Proposal - Iron Man Mouse

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1. Introduction

a. **Problem:** We often find ourselves tied to the monitor/mouse system while giving a presentation or in a group working session. This could limit our delivery in presentation due to audience boredom and limit group workflow by blocking the monitor. It would be a lot cooler and more efficient if we could hover our cursor and control the computer system with our hands in the air just like Iron Man. It is also a problem that sometimes we want to have more functionalities packed in our mouse to be more productive. If we can add a depth/3rd dimension to using a mouse by bringing it into the air and expanding user work/input space, we could open up a wide range of possibilities.

b. **Solution:** We aim to create a mouse that works in 3 dimensions like an Iron Man glove. The device would have a wrist band portion that acts as the tracker of the mouse pointer (implemented by accelerometer and perhaps optical sensors), a 3-finger-cot system with gyroscopes or accelerometers. A microcontroller on the glove would translate these translational/rotational data to imitate a mouse or trackpad movements with possible custom operation. Then the glove would render the signal to a PC via bluetooth, with custom drivers to further process these data on the computer side.

c. **Visual Aid:**

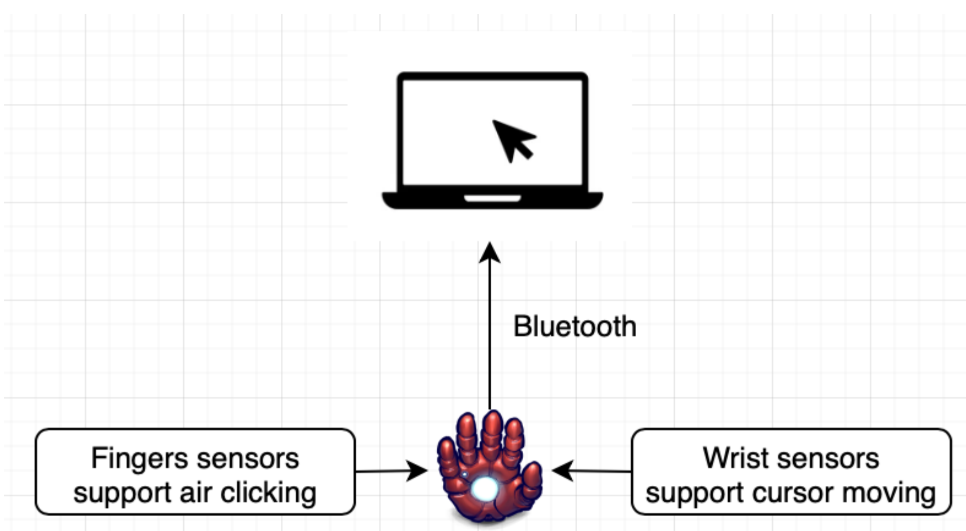

Figure 1

d. **High-level Requirements List:**
   i. Support basic mouse functionalities such as click, scroll, cursor movement as well as some advanced functionalities such as zoom in/out, volume control.
   ii. The mouse should achieve at least 70% target efficiency (total hits/targets) and at least 60% click accuracy (total hits/clicks)
   iii. The device would have a minimum polling rate of 125Hz, which corresponds to 8ms response time.

2. Design

a. **Block Diagram:**

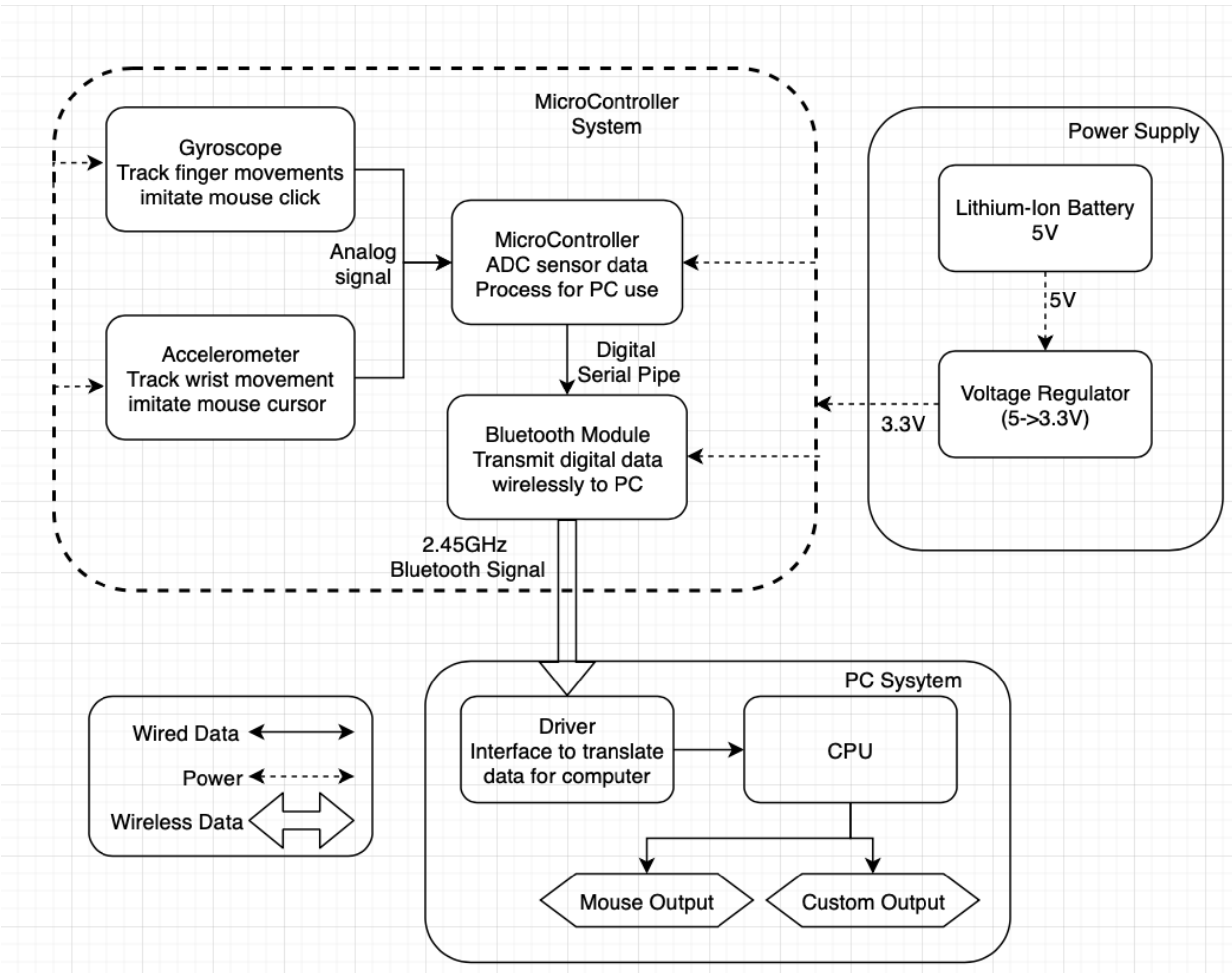

Figure 2

b. **Power System:**
   i. Battery:
      1. Overview: A rechargeable battery that provides enough power for all sensors and modules on board.
      2. Requirement 1: It has to be lightweight (within 100g) for user to move it easily in the air

3. Requirement 2: It should be a rechargeable lithium-ion battery that can power the device for 2 days of normal use (at least 100mAh).

ii. Voltage Regulator:
1. Overview: A regulator circuit that reduces the battery voltage to microcontroller-acceptable voltage
2. Requirement 1: able to bring the typical 3.7V lithium-ion battery voltage down to microcontroller Vin at 3.3±0.2V.

c. **Controller Unit:**

i. Microcontroller (Model: STM32L15x)
1. Overview: A microcontroller to pre-process the data received from the 4 sensors. It is responsible for any ADC operations for the sensors, integrations, and synchronization of data before transmitting it. We are planning on using STM32L15x processors.
2. Requirement 1: must have at least 3 digital connection ports/interface (SPI, I2C, or UART), and 1 analog port
3. Requirement 2: Multi Channels 16-bit ADC
4. Requirement 3: Speed at least 20MHz

ii. Bluetooth module (Model:BLUENRG-232N)
1. Overview: A bluetooth module that can transmit the digital data processed by the microcontroller with efficiency to the computer
2. Requirement 1: It should be Bluetooth 4.0 for data transfer rate up to 24Mbit and low power consumption.
3. Requirement 2: Good RF link budget (up to 96 db).

d. **Sensors:**

i. Accelerometer (Model: ADXL335)
1. Overview: Accelerometer attached to the wrist band portion of the device to collect translational movement when the user move their hands (for mouse cursor tracking)
2. Requirement: Able to output analog signal in 3 dimensions for acceleration data, with a minimum full-scale range of ±3g.

ii. Gyroscope
1. Overview: gyroscope attached to 3 finger cots portion to collect angular motion when user bend their fingers in different angles (for different clicking/zoom-in/etc operations)
2. Requirement: the gyroscope should use a digital interface using either SPI or I2C, with a sample rate of at least 125Hz.

e. **PC Driver:**

i. Overview: we develop a device driver on the PC to process the data, to accomplish advanced operations, and to ensure compatibility
ii. Requirement 1: The device should be compatible with both Windows and Mac operating systems.
iii. Requirement 2: The driver should be easily downloadable for any user for use.

f. **Risk Analysis:**
The most important risk factor that we identify is the accuracy of location using the accelerometer. Accelerometers usually measure accelerations in 2 or 3 dimensions. We need to integrate acceleration data twice to obtain location values. If we want relatively precise location data, we need more precise acceleration data. It is worth noting that $\Delta S(distance) \propto \Delta at^2$. The error on location values increases over time. Therefore, it is critical for us to incorporate some recalibration mechanisms to improve accuracy. We may need to add some more sensors (e.g. optical sensors) to achieve 70% target accuracy.

3. Ethics and Safety

a. Ethical Issues

There are relatively few ethical issues associated with our project since we are developing a smart computer peripheral device. However, we identify several ethical codes that we need to observe during the development of our project. First, we need to put the safety of others and ourselves first. Since we are going to be working in a lab (for soldering parts together), we need to strictly follow the lab (ECEB 2070) safety rules. Second, we need to ensure that our team communicates in an honest, equal, and fair manner. Finally, since a significant part of our project is software development, we should never commit code plagiarism. Any open source code that we use needs to be properly cited.

b. Safety

Our project may require us to work in a lab. We need to solder parts together on a pcb and we also need to conduct various testings on parts of the device or the device. Therefore, we have to strictly follow the lab safety rules. For example, we should never work in the lab alone. We should always wear eye protection when soldering, and etc.