved much more beneficial in the development and directions of the project.

This revelation drew me to incorporate mirrors in my project as this would not only give a cleaner reflection but fix the issue with ambient light. Following this decision I began to draw out a blueprint of how it would work, including placement of the laser and motor and mirror combination. After studying and adjusting the blueprint I began to look at smoke machine's to increase the visibility of the laser. There were a few commercial compact smoke machines I could use for this and it gave me an idea to develop the project further to integrate its own smoke machine to truly make it an 'all in one' box. This idea while on brand with what I wanted to achieve proved too much for the budget and time frame for what I would need to bring that element into the project, therefore I instead opted for an external fully functioning smoke machine to demonstrate the overall idea (GetFogMachine 2021).

The mechanism designed to move the vertical mirror proved to be the most challenging to overcome as to achieve the intended results I would have to put myself to work with not only Arduino boards but familiarize myself with forms of code languages such as C++ (Circuito Team 2018). Starting with the motor itself and after liaising with John Nussey I came to the decision that a servo motor would best serve the purpose of what I wanted to achieve as I needed precision based motion for this project (Gastreich 2018).

Before I could begin work on the motor I would have to write code to get motor function as well as being able to have it sequenced to different beats per minute. I began by using a sketchbook code for a servo motor which was supplied by Arduino IDE which is an open source software designed to write code for Arduino boards. The original sketchbook code allowed me to move the motor 180 degrees continuously with constant motion (See Appendix B for example). The motor was connected to an Arduino Uno board via three jumper wires. The first was for the signal flow (yellow wire), the second for voltage (red wire) and the third was for grounding (brown) (cornelam 2016). Following on from this the next task in the project was to write up the code to move in time to various beats per minute. To help me streamline this process I collaborated with a friend who had experience with coding. After encountering a few problems and troubleshooting these issues we managed to build a working code which was able to read beats per minute and depending on the values input in the code could move the motor in tandem to every 2 beats in a bar or every one beat.

Now we had the motor working I could begin crafting the housing unit for the laser and mirrors. The box was made out of spare timber and measured out to have a height of 14cm, width of 44.5cm and depth of 9.6cm. Once the dimensions were measured out the timber was cut and assembled then left overnight to adhere with the mirrors cut within the box. The mirrors were made of acrylic to make cutting them into shape and size easier and decrease the chance of

damage while building the unit. Once the mirrors and the box had adhered I could work on cutting the space for the laser. The laser was housed at the other end of the box with a hole cut through the timber and mirror the same diameter of the laser pointer itself. The laser was then fed through and could be turned off and on by the laser's rotation. This was made possible by a block I had constructed where the laser would sit horizontally inside the block and through the rotation of the laser would apply pressure to the button meaning it could stay active. Once the laser was in place I could begin building the mirror and motor function.

I started building the mirror and motor function by cutting out a space for the arm to sit so it could easily access and pivot the mirror, I then began to drill holes at the top of the mirror and inserted old mini earring hoops to hold the mirror on a bar which was placed at the back of the box, similar to that of a shower curtain. Following on from this I inserted the motor back into the slot and tested out the function and after a few adjustments it began to work as intended.

Product Visual Aesthetic and Branding

I chose to approach the visual aesthetic of this project with a minimalist and angular design to allow the true intentions of the product to be on full display. This design choice meant I was able to keep the shape and colour rather basic which allowed me to focus on the mechanisms practicality and did not have to work around any constraints in terms of placement of the electronics (Hohenadel 2022). I also made the decision to paint the unit black to help absorb as much of the ambient light from the laser as possible (Bhamidipati 2019). When painting the unit I had realized the backboard of the box while painted black still reflected a lot of ambient light. So when it comes to making revisions on the product I would remove the backboard entirely which would negate a lot of that reflective light.

If I was to release this as a commercial product there would have to be some thought and consideration in how I would brand it, and after looking at what I want to achieve with this product as well as the potential target demographic I have opted to work on branding and aptly name the product "The Lazykit". Having it as a play on the word for lasers as well as my ambition for the product to be a hassle free laser light show kit for musicians. With the majority of the branding showcasing the apparent ease of use for musicians to start up their own custom light shows.

Showcasing the product to my peers informed me of the commercial viability of the product with some feedback saying "I'd buy one of those and keep it in the studio, be great when I'm having a mix" which is in line with what i wanted to achieve. Although many questioned the price point of which such a product would be at. So any further revisions would have to strike a fair balance between affordable pricing and quality parts to ensure such a product does not break easily and works as intended.

Troubleshooting and Problem Solving

During the building process of the project I encountered many problems and issues which led me to find workable solutions or has allowed me to better plan on what materials and methods I employ in the future. The first problem I encountered when building the unit was with the fame

itself. Once I had glued and left it to adhere I had realized that the wood had bent out of shape when adhering. To remedy this I used a sheet of acrylic glass in between the open frame to help hold the shape of the frame in place. This has led to me making the decision to potentially invest in the use of 3D printing the next time I build a variation of this machine. This will allow me to not only have better control over the dimensions of the product but alleviate the time spent on building the frame and any other potential construction issues allowing me to spend more time on other materials and fixes (Makerbot 2020).

Following on from the previous issue I had also noticed that when letting the mirrors adhere to the frame, the reflective material used in the mirrors started to bubble and erode due to the adhesive used. As by this point in the process I had the pieces together it would be difficult for me to disassemble or start again so a workable compromise was made to place new mirrors over the top of the old ones and reduce the size of the overall laser effect. Similar to the previous solution I feel that 3D printing would help solve this issue as I could instead build the frame to have holsters where the mirrors could be slid in and out fixing the need for any adhesive and further reduce the risk of damage to the mirrors.

Issues with the electronics were prevalent when building the project, most notably coding the motor to move to exact beats per minute. These problems included the inability to read decimals of milliseconds. For instance I coded the arm to move at 128 beats per minute which meant I had to know the time spent in between each beat which after some calculations was 468.75 milliseconds (studioslave 2018). This number caused an issue when timing the motor as C++ was struggling to time the space in between the decimal numbers which caused the motor to slowly go out of phase to the music. The first attempt at troubleshooting began with writing a new code to reset the motor loop every 4 beats so it would go back in phase but this proved to produce no valid fixes. Following this I ended up employing the use of a function called TimerOne (Arduino 2018). This allowed me to attain finer control and motion over the pulse width modulation and was able to periodically interrupt the motor function allowing me to reset the loop in time with the music (Arduino 2005). Looking at the motor function in hindsight I would instead next time acquire a microphone and link that into the circuit. I would then write code for the motor to trigger when certain frequency bands are picked up by the microphone therefore eliminating the need for rhythm sensitive motor functions and allow the product to be used with a wider variety of music genres as well. This decision could potentially widen the market for such a product.

While assembling the unit, I also encountered another problem with the motor. The original motor I had acquired was a Tower Pro SG90-HV servo motor which is built for continuous 360 degree rotation. While being able to do the requirement of pivoting the mirror it proved unreliable to rotate back and forth as this was not its intended design. I encountered various coding issues all which ended in either the motor continuously rotating 360 degrees or with the correct motion but came with a noticeable delay time. This brought me to perform more research and discovered I would need a different model and chose the model SG92R which was designed for 180 degree rotations. This solved all the previous issues of noticeable delay and continuous rotation and allowed me to continue work on the rest of the project.

Following on from the motor and its coding I could now work on getting the motor and mirror mechanism working together, but this too had me encountering many problems which had me finding ways to work around these issues. Starting with how I could get the motor to pivot the mirror. My initial idea was to employ the use of something similar to that of a lever going from the motor to the mirror, similar to the wheels of a locomotive train. But due to sourcing the parts and scale of the project I could not find parts of a suitable size for the project. Instead I focused on building this prototype to work by any means and so I built it to be held on by two hoops which were then knocked by the motor arm creating the motion of the mirror reflecting. While this worked it did bring up an issue where the mirror would scrape and get stuck on the mirror below it and would totally cut the rhythm loop as the mirror couldn't be reset in time for the next motor function to occur. Another problem I found when creating this mechanism was the motor itself hitting the mirror caused too much knock back and looked rather lacking in its motion. This rather disappointing issue had confirmed my thoughts that I should next time make sure the mirror is connected to the motor directly as this one fix would solve both issues to ensure precise motion between the motor and attached mirror.

Having a smoke machine in the vicinity was integral when testing out the project as I needed to adjust the laser trajectory and mirror placement frequently. As I tested out the repeating reflections of the mirror I enounced an issue where the laser would over time and with each reflection start to dim and diminish in its power. This was due to the nature of reflections as mirrors are not perfectly reflective and so the light reflecting would lose power with every reflection as the reflective material would absorb some of the light energy as well as the glass in front of it (Naked Scientists 2012). This situation made me reevaluate the scale and possibilities of my project as I would now need to either employ more lasers or less reflection which would in return totally change the build and viability of my product. The next revision would allow me to experiment with smaller builds which in the long term could potentially be more cost effective.

The current state of the project is powered by usb via the Arduino board, the laser being separately powered by battery and the smoke machine directly by the socket. For the current state of the prototype to showcase the product this is not an issue but upon any further revisions I would need to work on streamlining this connection as well as building an internal smoke machine within the product as this is an important feature to showcase the effects and needs to be easily accessible for the consumer.

After encountering these issues the next revision would include a connected class 3 laser diode powered by an Arduino board, a microphone which would pick up set frequency bands and then trigger the motor to rotate upon hearing the set frequencies and an internal smoke machine which can be activated by the user. On top of this I would also look into the structural design, making it more compact and built out of a different material which would ease the process of testing leading up to a potential release.

Comparison to Existing Products

The inspiration behind this project began when studying the live shows of acts such as Deadmau5, Feed Me and Eric Prydz, who all have visually impressive and entrancing visual elements which are synced up and sequenced to their music. When studying Deadmau5 and his live set I discovered he implements the use of a rotating cube laced with LEDs which when combined with the rest of his show create insane and extravagant imagery (Sheffer 2019). After looking at Feed Me and his With Teeth live show I learned that his project was based around the idea of his logo and has created a stage show that has light panels and LEDs which when together look like an evil grinning face (Gooch 2012). Eric Prydz has the most advanced and encapsulating live show, employing the use of AI technology, 3D visual effects and high resolution imagery which are all controlled live with no pre-sequenced material (LIVEDESIGN 2018, Prydz 2018).

While studying these live shows and what they can offer it was important to bring my project with the same creativity yet with a completely different mindset. Making the project affordable and realistic for the up and coming musician, the idea was to give musicians who would not be able to afford that level of stage production a starting point to build and construct their own show. While researching if there were any commercial products similar to what I wanted to achieve I could only find either basic laser machines which would produce random imagery or smoke machines with basic lights. I could not find any products that brought the middle ground between a basic light show and the creativity that a custom stage show could bring. The only few instances of ingenious custom built laser shows were when I took my research to Youtube where then I could find a few people who had used similar practices as me, using Arduino to create laser shows. It was this level of creativity I wanted to bring to a commercial market without the consumer having to learn the accompanying skills that they would typically either need to learn or employ to achieve.

Following on from this research I saw a gap in the market which this product could potentially fill. While this product as a base model only employs one visual effect there still are plenty of other laser light effects which could be used. The realization of this has informed me of the potential to build the project into a product which allows you to buy attachments for the base unit allowing the user to build up their custom live show with various effects which work together which will alleviate the need for a musician to employ various light show effects and engineers.

Conclusion

The original project has gone through many iterations of which has evolved from being a private custom laser show for my own events and productions to a compact package light show for musicians to employ and build their own sets with the potential to develop it further through paid attachments extensions to the original product.

The troubleshooting encountered along the way has educated me immensely towards the dedication, budget and skills required towards building a product from the ground up which will influence my negotiation, teamwork and market awareness of any future projects and collaborations as well as my willingness to perform deep research and planning of any future projects before I begin building prototypes.

With the base idea for the project coming together through rigorous trial and error, the end result has proven that there is potential for an interesting final product, and after a few more revisions to streamline the features and build I am confident that such a product could exist comfortably somewhere in the commercial market. That being said, where exactly in the market I am not sure but through extensive focus groups as well as surveys the results could direct in which way the product is brought to the forefront as either a commercial product or a unique live element for music performances.

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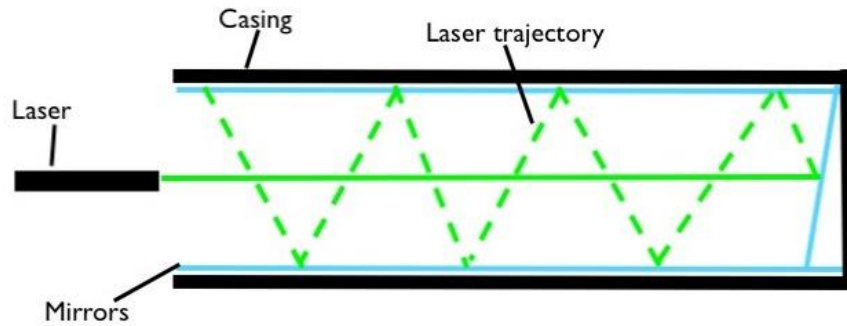
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Appendix A



Appendix B

```
// Include the Servo library
#include <Servo.h>
// Declare the Servo pin
int servoPin = 3;
// Create a servo object
Servo Servo1;
void setup() {
    // We need to attach the servo to the used pin number
    Servo1.attach(servoPin);
}
void loop(){
    // Make servo go to 0 degrees
    Servo1.write(0);
    delay(1000);
    // Make servo go to 90 degrees
    Servo1.write(90);
    delay(1000);
    // Make servo go to 180 degrees
    Servo1.write(180);
    delay(1000);
}
```