EEL 4914: Senior Design 1

Project Descriptive Title: Handheld Color Sliding Game

Group Number: Group 24
Group Members w/ Major:
Josh Bell - Computer Engineering
Eric Espinosa - Electrical Engineering
Linus Fountain - Electrical Engineering
Customers / Sponsors / Significant Contributors: N/A

Section 1: Executive Summary

As a group we have realized a steady decline in the standalone handheld game market. Over just the past year there has been an 11.5% decline in sales of these types of electronics [1]. This comes as no surprise as most of the target audience for this product may have gone to other game devices such as video game consoles like the Nintendo Switch or maybe a Playstation console. However, as a group we remember from our childhood playing with a vast majority of handheld devices such as the Bop It. Our device is an attempt at attacking this market head on and challenging ourselves to create something that will be well received by a large number of consumers.

Our handheld color sliding game aims to bring this type of game back to life. To do this we hope to have a final product that has a sleek design, sound mechanics and most of all, challenging and rewarding gameplay. To begin this journey we are forming this technical paper that we will use as guidelines and goals that we hope to achieve over the course of this project. We will expand upon this paper as we continue to work towards our final product while simultaneously researching and developing components we will need. After we acquire these components we will have to test our initial design and redesign where it needs to be done. Finally, when we have our final design we will fine tune and make final changes that we believe will provide the best experience for the user.

Section 2: Project Information

2.1 Project Motivation

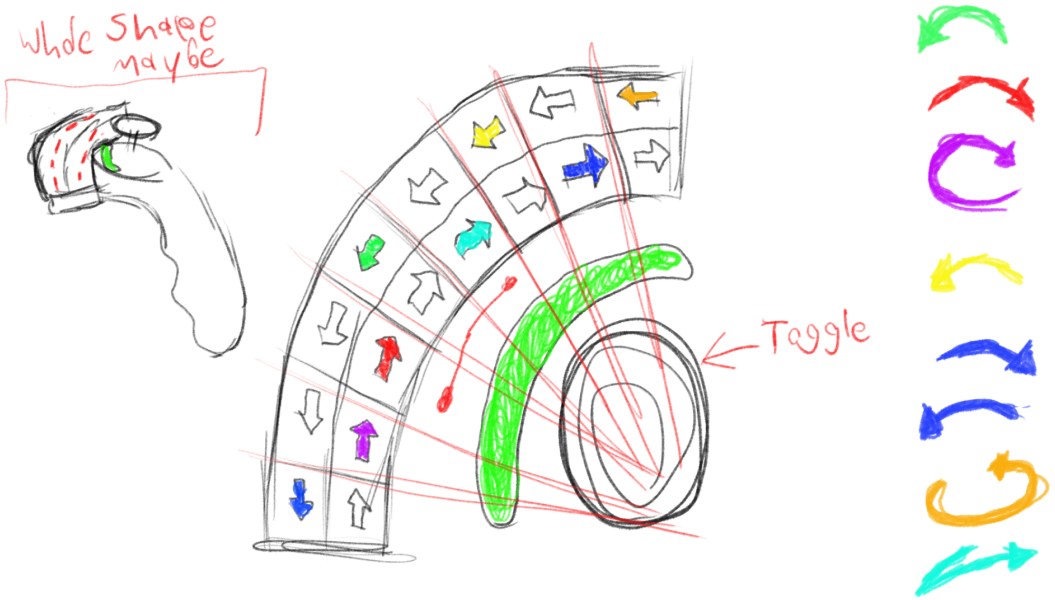
From the start when forming our group, we have made a unanimous decision that we wanted to create an idea that promises enjoyment for consumers, but also ignites our own excitement and passion for something to work on and develop. For all three of us, we grew up in an era of rising technology and games, where there was always something new and developing every week. This is an area that we all enjoy and are familiar with, so we agreed to look into this direction for our project. We took inspiration from our childhood, and desired to generate our own new and unique game. Our project design is something we believed would be compact, entertaining to use, and comfortable to grip for the consumer. Especially those familiar with more modern day consoles, such as the Nintendo Wii, Nintendo Switch, various arcade machines, and virtual reality(VR) gaming. Furthermore, our design is also user-friendly and comprehensible to individuals of all age groups. We regard this project as a valuable evaluation of our existing skill set, while also serving as a means to expand upon and acquire new abilities.

2.2 Project Description

As a group, we have collectively embraced the concept of a handheld physical, mechanical game. This innovative system boasts a sleek, ergonomic design resembling a hand grip, complete with a convenient toggle thumbstick positioned on top. When the game commences, 8 random colors and directions spanning from left and right on top of the system. A central LED near the

toggle corresponds to one of these 8 arrows and colors, informing the user of their current target. To advance in the game, the user must manipulate the toggle in the direction past the lit up LED, that is of the same color as the central LED, and direction of the arrow. When the user moves the toggle past the correct arrow zone it will be marked as complete and the LED will turn off. Then the central LED will change the color to the next target. Once all arrows have turned off, the game will restart with less time to complete the new game. A dedicated display will showcase both the remaining time and the user's high score, which will showcase their progress.

2.3 Design Sketch



2.4 Project Market Analysis

We have looked at comparable devices that are already in stores such as the game Bop It, Rubiks Revolution, and other games that have similar properties. While looking at these games and their sales history we have found that similar type games have accounted for 4 billion dollars worth of sales over the course of 2022 which is identical to the previous years sales as well as up half a billion dollars from 2020 [1]. We believe that there is plenty of room for a competing product to join the market as the type of product we are designing only takes up about 7.3% of the current toy market, leaving only room for growth with the insertion of a new product. Compared to the Bop It that is currently selling between $12 - $44 and the Rubiks Revolution that is currently selling at $20-$22 we think that hypothetically we would be able to sell our product for $35. While this is greatly below our estimated total cost of production we think that if we were to mass produce this there would be much room to bring the total cost of production down well below the $35 price point.

2.3 Project Goals

Our primary goal for this project is to create and design a completely functional, handheld, mechanical game that promises entertainment and is easy to use for a wide spectrum of consumers. We want this device to have a screen consisting of 8 sectional LEDs that will be used for the gameplay itself. On these 8 LEDs we will have colored arrows, each arrow will light up a specific color. For this to be a stimulating and fun experience to the consumer, we would like to have a central toggle with set zones for each arrow to be able to determine the path the user goes. We would also like to have a speaker that will play a timer of sorts, so the user knows how much time they have left for each level, and some feedback music that plays once you pass an arrow. Once the user fails, we will have a system to keep track of the high score to provide a challenge for the user, so they can keep pushing themselves to beat their score, or invite a friend to compete with them. If time provides and we are able to, we would like to have a fully programmable screen for the arrows, instead of plastic with LED underneath, that would allow us to program arrows to go in either direction. This would allow us to customize the game more, and diversify each round to provide a better experience to the consumer. We would also like to have the main screen have a scrolling text system that would allow us to present messages such as “game over” or “new high score!”.

2.3.1 Project Objectives

- Program the LEDs to switch between a variety of colors
- Program the device to keep track of time and high score
- Design a UI
- Ensure thumbstick control works and is responsive
- Have speakers to play audio for timer and sound effects
- Assemble device and test functionality

2.3.2 Advanced Goals

- 3.5 mm headphone jack
- Fully programmable screen to have arrows going either direction
- Add difficulty option

2.3.3 Stretch Goals

- Scrolling text across the main screen to show high scores ect.
- Bluetooth capability
- Phone connectivity
- Highscore Leaderboard

Section 3: List of Requirement Specifications

3.1 Functional Requirements:

The functional requirements this game project must have is being able to start and pause the game. LEDs should provide visual feedback by showing the current color target on the main LED, and the targets to hit on the main board. A mini LCD screen that displays game related information, such as the highest score, a timer, and pause/start, and scores should be updated in real time. The device has to be user friendly, that is comfortable and easy to use. It should have a functioning toggle joystick that operates for our intended use to control the game and menu. It should be responsive and provide feedback to the user. The game should have a difficulty or progression system. Where from the start you can pick your difficulty, or if level based, then when you beat level 1, you go to 2, etc. This way the game can keep being enjoyed, while also challenging the user to progress and get better. A nice requirement to include is some type of feedback, whether it be physical, audio or visual. The feedback can include the thumbstick or controller vibrating to let you know when you have passed a color. An audio that plays when you pass a color, or beat a level. Or visual, if we do an LCD screen we can display text on the screen to inform the user of certain actions.

3.2. Technical Requirements

The type of LEDs that we're thinking of using, would be an assorted color set of 5mm or smaller, that way we can implement them into the microcontroller unit. If we use an LCD screen rather than LEDs, it would be a small 4-5 inch x 1-2 inch screen, and a mini LCD. The LCD on the main display, would display the arrows going left and right, as well as give the arrows the color needed for the game. It would also display a type of cursor that moves in the direction you are choosing, to let the user know which direction they are going so they do not get lost.
The cursor is updated in real time, without delay to ensure a smooth experience for the user. The mini side LCD screen will display the menu at the start of the game, which will have a start option to start the game, a high score option to check what the highest score is on the device, and maybe a volume option to control the volume. When the game starts, the side LCD screen will display the current score of the game, and a timer that counts down to showcase how much time the user has to complete it. For the microcontroller unit, we were deciding between using something like the MSP430 or an arduino kit, since we are most familiar with C, C++ and Java. The device will be powered by 2 AA batteries, but a rechargeable power source is being considered in order to avoid electronic waste of having to replace the batteries every so often. It will have built in speakers and will either have a switch or button to power the device on, and it might have a volume slider depending on how we decide to control the volume, whether it is physical or digital. The device might have an audio jack or bluetooth option, but it is not really needed so these features would be added towards the end once we completed our main goals and objectives. The controller would use non-volatile memory, in the form of an electrically erasable programmable read-only memory(EEPROM) or non-volatile RAM(NVRAM) in order to store score data and high score information. This type of memory is used in arcade games and pinball machines, as it is essential for maintaining records and will save the data even after turning off.

3.2.1 Engineering Specifications

Prototype Dimensions	6” x 7”
Projected weight	~ 600 grams
Screen Refresh Rate	~ 30 HZ
Screen Resolution	**128 x 64 pixels per panel**
Audio Output Power	
Battery life (AA)	2+ days for AA batteries
Charge time	~ 7 hours for rechargeable battery
Power Consumption	TBD
Controller Feedback	**Using haptic technology**

Figure 2.2.3 Technical Specifications of device

Listed above are specific engineering specifications we plan on meeting for our final design. Due to the limiting factor of time when demonstrating our final product we will not be able to display things like power consumption and battery life. However, three components we will be able to demonstrate are controller feedback, audio, and screen resolution which are bolded above.

3.3 Project Constraints

Building and designing this device comes with certain constraints and limitations, some of those are as follows. One of the constraints is resource limitation. Due to ongoing events, such as the chip shortage, we might not be able to find certain needed parts. Therefore, we have to use what's available to us, in the market, at the moment. Another constraint is our supplies and materials not arriving on time, due to shipping times, Florida storms, or other travel related issues. In order to offset this constraint, we will order the parts needed as soon as possible, because the earlier the better. Some other issues might occur, such as receiving defective parts, or parts malfunctioning during the project. Our solution to this is to order double parts on components we think might have some issues. Due to the size of the design, there might
be some size and weight constraints that can affect our project. We might have to increase the size, decrease the size, or adjust certain areas in order to fit the parts. There can be battery constraints as well, relating to size, we have to adjust or make space for the battery source, and ensure our device has a lasting battery life.

Section 4: Block Diagram and Designs

Shown below in figures 4.1 and 4.2 are the block diagrams detailing how the hardware components and software components of our project will be set up. All the hardware components will be acquired over the course of the semester. At the moment of writing this paper we are in the process of deciding what specific components we need in order to ensure minimum problems down the road. As for the software block diagram we are currently laying the foundation of how we think the programing for this product will look and what specific functions we may need. We believe we will need to break up each panel into “zones” so that way we can keep track of the toggle. Doing this will then allow us to have a checkmark system that we will use to keep track of the users pathing. The idea is that the user must move the toggle through the arrow in the direction it is facing, going through the zone before it, through the arrow, and then through the zone after it. Having the zones allows us to check to see if all three zones are hit in the desired order. After the zones have been checked off in the desired order we will have a counter of how many arrows have been cleared for this stage. Once the number of arrows cleared and the number of starting arrows lit up are equal, the stage will be completed. This will then repeat for each level. If the player fails to complete the level before the timer finishes then the system will check if there was a new high score by comparing the current score with the stored high score. If there was a highscore then the new value will replace the old one and the system restarts to the beginning allowing for a new game to begin. If there was not a new highscore then the system will fore-go updating the high score and restart in the same way. While the user is playing we will keep track of the level they are on by simply incrementing a counter.

4.1 Hardware Block Diagram

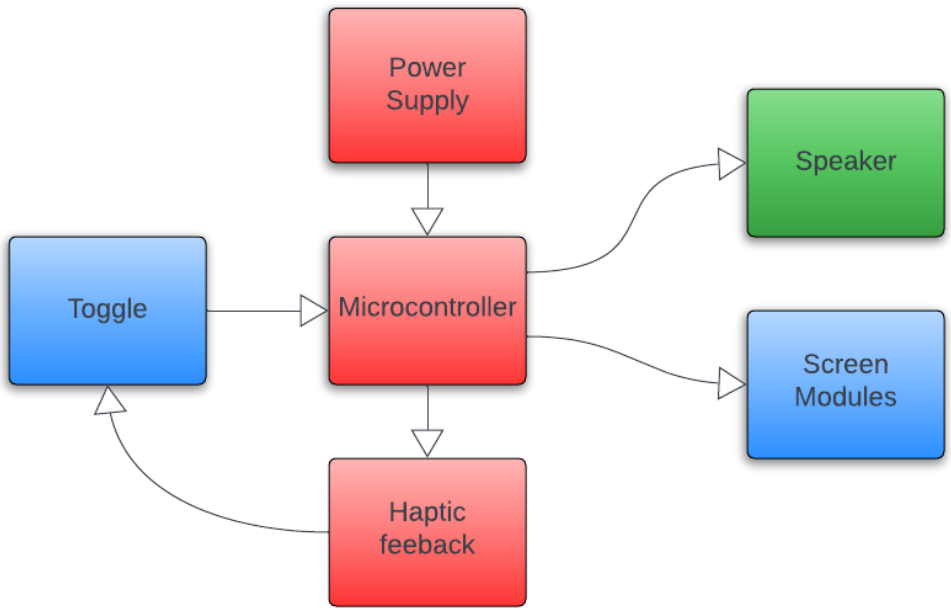


Figure 4.1 - Break down of all input and output components to be installed

4.2 Software Block Diagram

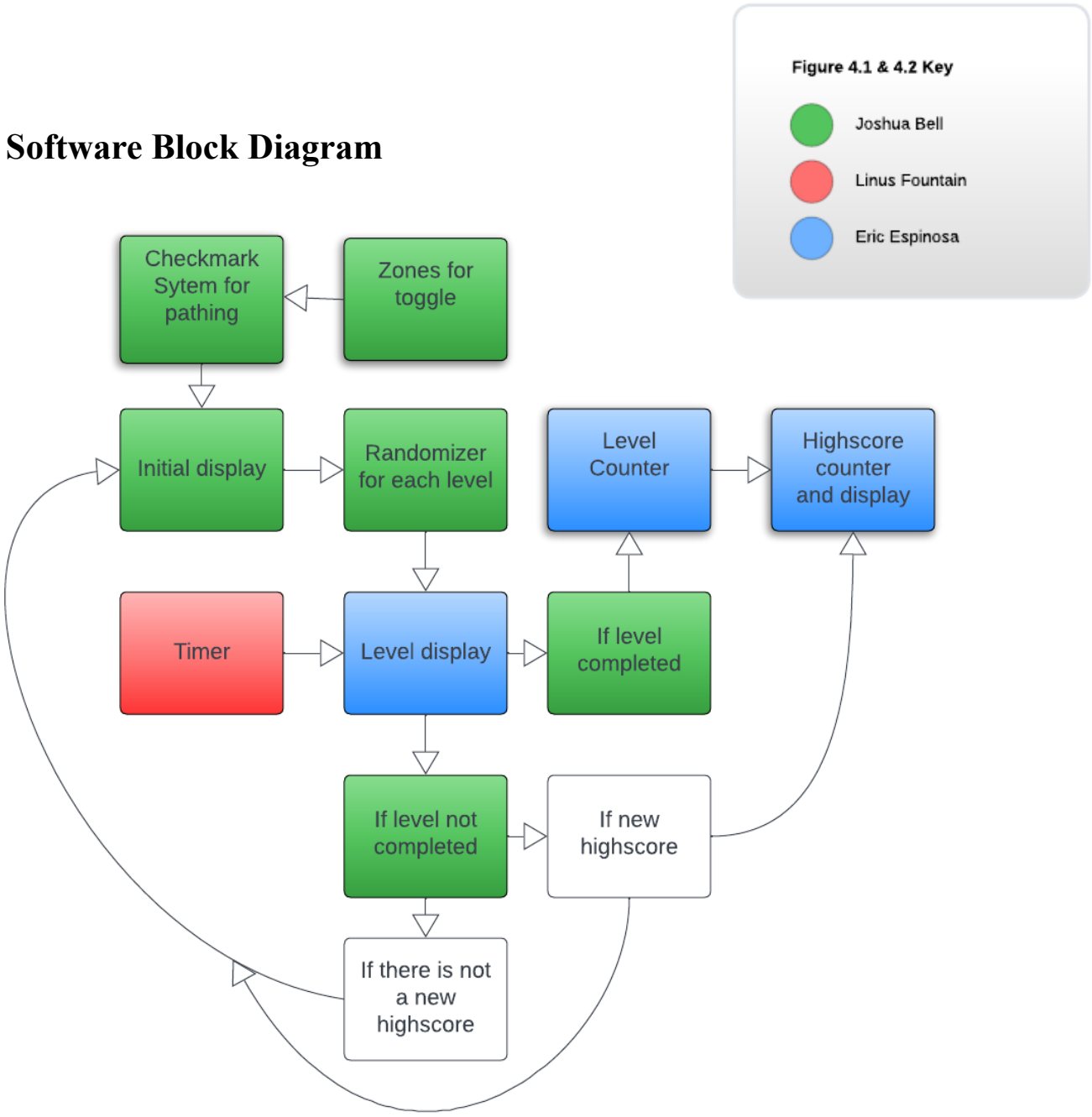


Figure 4.2 Software Block Diagram - Break down of different programing requirements needed

Block Description	Group Member Assigned	Block Status
Power Supply	Linus Fountain	In progress
Haptic feedback	Linus Fountain	In progress
Toggle	Eric Espinosa	In progress
Screen Modules	Eric Espinosa	In progress
Microcontroller	Linus Fountain	In progress
Speaker	Joshua Bell	In progress
Zones for toggle	Joshua Bell	In progress
Checkmark System - pathing	Joshua Bell	In progress
Initial display	Joshua Bell	In progress
Highscore counter and display	Eric Espinosa	In progress
Level Counter	Eric Espinosa	In progress
Level display	Eric Espinosa	In progress
Timer	Linus Fountain	In progress
If level not completed	Joshua Bell	In progress
If level completed	Joshua Bell	In progress
Randomizer for each level	Joshua Bell	In progress

Figure 4.2.2 - Represents who is assigned to acquire the component or complete the task. As well as the status of the component or task

4.3 House of Quality

Correlation matrix	
+ +	Strong positive
+	Positive
–	Negative
– –	Strong negative
	Not correlated

Relationship matrix		
◉	Strong	9
○	Medium	3
△	Weak	1
	No assignment	0

	Customer importance rating (1 = low, 5 = high)	Percent of customer importance rating	Weight	Cost of production	Expected life	User Interface	Speaker	Battery	Competitor research: Bop It	Competitor research: Rubiks Revolution		
Ease of use ▲	5	30%	○		△	◉	△	△	5	2		
Weight ▼	4	25%	◉	○			△	△	2	2		
Battery life ▲	3	20%	△	○	◉	△	△	△	4	2		
Size ▼	1	10%	◉				△	△	2	3		
Screen quality ▲	2	15%	○	○	◉	○		◉	N/A			
Importance rating			5.0	1.8	3.8	2.6	.8	2.6				
Percent of importance			50%	12%	38%	26%	8%	26%				

Figure 4.1

Displayed above is our house of quality. We wanted to make a conscious effort to show that we want this device to be portable and easy to use for everyone. It is easy to see this by our ease of use being our highest rated standard with the weight being right behind it. We also want to make sure that we do not forfeit overall quality in order to do this.

Section 5: Budget and Financing

Item Description	Quantity	Total Estimated cost
Display	**1-2**	**$45**
Toggle	**1**	**$10**
Speaker	**1**	**$10**
Controller (casing)	**1**	**$35**
Printed Circuit Board	**1**	**$50**
Microcontroller	**1**	**$20**
Total estimate		**~ $170**

Figure 5.1 - Estimation of total product cost

Section 6: Project Milestone

Task	Complete by date	Status
Project discussions	August 25th, 2023	Complete
Project Decision	September 4th, 2023	Complete
10 page Divide-and-Conquer report	September 15, 2023	Complete
Component research and decision	September 28th, 2023	In development
PCB research	October 12th, 2023	In development
Bill of Materials	October 20th, 2023	In development
Table of Contents	October 28th, 2023	In development
60 Page Documentation	November 3rd, 2023	In development

Final 90 Page Documentation	December 5th, 2023	In development
Obtain parts	During winter break starting December 2nd, 2023	In development
Senior Design 2	----------	----------
Individual part testing	N/A	N/A
Assembly	N/A	N/A
Full testing and redesigning	N/A	N/A
Final testing	N/A	N/A
Presentation	N/A	N/A

Figure 6.1 - Estimation of milestones until finish

Appendix A - Sources and references

[1]
https://www.toyassociation.org/ta/research/data/u-s-sales-data/toys/research-and-data/data/us-sales-data.aspx