Project Proposal

ECE 445

Project 23 - Full Movement Gaming Mouse

Drake Bernhard and Michael Bindon

Introduction:

Objective:

The traditional mouse has the ability to point on a 2-D surface and has a few buttons. This commonly must be supplemented with other input for higher end computer uses. A mouse with more functionality could be very useful to multiple groups of people. CAD drafting and similar programs have 3D space to navigate through, and computer games commonly have 5 axis of direction (2 for looking and 3 for movement). Our goal is to build a mouse that can allow for 4 axis of movement comfortably and compactly while not altering the basic design of the mouse where it effects use for other typical computer uses. This project will attempt to solve this through adding a joystick device to the thumb rest area of a common mouse.

Background:

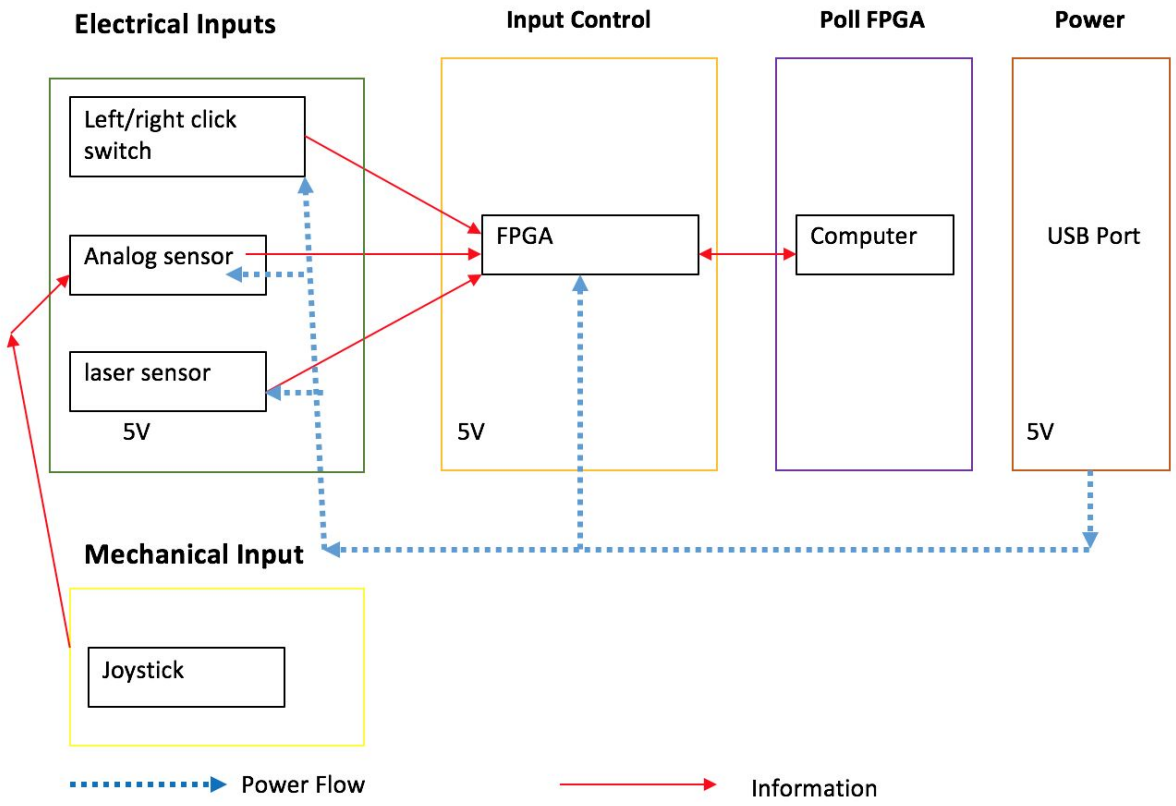
Some computer gaming mouses have implemented a thumb joystick previously. The largest problem with these existing mouses is the awkwardness of the thumb movements on a true joystick. Many of these mouses take time to get a feel for what ‘true forward’ is. Our mouse aims to provide a more natural feeling thumb joystick while keeping the remainder of the mouse normal.

Requirements:

- Joystick feels natural on the hand during use and provides smooth function during gameplay.
- Mouse use must be familiar or intuitive as well as easy to move in daily use. The mouse should also be comfortable enough for continuous uses of hours on end for long gaming runs as well as CAD projects.
- The mouse will have to be sufficiently responsive for computer gamers. We will strive for less than 15 ms of latency with our mouse, which is delay of a single 60Hz frame and considered good, even for gaming.

Design:

Block Diagram:



Functional Overview and Block Requirements:

Joystick

The joystick will be the mechanical device between the user and analog sensor. The goal of the joystick is for the user to be able to control the mouse with his thumb. Likewise, the joystick should be able to move forward, backwards, left, right, and all possible combinations of directions. In addition when user is not moving the joystick, the joystick should remain in the original position and not drift in one direction.

The feel of the joystick is one of the largest parts of being able to define this project as a success. Therefore the joystick will have to be able to respond to very small movements (millimeters). The user will also need to have a good feel with the joystick, as in being

able to feel true forward as opposed to having an action that would move a few degrees off from straight forward.

Analog Sensor

The analog sensor will be able to read the movement of the joystick and properly encode the movement to electrical signal that the FPGA understands. In order to complete this task, the analog sensor will be able to tell the direction and magnitude at which the joystick is pushed. Importantly, this sensor will need to be compact to fit either in the mouse or on the joystick.

Click Left and Click Right Buttons

The click left and click right buttons are designed to register when the user presses down on the mouse. This will be implemented by two electrical pushbuttons. Both switches will operate independently and be assigned to specific GPIO pins on the FPGA board. The switches need to be able to handle fast clicking for the common double clicking and also be able to hold up to tens of thousands of clicks over the life of the mouse.

Laser Sensor

The purpose of the laser sensor is to read the user's movement of the mouse and to transfer the information to the FPGA board. Since this mouse is designed to be higher end, this laser sensor should be sensitive to small movements of the mouse. Mouses have ratings of DPI (dots per inch) which correlates how many on screen pixels will correspond to 1 inch of mouse movement. Given high resolution gaming has 2560x1440 resolution the mouse will be responsible for going 2500 pixels all while staying within the confines of a typical mouse pad. Normal mouse movement stays within 2 inches of center so 4" of total travel means that we will need accurate resolution of 2500/4 inch movements. This equates to a minimum required 650 DPI. The upper limit on computer mouse DPI is roughly 4000 which would allow for a one inch movement to traverse an entire 4K monitor. Many computer mice have adjustable DPI which allows for a feel that works for the user without performance degrading software such as mouse acceleration.

FPGA

The FPGA chip is responsible for handling the incoming information from all the sensors. The FPGA will also set the thresholds for the analog sensor which will

determined based on feel at a later date. The chip will also handle communication to the laser sensor and computer through serial communication standards. After handling the information from the inputs, the FPGA board will send the proper information to the computer. Due to the power supplied from the USB, our FPGA will need to be able to accept 5V as a power source. The chip will also need to have access to a clock fast enough for the multiple serial communication protocols it will be using.

Computer

In this project the computer is the component that requests information from the FPGA board. The computer's monitor will be able to display the movement of the user's mouse and position of the joystick. The polling rate of a typical office mouse is 125 Hz, however gaming mouses commonly reach 1000 Hz. In modern computers the increased polling frequency does not have any negative effects on the rest of the computers usage while providing slightly better response.

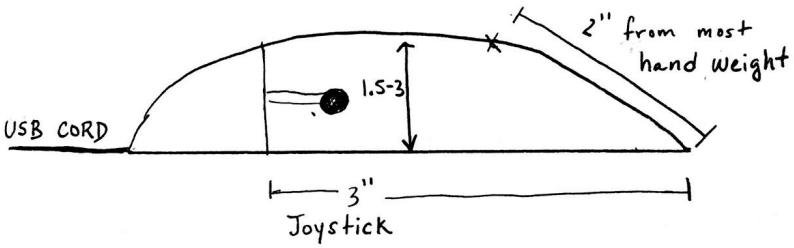
USB Port

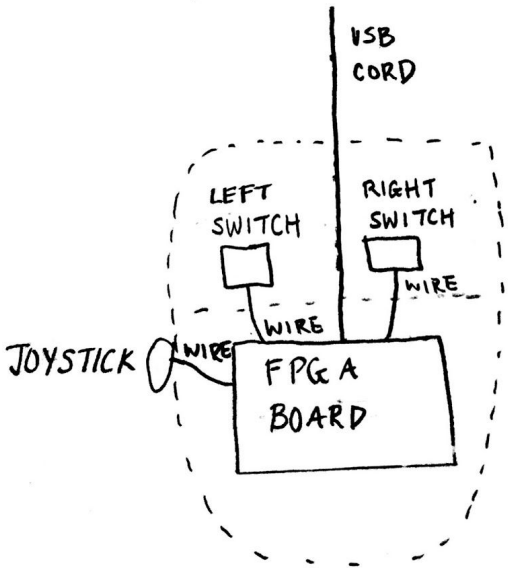
The USB port provides power to the FPGA board, the analog sensor, laser sensor, and click left/click right switches. The USB will provide 5V through the USB cord to the mouse. The actual amount of power provided from the port will be determined at a later date when the current can be better estimated. The power consumption of the board and sensor shouldn't be a major concern for this project. USB 2.0 can provide 5V through a single cord and a maximum of 500mA, for a total of 2.5W. Preliminary estimates shows the power usage of the mouse is below that.

The USB port will also handle the communication between computer and FPGA through either USB or USB 2.0 depending on data rate requirements.

Physical Design:

Since the goal is to provide a natural feel we do not want to radically change the design of the mouse. Due to this we will base most physical measurements off of other typical mouses. Mouses come in many sizes, ours will be larger since portability is not a concern for our target market. Also the larger mouse housing will give more internal space to the joystick electronics.


2" from most
hand weight
1.5-3
USB CORD
3"
Joystick


USB
CORD
LEFT
SWITCH
RIGHT
SWITCH
WIRE
WIRE
WIRE
JOYSTICK
FPGA
BOARD

Risk Analysis:

The largest risk to a successful completion of our project is likely to be time management and successfully designing and ordering our PCB to match the chosen FPGA. Most other parts either have low lead time, are straightforward to implement, or are fairly interchangeable with a variety of similar or common parts.

Safety:

Given the low voltage we will be using as out power supply our biggest safety concern is to the hardware and making sure we aren't exposed to dangerous metals such as lead. We will be ordering RoHs compliant components to prevent unnecessary exposure. We will also take precautions when soldering components, both while prototyping and also for assembling final components to the PCB.

Ethics:

We do not anticipate that the development of our product would unleash any possibilities of misuse that did not already exist with other computer mice. The largest ethical concern is that we must consider the existing products that are similar and be confident that our product is sufficiently differentiated and unique so as to not upset any existing works.

Sources:

[1] https://eliteownage.com/mouseguide.html

[2] https://www.reddit.com/r/pcgaming/comments/4wi5ar/mouse_click_latencies_compiled_on_a_chart_xpost/d682aj7/