Single-Handed Video Game Controller

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Abstract

Contents

1 Introduction

Standard video games on the Xbox and GameCube are not accessible to people without the full use of two hands. Our group aims to design a symmetric USB one-hand controller which could be used by either hand, benefiting groups with disabilities.

1.1 Background

The video game "Call of Duty" requires players to do three things at the same time: move the player character, look around and shoot other players. My family member only has use of one of their hands, and cannot do everything at the same time with a standard two-handed controller, making it impossible for us to play together. There are over 2 million Americans who have had limbs amputated or were born with limb abnormalities [1].

Other products generally fall into one of two categories: Overly complex, gigantic joysticks that need to be programmed, or simplistic joysticks that are limited to certain games. Our project is unique because it is plug-and-play, meaning you do not need to program it. Additionally, it can play any game that a regular controller could, because all of the original controller's functionality is preserved.

1.2 High-Level Requirement List

Table 1 shows the high-level requirements for our project, and how we will evaluate and verify our compliance with these requirements.

Table 1: High-level requirements and verification.

Requirement	Verification
Successfully map all controls commonly performed on a two-handed controller, so that it all can be done with a single hand.	x
The controller should successfully provide input to standard video game consoles such as the Xbox 360 [2] and Nintendo GameCube [3], taking inspiration from protocols and libraries we have gathered from the internet.	x
Controller will be symmetrical. This adaptive controller should be usable regardless of using only your left or right hand.	x

2 Design

This section will detail our design considerations for the video game controller. Figure 1 shows the overview block diagram for our design. Table 2 shows some concept illustrations.

2.1 Functional Overview

We now provide a functional overview of our project and its components.

2.1.1 Sensors

- Touch sensors: The touch sensors will function as buttons on the controller. All the touch sensors must provide digital output signals in order to operate each button.
- Joysticks: The joysticks will function as circle pads on the controller. Two joysticks must be used in this project.
  - Each joystick provides analog output signals on X and Y direction and digital output signal on Z direction. The main joystick will be attached to the control unit box as it is shown in the physical design picture, and the second joystick will be attached on the top of the main joystick.
  - Our joystick combines the functionality of the left and right sides of the controller by allowing your right wrist to do what your left thumb would normally do. All other major buttons are mapped to the handle of the joystick.
- Flex sensors: Flex sensors will be used to generate analog output signals for the trigger button which will be used for L2 and R2 buttons in our controller.
- Twist Sensors: The twist sensor will change the functionality of the main joystick from the circle pad to the direction pad.

2.1.2 Control Unit

- A microcontroller will be used as the control unit for the one-handed controller, to both provide enough computing power, and keep the price of the controller relatively low.
- The sensors are connected to the controller chip through wires. The microcontroller is programmed so that each sensor is mapped to hold the function of one button or joystick of an original Xbox 360.
- When the user provides input information through the sensors by interacting with buttons and joysticks, the microcontroller will relate the signal from the sensors accordingly to Xbox controller buttons, and send the information to the console the user is playing on, be it an Xbox 360 console or a PC.

2.1.3 Power Supply & Connection with Console

- A power supply is required for the controller to function. The controller will be powered through a USB cable, which provides electricity for the electronic parts and microcontroller to function, and also allows the controller to have I/O communications with the console.

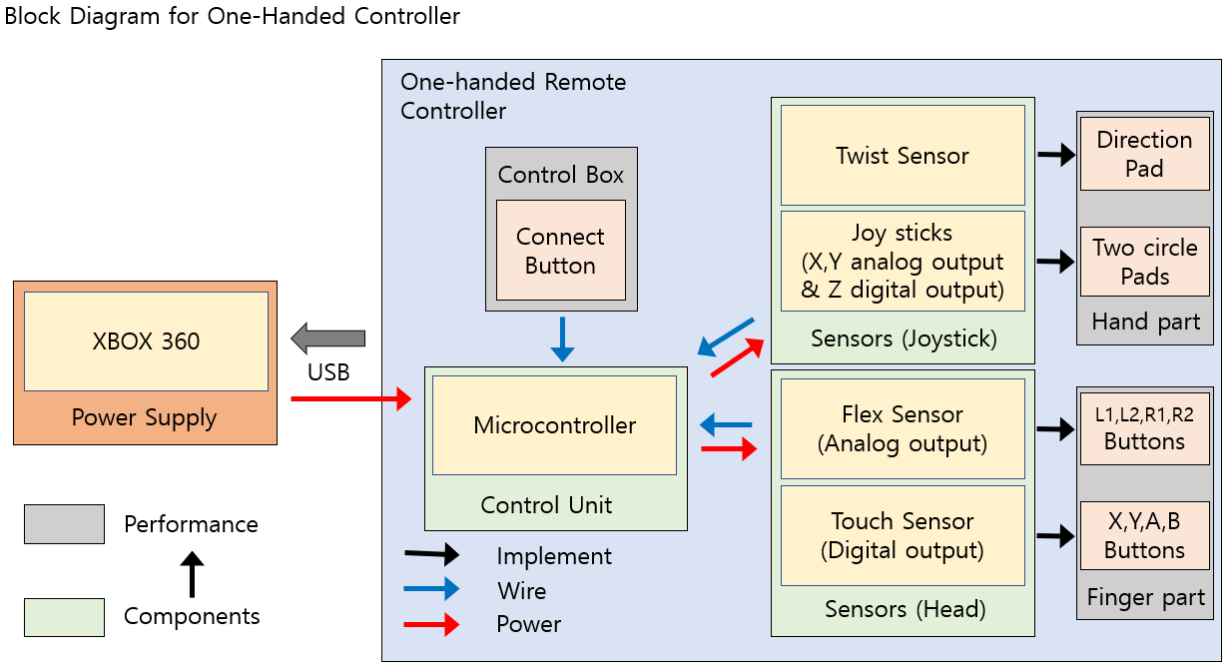
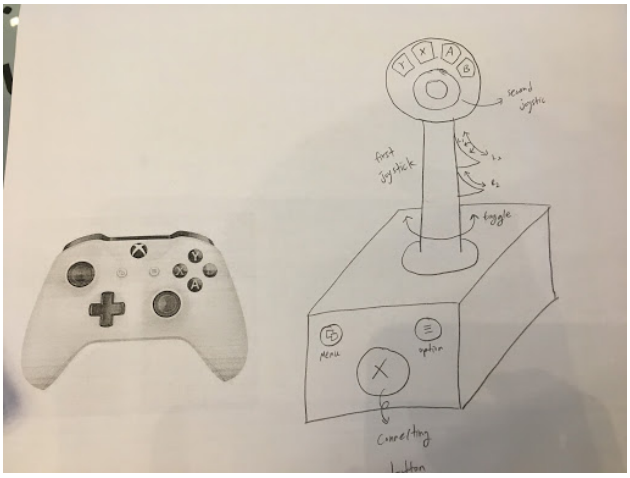
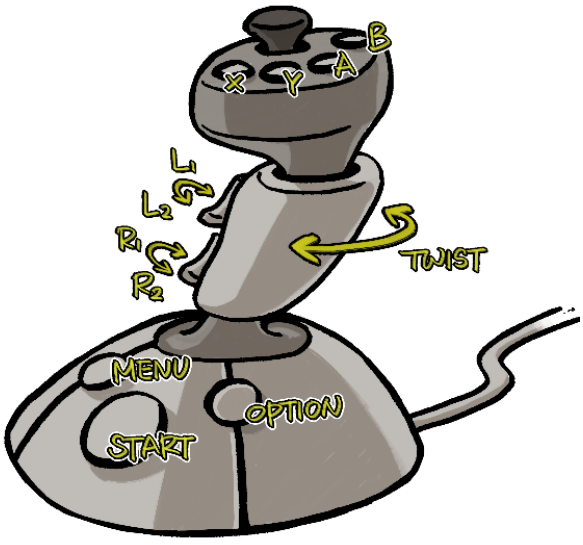


Figure 1: Block diagram for one-handed video game controller.

Table 2: Design illustrations.



(a) Initial concept sketch.



(b) Digital mockup of controller design

2.2 Block Requirements

This section describes the functionality requirements of each major component within the controller.

2.2.1 Control Unit

This component must take in the values of all buttons and triggers and communicate with the console.

1. Inputs (17)
   (a) Analog Inputs (6)
      i. 2x2 analog circle pad reading
      ii. 2x analog trigger reading
   (b) Digital Inputs (11)
      i. 4x X,Y,A,B buttons
      ii. 2x joystick push buttons
      iii. 2x R2, L2 bumpers
      iv. 1x Left stick / Left D-pad toggle (twist sensor)
      v. Start button
      vi. Back button
2. Organize digital and analog readings into controller protocol array and send to console at least 20x/sec (via USB)
3. The ATmega328 chip should provide the functionality we need

2.2.2 Standard Buttons

1. Must provide a digital signal with digital 1 between 1-5 V corresponding to when the X, Y, A, B, Start, and Back buttons are pressed

2.2.3 Circle Pads

1. Must provide 2D analog reading of X/Y orientation, between 0-5 V
2. Must provide digital push reading with digital 1 between 1-5 V (press the stick in)

2.2.4 Twist Sensor

1. Must detect whether joystick is twisted (about 30-45 degrees?) or in default orientation
   (a) Must provide a digital signal with digital 1 between 1-5 V corresponding to when joystick is twisted
2. Twisting mechanism must be sprung towards default position

2.2.5 Triggers

1. Must provide analog reading for amount of trigger depression between 0-5 V
2. Range of motion must be restricted to in/out
3. Triggers must be sprung out

2.2.6 Bumper buttons

1. Must provide digital signal with digital 1 between 1-5 V corresponding to when buttons are pressed

2.3 Risk Analysis

The component that will pose the biggest challenge will be the twisting mechanism on the joystick. We will need to figure out how we will mount the twisting part, and how we will sense the twisting. Furthermore, we must ensure that the range of twisting is limited.

3 Conclusion

3.1 Ethical considerations

We do not have any serious ethical concerns over this project, although we do need to concentrate on certain safety aspects [4].

- Due to the quick, reaction-based nature of many video games, we need to expect considerable wear and stress on the controller. In compliance with IEEE Policy 7.8.1, we will seek to have all electronic components be secured within the controller body so as to avoid any electrical exposure.
- In observation of IEEE Policy 7.8.9, we also want to refrain from damaging whatever video game consoles with which we interact, and so we will use the standard USB protocol to minimize the probability of miscommunication.
- Also with respect to IEEE Policy 7.8.1, the shell of the controller needs to be relatively strong, so kids and pets cannot break it open and accidentally swallow small parts.

References

[1] A. Coalition, "About us - amputee coalition," 2020. [Online]. Available: https://www.amputee-coalition.org/about-us/

[2] zlittell, "zlittell/msf-xinput," 09 2018. [Online]. Available: https://github.com/zlittell/MSF-XINPUT

[3] NicoHood, "Nicohood/nintendo," 09 2018. [Online]. Available: https://github.com/NicoHood/Nintendo

[4] IEEE, "Ieee code of ethics," 2018. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html

Appendix A Sensors We Have in Mind

This section provides a few links to sensors we are thinking of using in our project.

- Buttons: 6 x Tactile Button Module for Arduino, Raspberry Pi 6 Color set, Science Project https://ebay.us/qbknZW
- Trigger analog sensor: KEYESTUDIO 0-0.5kg Thin-film Pressure Force Sensor Module for Arduino Micro bit https://ebay.us/gEpMVQ
- Circle Pads: Analog 2-axis Thumb Joystick with Select Button + Breakout Board https://www.adafruit.com/product/512?gclid=EAIaIQobChMIq_r0s6a55wIVSrzACh3swQozEAkYAyABEgKhrPD_BwE
- Microcontroller: ATmega328P-PU https://www.digikey.com/short/z3d2rr
  - We will need USB as well for programming and communication protocol
  - Possibly V-USB https://www.obdev.at/products/vusb/index.htmlorintermediatechip