6.111 Final Project Proposal: E.D.I.T.H.

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Project Introduction:

Our project, inspired by Tony Stark's technology, is in order to establish the ability to interact with computers and screen technologies with the standard keyboard and mouse, but with your hands and voice. Thus, in this project the goal is to demo interacting a website home screen and different shapes as a proof of concept. Your hands and a convenient button will be able to to act as the left and right click as well as the scroll. Your voice will act as an undo/back and redo/forward command interface with the computer.

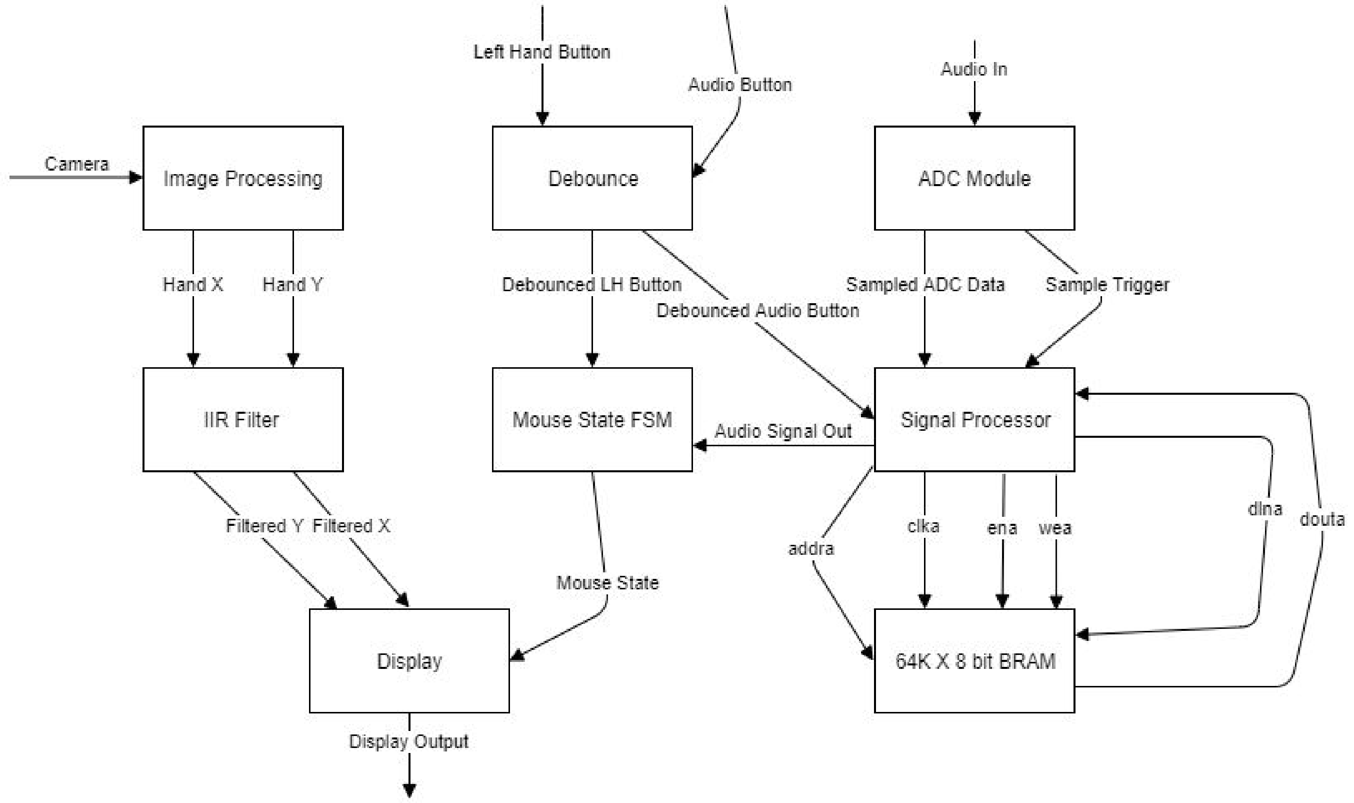
Required Components:

- Nexys4 DDR Artix-7 FPGA Board
- Teensy USB Development Board
- Laptop
- Black Gloves (~$5-10)
- Camera
- External Microphone
- Resistors, Capacitors, Breadboard
- Light Emitting Diode (~$5-10)

Project Overview:

The camera will be wired up directly to the FPGA, which will process the image information to extract the x- and y-coordinates of the light emitting diode that will be attached to one of the black gloves that will be worn on the right hand of a user. These coordinates as well as whether or not the mouse should be clicked or selected will be sent to the Teensy, which is hooked up to the laptop and will function as the mouse. For the microphone, it will be wired directly to the FPGA, and the audio in will pass through a low filter before signal processing in order to clean the signal, making it more discernible for high and low tones. Once the signal is clean we will compare to a high and low threshold. The high threshold will correspond to the undo command and the low threshold will correspond to the redo command. It is important to note that there will be a gap in terms of tones between the high and low thresholds, so that not all noise coming into the microphone will cause a reaction. This is so that the system can be more certain that the audio in is a command rather than ambient sound.

Block Diagram:



Modules:

Audio:

The Audio portion is split up into multiple smaller modules within the larger main file that that sends one of two signals: an undo or redo for the last command given. For instance, if the user was typing and misspelled a certain word, then she can udo the creation of that word. However, if she realizes after that she had correctly spelled that word, then she can redo the creation of that word as well.

One of the smaller parts that I want to highlight is the audio filter. The filter works by taking in the messy noise coming in and cleaning it so that the noise below and above certain frequencies are erased. After this removal, the clean sound will be passed to the audio processor to see whether an output needs to be given to the wider system.

TESTING:

We plan to test the audio module with both test benches and manual testing. For the test benches, they are important because they give an insight to the internal workings of our modules. Something that we cannot access. For the manual testing, we want to confirm that the signal is properly getting cleaned and clear so that no ambient sound is incorrectly affecting our signal. Thus, while we will not need a memory bank for the live implementation of the system, we will use memory of the audio for testing purposes in order to analyze the signal.

Visual:

The first major module for the visual side of things is the image processing module. This module will take in image information from the camera (specifically, the position of the light emitting diode on the black glove), and produce x- and y-coordinates corresponding to where the mouse should be on the display screen. These coordinates will be passed in to an Infinite Impulse Response Filter to eliminate some of the electrical noise as well as slight vibrations of the glove. These filtered values can finally be passed into the Teensy which will function as the mouse of the given laptop.

TESTING:

Just like with the audio, we plan to test the visual modules with both test benches and physical tests. The test benches will be more important for the image processing module, but once that is working, it will be very important to run physical tests using the laptop display to make sure that the mouse is doing what it's supposed to.

Division of Work:

Since there are two main types of modules (audio and visual), we have decided to split it up such that Timi will handle the audio components of the project and Roberto will handle the visual components. Given the varying complexities of the two types of modules, however, it is possible that the audio modules will be completed before the visual modules, in which case Timi will either add additional functionality to the audio components of the project (in the form of more audio commands) or shift his effort towards assisting with the visual modules. Since the mouse state FSM takes input from both the audio and visual components of the project, both Timi and Roberto will work on that module in order to ensure that the mouse output to the display works correctly.

In terms of testing, Timi and Roberto will each test the respective modules that they work on since working on each others' test benches would require more time, and figuring out which parts of a module need to be tested extensively can only be done efficiently by the person who wrote and designed that module. Setting up the camera, microphone, and other external components of the project will be done together, however, since we need to ensure that these components are set up and working correctly for the modules to work as intended.

Timeline:

Week 1;

Integrate Teensy
Integrate all hardware

Week 2:

FPGA can successfully identify between high and low tones by lighting hex display

Working UART system via Teensy

Week 3:

Camera can identify hands/gloves

Create and test Visual FSM

Week 4:

Refine image processing and complete related modules via testing

Week 5:

Combine and integrate the system - audio and visual components

Week 6:

Demo the project via Youtube/Google homepage as well as a google document in order to click and drag shapes.