PROJECT 3: HANDHELD RETRO VIDEO GAME CONSOLE

From February 13, 2023 to March 29, 2023

ENGG 200: Engineering Design, Innovation and Entrepreneurship

Group B1

Xavier Lachance
Bella Jang
Nuha Machhiwala
Isabel Luck

Instructor: Dr. Giuseppe Rosi

TABLE OF CONTENTS

1. Executive Summary

The goal of this project is to create a retro portable video game, which entails designing, putting together, and programming a gaming system that mimics 1980s video game consoles. This must be built within the constraints of the few materials provided, the five-week time window, and the range of team members' skills. In order to achieve this, the problem was reviewed and restated to be more clearly defined for the particular group, potential restrictions were evaluated, many solutions were formed and developed, and ideas were gradually reduced through group consensus. Testing and member communication was essential in the process of developing a final product.

Through this process we narrowed down the many ideas our group presented to the ‘snake game’. We completed this game using only materials from the Elegoo arduino mega starter kit and using 3D printing as the case to enclose our electrical components. The materials used in the kit were the power supply, joystick, buttons, LCD screen, lights and various cables and resistors and with testing and clear communication, we produced a user-friendly, retro handheld game, complete with a highscore board using these separate components.

Ultimately, the completed "Snake Game" is playable and practical. The hardest part was figuring out how to code the highscore board and keeping the memory of the score.This challenge forced the team to depend extensively on the educational materials that were at our disposal. The solution to this issue was sustained help from the group and technicians. Future projects can use this strategy of utilizing a variety of sources and resolving every problem with team members to achieve a high level of success.

2. Introduction

The gaming console is the last project for this ENGG 200 course that students must build. The assignment was to create a retro handheld video game to develop over the course of a month by utilizing project management, engineering, programming, entrepreneurship, as well as using various software applications such as Fusion 360. In completing these tasks, we were able to put the abilities that were emphasized in the course sessions into practice in our future careers as engineers. This project was meant to incorporate elements like the project management segment, the application of the design process, safety considerations, and efficient student communication. Students were able to gain practical experience in technical constructing and designing through the game console project.These were then applied to actual life scenarios that future engineering projects would present. The "snake game" mini-arcade was our group's solution to the challenge of the project.

Gaming enthusiasts and regular consumers can both enjoy this dynamic and thrilling single-player game. Growing the snake using the dots and not running into the snake's body are the only requirements to win the game.

3. Design Specifications and Constraints

The group must create a game console which can be turned on and off by a power button. This game console must be hand-held and portable, while running on an Arduino mega. One important aspect is to ensure no loose wires are exposed, meaning all electrical components must be encased. The deliverables required for this project are a physical 3D model for the game console and the C programming codes for the game and all the electronics we need in order to make the game console work properly.

This project has several restrictions (limiting factors) that must be evaluated and analyzed before the design process begins. This project's restrictions are as follows:

1. Members of the group must adjust their schedules to accommodate the work for this project.
2. Limiting purchases of non-recyclable materials and tools to recyclable materials and

those included with the Elegoo Arduino Mega starter kit.

3. Each group members' level of expertise during the game development process.
4. Group members must complete all needed deliverables (digital and physical) by the arbitrary deadline (week of March 29th).
5. Requests for 3D printing must be fulfilled "no earlier than one week." Coupled with the MakerSpace's 15-hour time limit for 3D printing.

4. Design Process

In the Design Process, the group had various approaches and ideas about the project and how it should be completed. That includes background research on the limited supplies(arduino kit) given and how we can use them in our design, design ideas of the product, sketches, and presenting a prototype of the product to resolve possible constraints.

After deciding on choosing 'Snake' for the project, the group worked on meeting the requirements of the final product by using the supplies provided to us in the ELEGOO Arduino Mega Kit, accompanied with the tools needed in the Makerspace in the ENG building on campus. The group also worked on mitigating conflict by assigning certain roles and tasks to the members that were the best fit for them.

Our group has made a prototype of 3D design using program Autodesk Fusion 360:

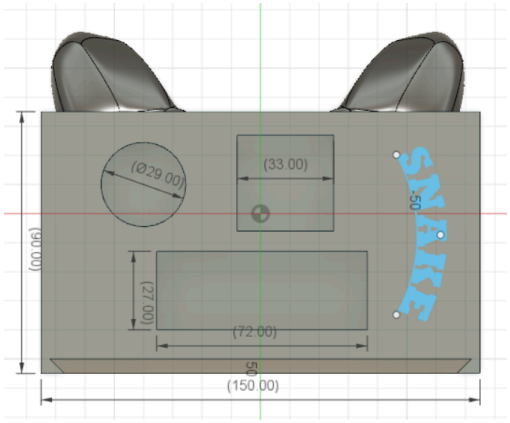

Figure1:

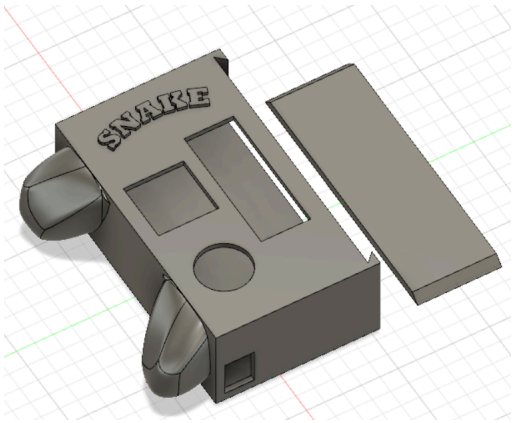

Figure2:

As shown in figure 1 and 2, the main body of the product is made of a rectangular prism and handles, with the dimensions indicated in the figure1. It also includes a sliding door to access for replacing the battery and all the electronics. In figure 1, there's a hole for a joystick with radius of 29mm, square hole for the panel with dimension of 33mm, and rectangular hole for a score screen with length of 72mm and width of 27mm. Two handles are attached to the rectangular prism for the convenience while playing the game. While a person is holding a game console, they could easily rest their hands on the handles. Form method from Fusion 360 was used to make the shape of the handle.

4.1 Problem Statement

The group's ultimate design objective of Project#3 Handheld Retro Video Game Console is to have the ability to transport the console with ease, while also maintaining the option to access the internal components with little effort. Another key component that is required is an on and off switch that is accessible at all times.

4.2 Design Alternatives

In case of the inability to use our decided 3D print design, due to the slicing problems, the group has come up with an alternative design for the encasing, which did not present an error in the PrusaSlicer program.

5. Building Process

Process of assembling the wiring:

All of the wiring was completed using the Elegoo Documentation PDF on D2L. Wiring the Joystick, 8x8 Led Matrix, and LCD1602 was all done following this documentation and using our intuition.

Process of creating the code:

This snake game code was created following 2 tutorials on YouTube, the first being: Chaker Gamra (Enjoy Mechatronics) who has an open GitHub with multiple amazing tutorials on Arduinos and C/C++ in general. However, this tutorial produced a code that had some issues, which is where the second source of the Elegoo Official YouTube channel came in. They created an Arduino snake game that was controlled by an accelerometer. Comparing the open source Elegoo Official code to the code the team had created following the tutorial, we merged them together, creating this final product. Using the Elegoo Official code as a base to control our game, we changed the input values to be values based on outputs from the joystick instead of the accelerometer. Chaker Gamra's GitHub page was a huge help as he had multiple game examples of how to take direct left, right, up, and down inputs from the joystick. After we had a functioning game, The next step was to create a current score and high score screen. This was done following the basic Elegoo Documentation PDF found under Week 6 of the D2L page content. Using the basic functions taught to us in the documentation, the team now had a working LCD1602 which displayed (High score:) on the first line and (Current score:) on the second line. The next step was to print the corresponding variables in place. Current score was easy to implement as all that was needed was to subtract 2 from the length of the snake, as the snake started off with 2 spots in the array and added a spot each time it ate an apple. However, the high score option was slightly more complicated. After looking through several documents on how to write integers to EEPROM, the team finally settled on a specific way to write to EEPROM. We looked into converting the integer to 2 bytes (16 bits) and storing it that way, but implementing this concept proved to be quite difficult. Mostly using the tutorial from Maker Pro's Arduino website, the team tested multiple different ways and reached a consensus on which was the best method. This method of just directly writing instead of converting to bytes and back into an integer proved over and over again to work flawlessly. Now we had a working high score tracker. The entire game was ready. We created a second version of the game, implementing the joysticks push input to erase the current high score. This version was planned to be our final version, however, we decided that we should just use the version with a permanent high score. This allowed us to have a "dev version" of the game, where we would check for bugs and ensure that everything worked flawlessly.

Issues:

Coding Issues:

The first coding issue we ran into was the speed at which the snake game proceeded. We had no issues developing the game, apart from the occasional bug which was fixed by merging the 2 codes together. This speed was fixed by recreating how the arrays update. This was done by adding a new function called CalculateDeltaTime, which calculated the difference between the last instance the time updated and the current time, returning this value as a float, which is added to "timer". Then we created a check to see when the timer reaches 1000. However this was later changed to be 1000/updaterate (a new variable) as changing the timer worked but had its issues, so instead we decided to change the update rate as this allowed the game to work faster and smoother. This acted as a "refresh rate". One of the other main problems we ran into was that when the current score reached 2-digit numbers, when the game reset it would continue to display the second digit as the screen was not wiped and the first number was the only one updated. This would cause the display to show the score and a value at the end of it. This was an easy fix, all that needed to be done was wiping the screen and rewriting all the values onto the LCD1602 when the snake died.

Wiring Issues:

The main wiring issues we faced was being short on male to female wires as we needed a total of 22. Luckily for us, one of the other groups provided us with 3 extra wires allowing us to complete our desired wiring. Our backup plan was to solder some wires directly onto the screen which would have worked but been a little more difficult. The second issue was fitting all the electronics inside our casing as we had limited room with a lot of wires and a breadboard. While assembling the console, the breadboard would not fit into our casing, therefore we had to move all the wiring and the potentiometer onto the smallest breadboard, which proved to be quite the challenge, but we completed this successfully and all of our electronics were enclosed nicely, more organized than we had originally planned.

6. Game Evaluation


The game works extremely well, it is easy to move the snake using the joystick and the design of the game console is very comfortable to hold. The game console has handles and the edges on the back of the product is sanded down so it doesn't cause discomfort when holding. The joystick is positioned to the right which is great for most people because most people are right handed but it will be harder for left

handed people to play this game because of the position of the joystick. We would suggest that there are two versions of the game console, one that has the joy stick to the right and one that has the joy stick to the left so it is inclusive and easily playable by both left and right handed people.

The positioning of the actual screen is good and centered because it catches your attention, it is easy to focus on and off the high score board screen doesn't distract the player. The positioning of the on/off switch is also good because it is out of the way of the player's hands which makes it nearly impossible to accidentally switch off whilst playing the game. The 'Snake' lettering on the console is also very visually appealing and helps the player identify the game immediately. Another pro of this game is how easily the top of the game slides out which makes changing the battery if it dies and fixing electric components very accessible. The high score board is also a benefit because it creates some competitiveness and motivation to beat the score. This board is also visually appealing.

A con is that the high score board and joystick are not 100% fitted in the area given for it by the 3D print. There is a small gap at the top and to make this more visually appealing we can improve the dimensions of the gap for the high score board.

7. Conclusion

We intended to create a retro snake game console and were successful.Working together to tackle problems worked very well for us and allowed us to achieve our end result.

The project was successful overall in that our group built a vintage portable game console, but there are a few suggestions for future projects to assure a high degree of success in a concise manner:

- acknowledging the time in connection to each team member's responsibilities
- Analyzing the dangers involved in assigning a group member a task they lack the necessary expertise.
- juggling personal and work obligations
- In order to guarantee that team members don't forget about their personal time, designate each member a suggested time window for future initiatives.

Finally, our game meets all the requirements,is very user-friendly and is aesthetically pleasing. It is a suitable game for all ages and the difficulty increases the longer it is played.

8. Bibliography

ELEGOO Documentation PDF V1.0.17.7.9 :
https://d2l.ucalgary.ca/d2l/le/content/499798/viewContent/5773922/View

GitHub Chaker Gamra Coding Tutorial:
https://github.com/Enjoy-Mechatronics

How to Permanently Store Data on Your Arduino, MakerPro, Daniel Hertz:
https://maker.pro/arduino/tutorial/how-to-permanently-store-data-on-your-arduino