GNG 2101

Design Project User and Product Manual

Adaptive Play- Group F 2.3

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Table 1. Acronyms

Acronym	Definition
BMC	Business Model Canvas
DFX	Design for X
BOM	Bill of Materials
MDF	Medium Density Fiberboard
ABS	Acrylonitrile butadiene styrene
PCB	Printed Circuit Board

1 Introduction

This User and Product Manual (UPM) provides the information necessary for individuals with disabilities and future design teams to effectively use the Adaptive Play adapted Nintendo Switch controller and for prototype documentation. The adapted Nintendo Switch Controller is a unique device with the potential to make a significant positive impact on the lives of people with disabilities. It can be assumed that many of the conventional video game controllers on the market are not able to suit the needs of every individual, which is where there is a gap in the industry that Adaptive Play has attempted to bridge. This document is organized into several sections including a brief overview of the project, considerations for beginning this product, how to use the system, troubleshooting and support, and complete product documentation. This document has been created with the intention of it being used as a guideline for any other team that may attempt this product in the future and to be used as a user manual when purchasing and using the product. Any information in this document related to the client is to be kept confidential.

2 Overview

The problem we are trying to solve is the lack of video game controllers for individuals with accessibility needs. This is an important problem today as many products are designed with the intention of only being used by individuals without any accessibility needs, as it is the easiest way to design a product if you can assume the user has no limitations. The video game controller is especially important as many individuals with disabilities find great joy in playing video games and the current controllers on the market either do not let them play comfortably at all or only for a short period of time.

The client we worked with this semester was a quadriplegic and was only able to use her nose to perform many daily tasks, such as using her phone or the Nintendo Switch controller. The fundamental needs of our client included the controller having larger and more spaced-out buttons, making the ZR, ZL, R, and L buttons more accessible, and the controller being comfortable to use for extended periods of time which included it being made of a soft material.

The product we have designed is different from any other on the market as there is currently only one Nintendo Switch compatible accessible controller made by Hori, however it does not fit our client's budget as it is $250 USD. The controller we have chosen to design would ideally retail for $150 CAD and have all the same features with the added benefit of larger and softer material buttons as well as better spacing. The other proposed designs for this project included removeable

paddles and extension pieces for the controller; however, the team decided to take this specific design approach as it was best suited to the client's needs and can completely replace the current Nintendo Switch controller with the same functionality aspects.

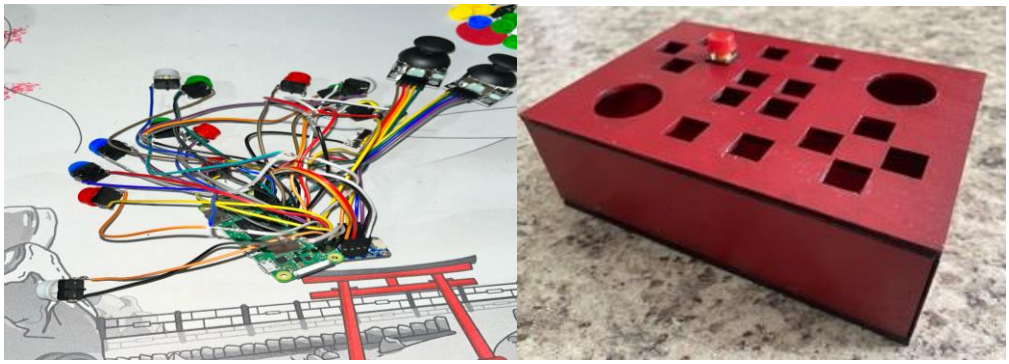

Figure 1. Final Prototype for Adapted Controller

The product has two main components, the box, and the internal wiring. The product features easy to press plastic buttons, joysticks, and a layout specific to the preference of the client with all the buttons on the front plane for easy access. It connects to the Nintendo Switch with a usb type c cord which is used to power the controller, however a battery pack could be included to make the device wireless. The controller built is wired to have the same functions as the existing Nintendo Switch controller. During our design day and final presentation, we ran into some issues therefore currently only the left, right, A, and B buttons are functional, and the box has been disassembled to allow for reconnection and rewiring of some soldered wires which broke.

The external component of the controller, the box/ housing unit has been laser cutter from 1/8-inch MDF, which is a type of wood, and has slots to fit the arcade style buttons and joysticks. The internal components include a raspberry pi microcomputer, raspberry pi wires, and a circuit board.

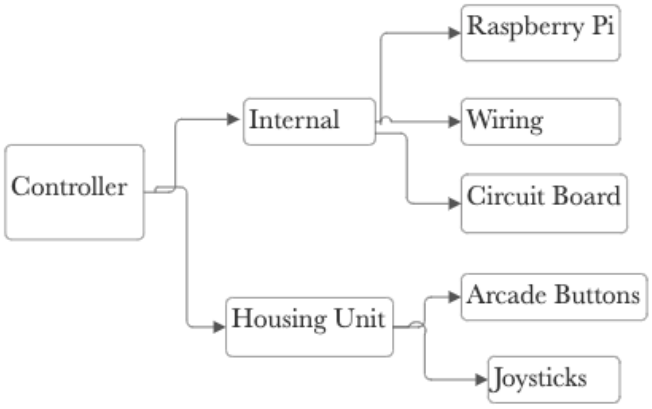

Figure 2. Block Diagram of Adapted Controller

2.1 Cautions & Warnings

The warning a user should know before using the prototype is that although the raspberry pi has been tested for overheating and should not emit any abnormal amounts of heat if the box design begins to heat up to elevated temperatures the device should be unplugged. The user should also note the raspberry pi automatically connects to any Nintendo Switch device it is plugged into or when wirelessly used, any Nintendo Switch close by.

3 Getting started

3.1 Configuration Considerations

The controller has been configured to connect the buttons nad joysticks with male-female and female-female jumper wires. These buttons and joysticks have been placed into the box without any sort of additional support, however, may benefit from being glued in. All controls are connected to the raspberry pi by soldering them to the pre-soldered headers on the board which allows the code to send specific functions to each button.

3.2 User Access Considerations

This product has been developed with the intention of being used by individuals with accessibility needs. It could be used by any individual as its layout with all buttons on the front plane makes the controller easier to use and may allow individuals to play games for longer.

3.3 Accessing/setting up the System

To set up the system it must be connected to a power source, either a battery or the Nintendo Switch. The controller will then automatically search for connections and connect with the nearest or plugged in Switch. The controller is then on and ready for use.

3.4 System Organization & Navigation

The main components of this device include its internal wiring and electrical circuit board components and the external housing unit. The external housing unit contains the buttons and

joysticks and the internal contains an electric circuit board, female-female jumper wires and male-female jumper wires. The parts are all linked together using these wires which are connected to the button or joystick and the ground connections on the board. The raspberry pi was the microcomputer used to transfer the code to the device. The internal components also include an ADC module to connect the joysticks.

3.5 Exiting the System

To properly turn off the system it must be unplugged from any power source and disconnected from the Nintendo Switch by using the buttons and joysticks to power off the system as with a standard Nintendo Switch controller.

4 Using the System

4.1 Housing Unit/ External Part of the Controller

The functions of the current product include the left, right, A, and B buttons which are inserted into the printed housing unit. These commands can be used to operate the Nintendo Switch and play games that use only these commands. For these buttons to work they must be lightly pressed, and a clicking noise should occur as well as some sort of on-screen movement, that is how the user can know they have pressed the button correctly. The buttons do not require much force as they have been designed to be easily pressed and accessible for all users.

5 Troubleshooting & Support

5.1 Error Messages or Behaviors

The system itself does not display any error messages however there are several problems that may arise:

1. Device not connecting to Nintendo Switch: the system will automatically continue looking for a Nintendo Switch.
2. Right, Left, A, and B buttons not working: check the soldered connection to the circuit board it may have come loose and needs to be resoldered.

5.2 Maintenance

The regular maintenance that should be performed on the prototype to avoid failure includes cleaning the outer surface with a damp cloth, when or if its gets dirty and performing a bug check on the code to ensure it is properly running.

5.3 Support

For any issues that may occur with the system the user may reach out to:

Nicole Moszkowicz- nmosz058@uottawa.ca

Any problem or question can be reported by email.

6 Product Documentation

6.1 Design Constraints

Two important non-functional design constraints that play a significant role in the development of our prototypes include the products ergonomic and comfort features and the devices' durability. For the client to enjoy using our prototype and be able to play her games it is important that the controller contains comfort features, such as a soft enough material to not injure her nose and good spacing so she can easily move around in the game without straining her neck. The durability of the controller will also be important since it should have a long lifespan and be easy to keep clean so that this option for gaming can remain accessible and affordable.

These design constraints should be satisfied mostly through our current design. For the ergonomic and comfort features the client we worked with this semester confirmed that the standard plastic material of the current buttons does not affect her nose; however, we have decided to increase the spacing to make them easier to press. In terms of spacing for ease of use, the Nintendo Switch spacing is not currently available online; however, we have estimated that about 7-10mm between each button should be sufficient. For the durability and maintenance aspects of the design constraints our final prototype will be made of MDF and ABS. Since both these materials are wood or plastic, they can be easily cleaned by wiping them with a damp cloth, or for any bigger issues there are cleaning agents available.

6.2 Housing Unit

6.2.1 BOM (Bill of Materials)

Item name	Description	Units of measure	Quantity	Unit cost	Extended cost	Link
Buttons	arcade type buttons	Unit	1	$8.95	$8.95	Tactile Buttons
Buttons	square arcade type buttons	Unit	1	$7.95	$7.95	Tactile Buttons

analog sticks	joysticks for movement	Unit	2	$2.95	$5.90	Joystick Buttons
MDF	For laser cutting the board	12” by 24” (1/8” thickness)	1	$2.50	$2.50	MDF
Wood Glue	To hold the pieces of the board together	Unit	1	$6.48	$6.48	Wood Glue

6.2.2 Equipment list

1. Laser Cutter

2. Inkscape Software

3. Exacto Knife

6.2.3 Instructions

1. Create an Inkscape drawing based on the CAD file in appendix 1.

2. Make sure there is no fill, and the width is set to 1.00 mm.

3. Load the MDF into the laser cutter and adjust the setting on the document properties to accommodate the specific machine and wood thickness configurations.

4. Glue the pieces together to form a box and trim down any rough edges with an exacto knife, sandpaper would also work.

5. Insert the buttons and joysticks through the top of the box, adding glue if necessary.

6. Once all wires are connected to buttons label each button.

Internal Components- Wiring and Circuit Boards

6.2.4 BOM

Item name	Description	Units of measure	Quantity	Unit cost	Extended cost	Link
raspberry pi zero 2 w with pre-soldered headers	Broadcom BCM2710A1, quad-core 64-bit SoC (Arm Cortex-A53 @ 1GHz) 512MB RAM Wi-Fi / Bluetooth Wireless communication technology: Wi-Fi	Unit	1	$28.95	$28.95	Raspberry PI Zero 2 W
ADC module	ADS1015 12-Bit ADC - 4 Channel with Programmable Gain Amplifier	Unit	1	$13.95	$13.95	ADC module
Wires	Male to female jumper wires	Cm	1	$2.95	$2.95	Jumper Wires
Wires	Female to female jumper wires	Cm	1	$2.95	$2.95	Jumper Wires

Equipment List

1. Soldering Iron

2. Application to run python

Instructions

1. Check the code for bugs

2. Upload the code to the raspberry pi zero

3. Splice the wires to accommodate 3 buttons per wire and connect one end to the electric circuit board and one to the ground using soldering.

4. Connect each joystick separately to one ground wire each and the circuit board.

5. Use the two-remaining ground connections to connect the ADC module.

6. Plug the raspberry pi into the Nintendo Switch using a usb type c cord for power.

7. Connect all wiring for the buttons and joycons to their corresponding buttons in the box.

6.3 Testing & Validation

Target Spec	Ideal Value	Marginally Accepted Value	Method of Testing	Result of Testing
Weight and Stability	0.3kg	0.28kg -0.5kg	Applying weights to the top of the box on the largest flat side.	The board withstood 2kg of weight without any signs of deformation.
Heating Factor of Raspberry Pi	Minimal to no heating while running for 1 hour.	Minimal to no heating while running for 1 hour.	Emulating a controller with a laptop and running the raspberry pi for 1 hour.	Minimal to no heating while running for 1 hour.
Cost	$30	$30-$100	Bill of materials was created	$91.01

The tests that were completed were crucial for validation of the final design. These results verify that the board will be stable, and its weight will be light enough to attach to the wheelchair of our client without falling. The heating factor was important to ensure the board would not be highly flammable or dangerous to the client when using and the cost was significantly less than that of current alternatives on the market.

6.4 Alternative Materials

Alternative materials that could be considered include using ABS or plastic and 3D printing for the housing unit compared to MDF, wood and laser cutting. This would allow the box to have more curved edges and may create a more ergonomic design. As previously mentioned, the product would also benefit from a PCB, printed circuit board to disregard the need for soldering and prevent loose connections.

7 Conclusions and Recommendations for Future Work

There have been numerous lessons learned throughout this project relating to technical skills and time management. It is important to always begin any designing work as soon as possible prior to the deadline to ensure the device will be working and any errors can be fixed or considered and fixed ahead of time. The most productive avenues for future work to improve our work would be in relation to the internal components and wiring. A PCB would be a beneficial aspect as it would remove the need for resoldering the wires with connectivity issues. Another suggestion would be rewriting the aspect of the code to include a better code for the joysticks. Due to a lack of time we had to abandon both ideas, however they would have product a much more effective product.

8 APPENDIX I: Design Files

The following documents have been provided as a supplement to this one. The project progress document outlines the work completed throughout the semester in detail and may be useful for future groups designing this system.

Table 2. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
MakerRepo Link	Adaptive Play- MakerRepo	09/04/2024
Project Progress Document	Design Project Progress	09/04/2024
Code File	Python Code for Adapted Nintendo	09/04/2024
CAD Drawing	Link to CAD	09/04/2024