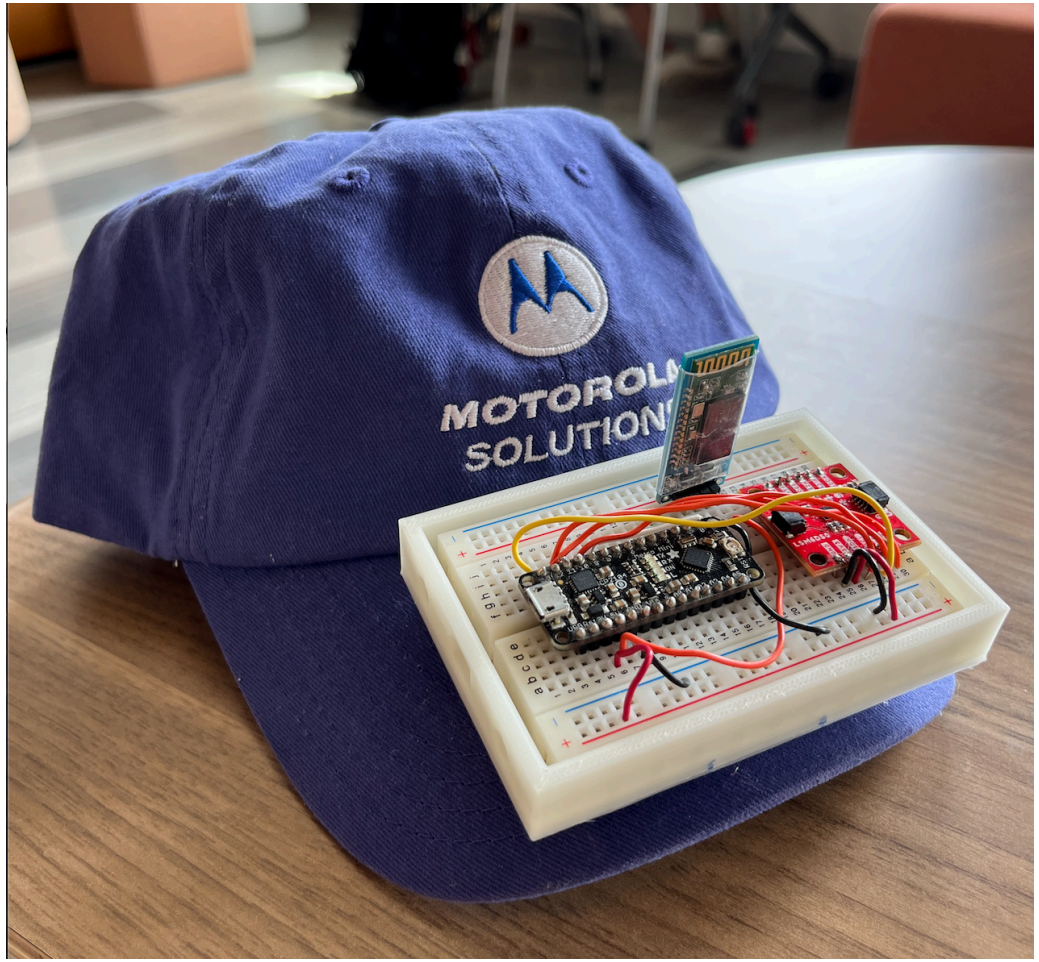
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Team 44: Head-Controlled Mouse

Amanda Favila, Asher Mai, Lauren Wilcox

27 April 2023

Head-Controlled Mouse



Problem

Some disabilities such as arthritis and paralysis prevent people from being able to use their hands to operate a computer

Solution

We designed a head-controlled mouse mounted on a baseball cap which allows the user to control the mouse by simply moving and tilting their head.

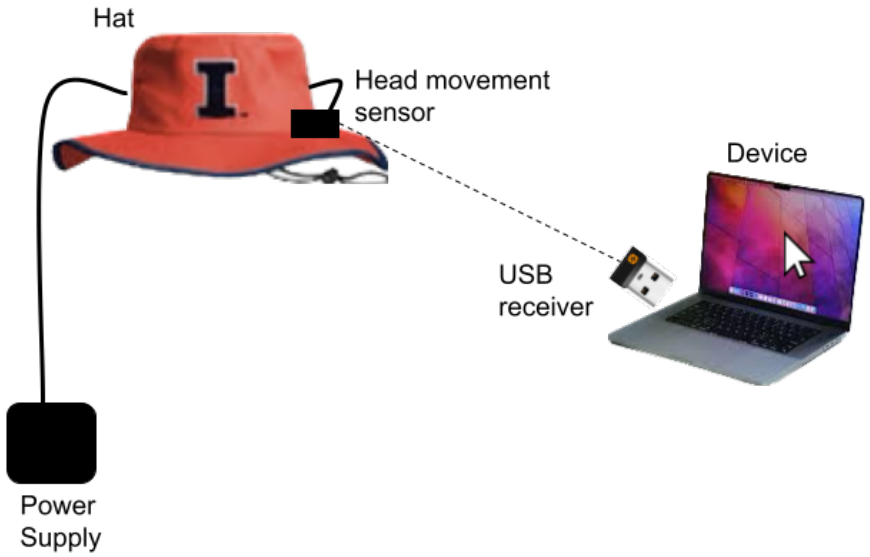
Project Demo

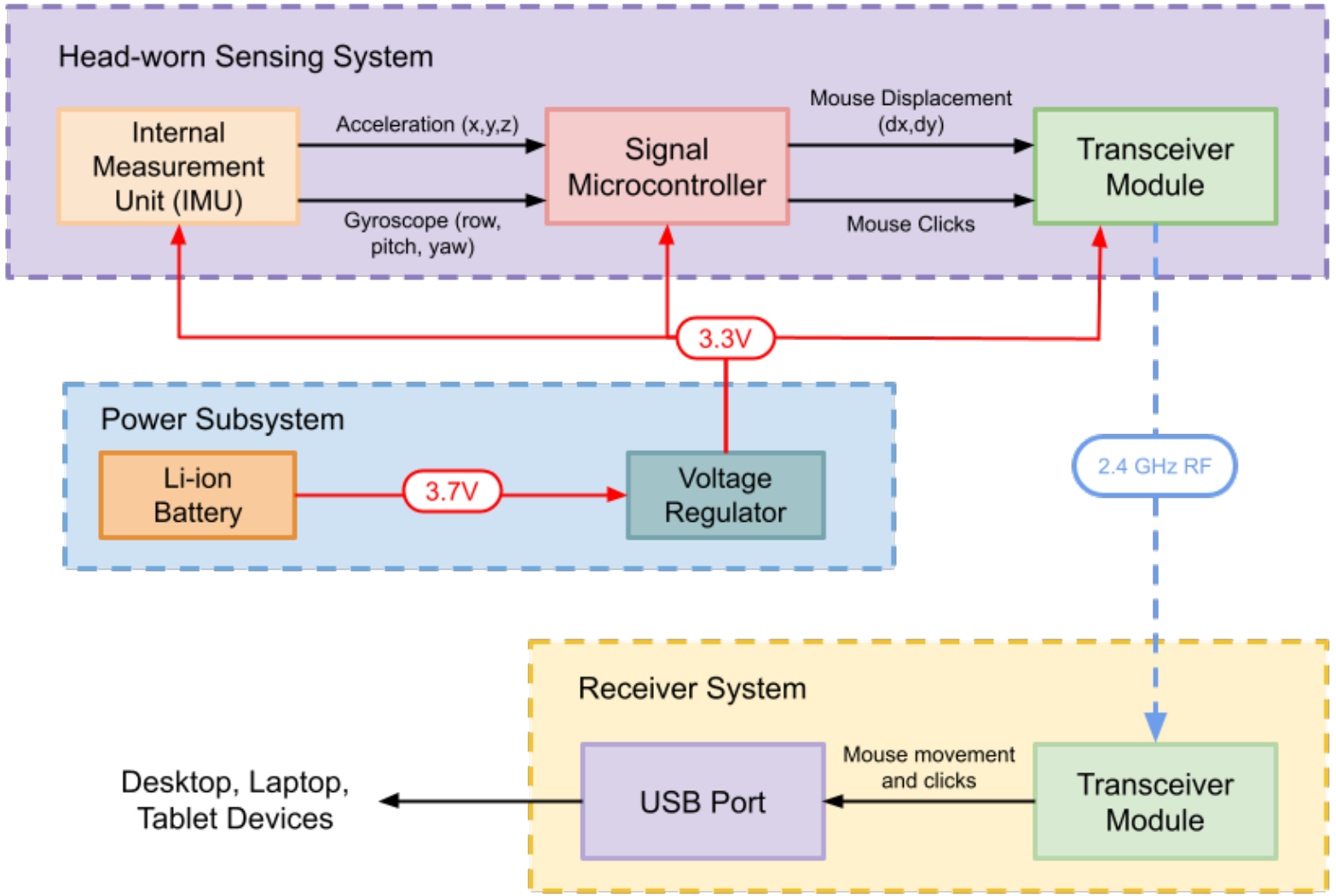
Design

High Level Requirements

1. The device must calculate appropriate distances and speeds for cursor movement based on the user's head movements.
2. The device must accurately move and click the mouse cursor based on the user's head movements.
3. The device must be able to be used on both Macs and PCs.
4. The device must utilize user adjustable sensitivity that maps different cursor speeds to the same head rotation speeds.

Original Design

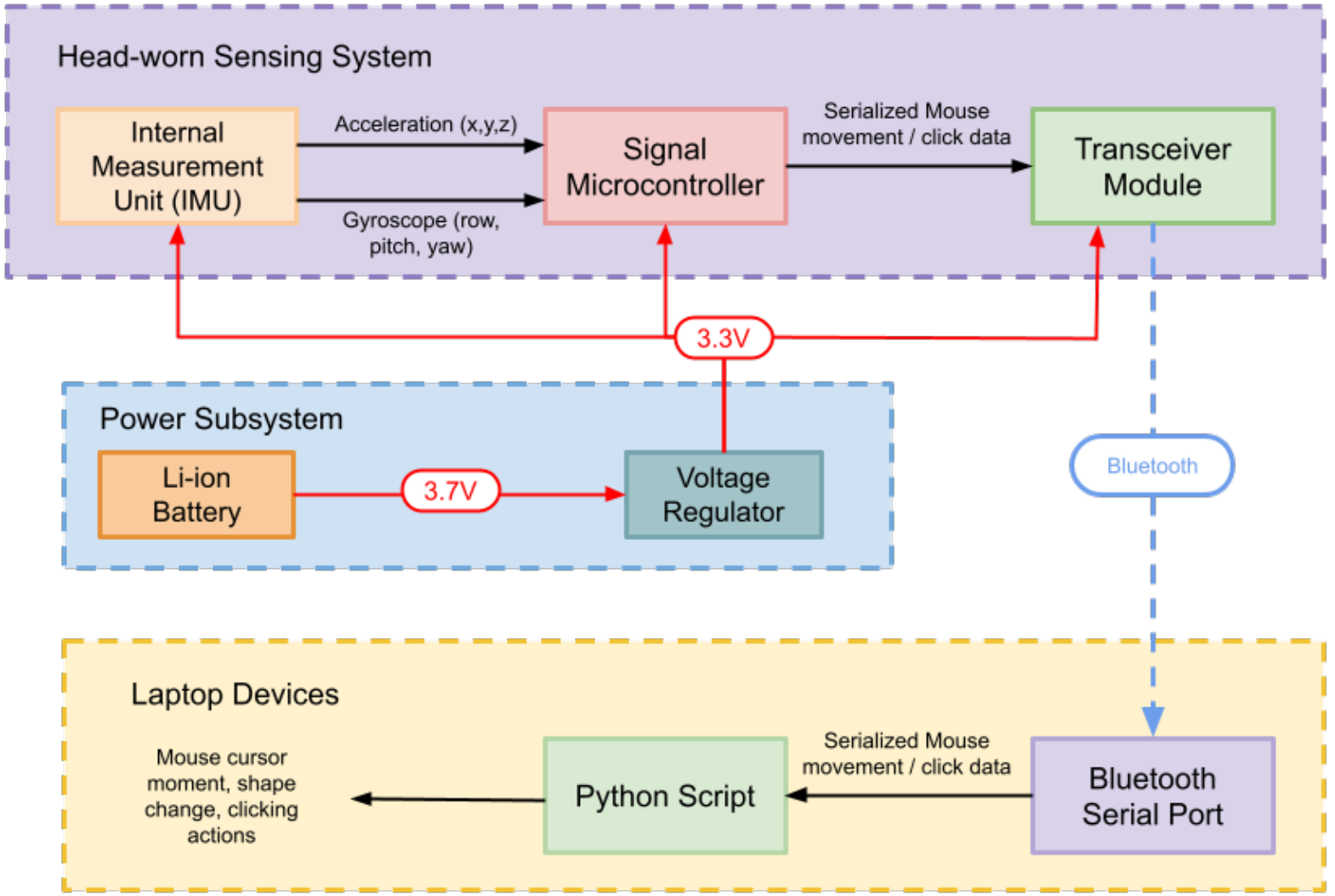




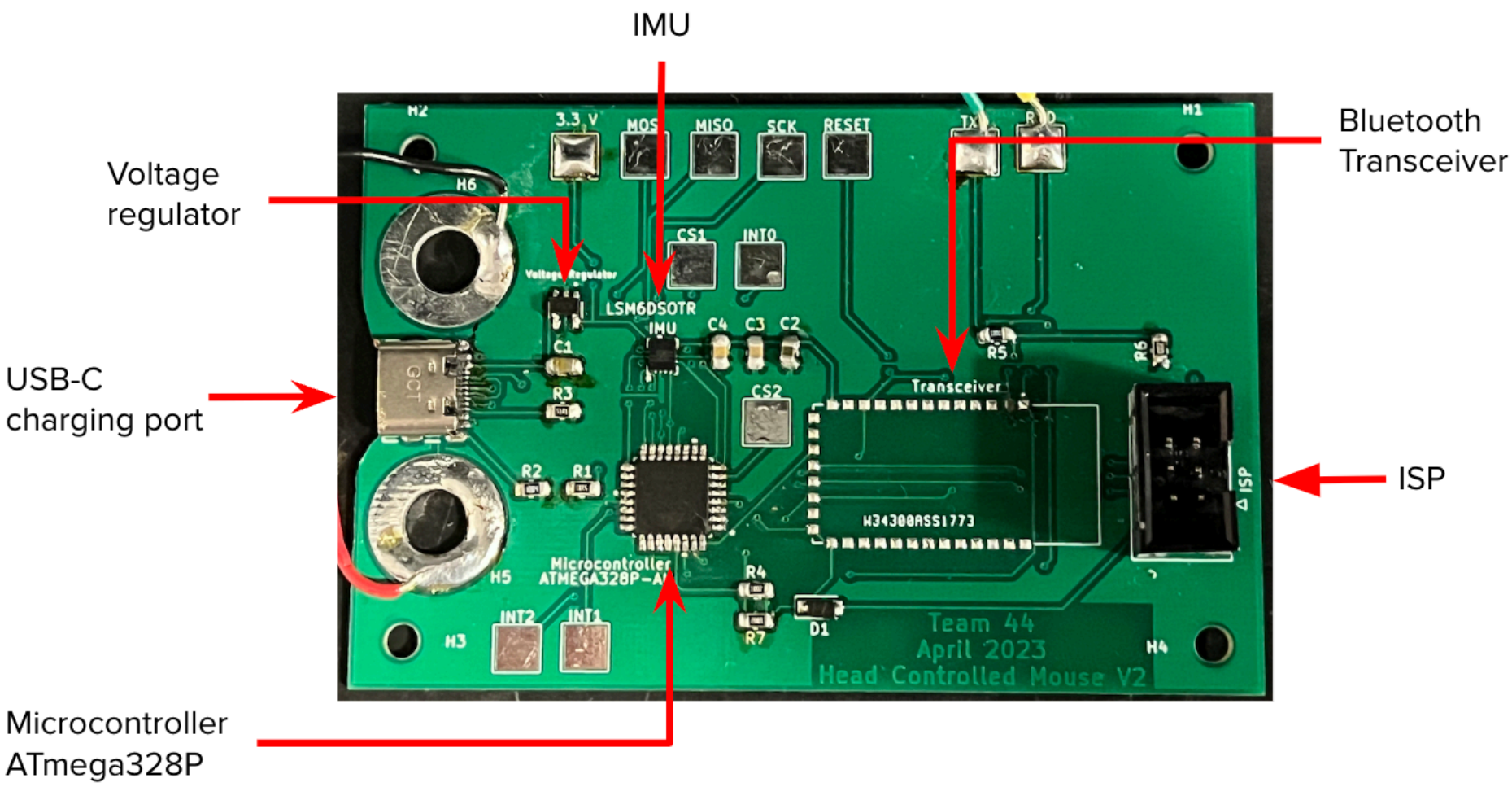
Design Changes

1. 2.4 GHz transmission and USB receiver → Bluetooth transmission and no external receiver
2. Only mode of power was battery → battery and USB-C charger power modes

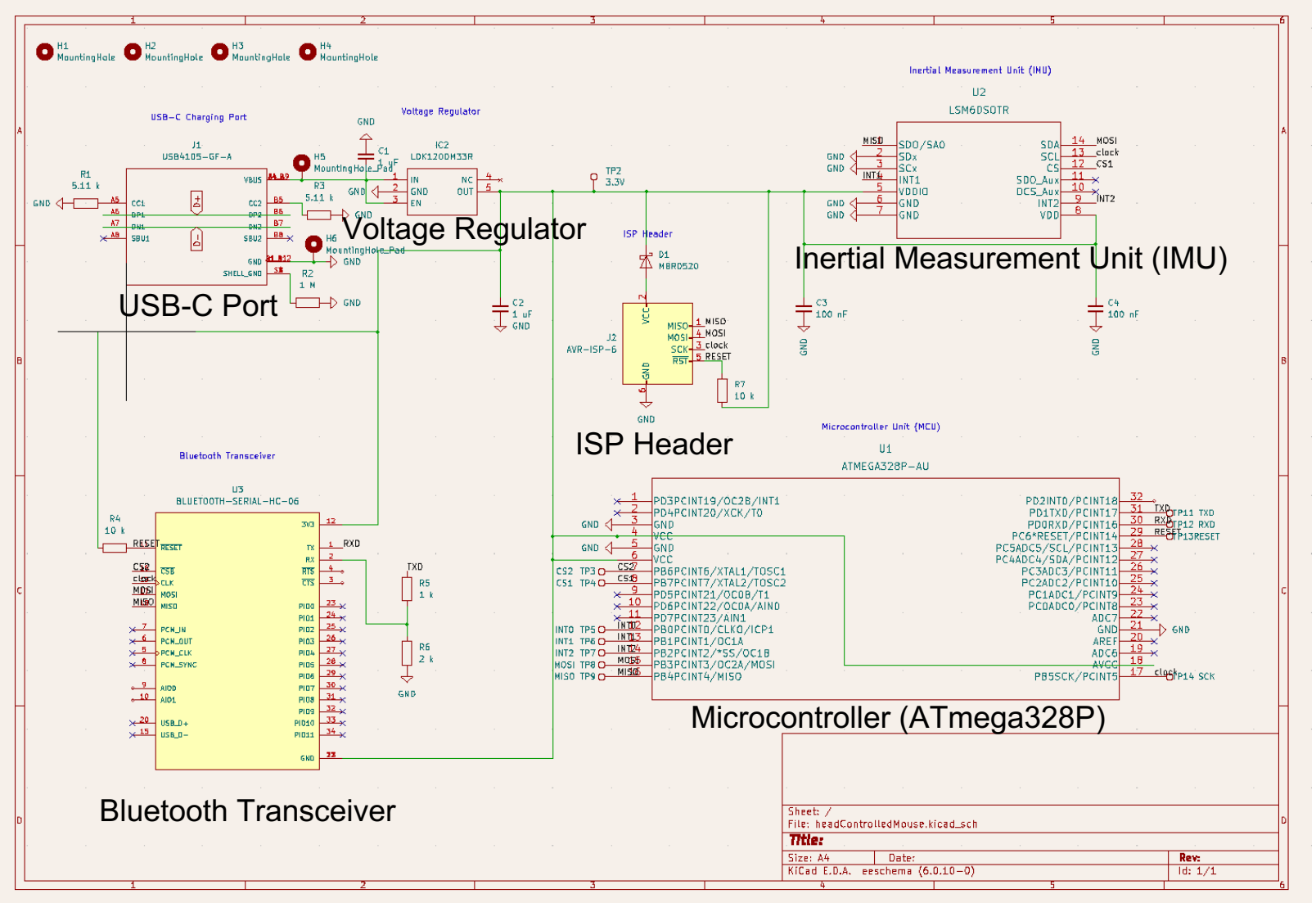
Block Diagram



PCB


IMU
Voltage regulator
USB-C charging port
Microcontroller ATmega328P
Bluetooth Transceiver
ISP
3.3 V
MOSI
MISO
SCK
RESET
TX
RX
H1
H2
H3
H4
H5
H6
CS1
INT0
LSM6DSOTR
IMU
C1
C2
C3
C4
R1
R2
R3
R4
R5
R6
R7
CS2
Transceiver
W34300ASS1773
ISP
INT2
INT1
D1
Team 44
April 2023
Head Controlled Mouse V2

PCB Schematic



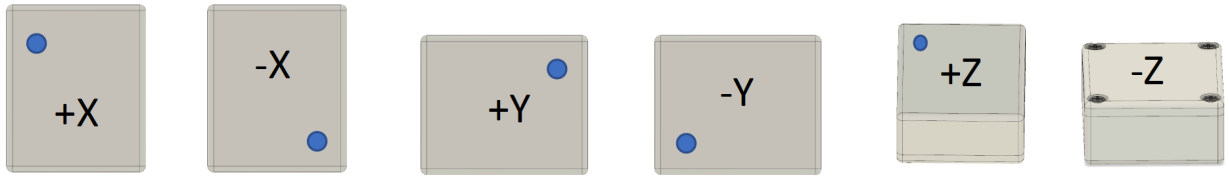
Subsystems

Inertial Measurement Unit (IMU)

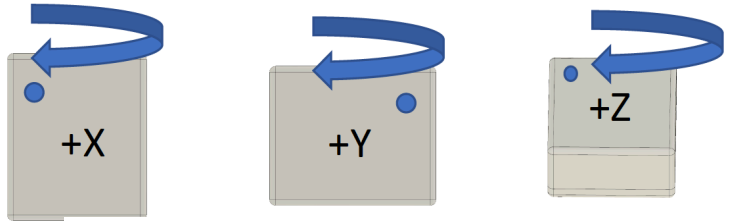
LSM6DSOTR

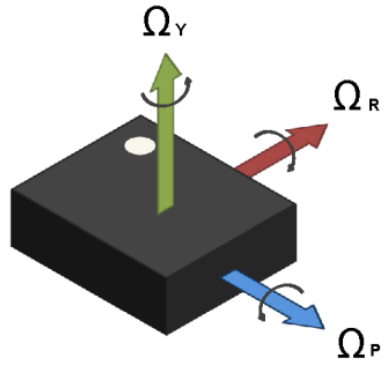
- 1.71 V – 3.6 V
- SPI protocol
- Calibrated with **imucal** Python library

Ferraris Calibration / Acc

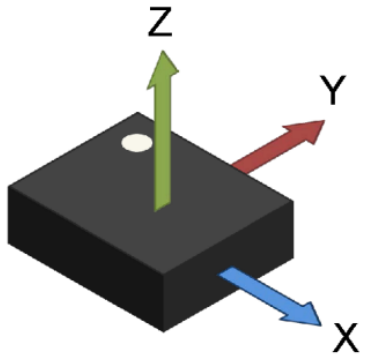


Ferraris Calibration / Gyro (Rotate clockwise)





Direction of detectable angular rate (top view)



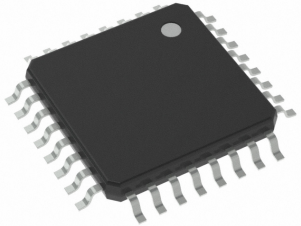
Direction of detectable acceleration (top view)

Inertial Measurement Unit (IMU)

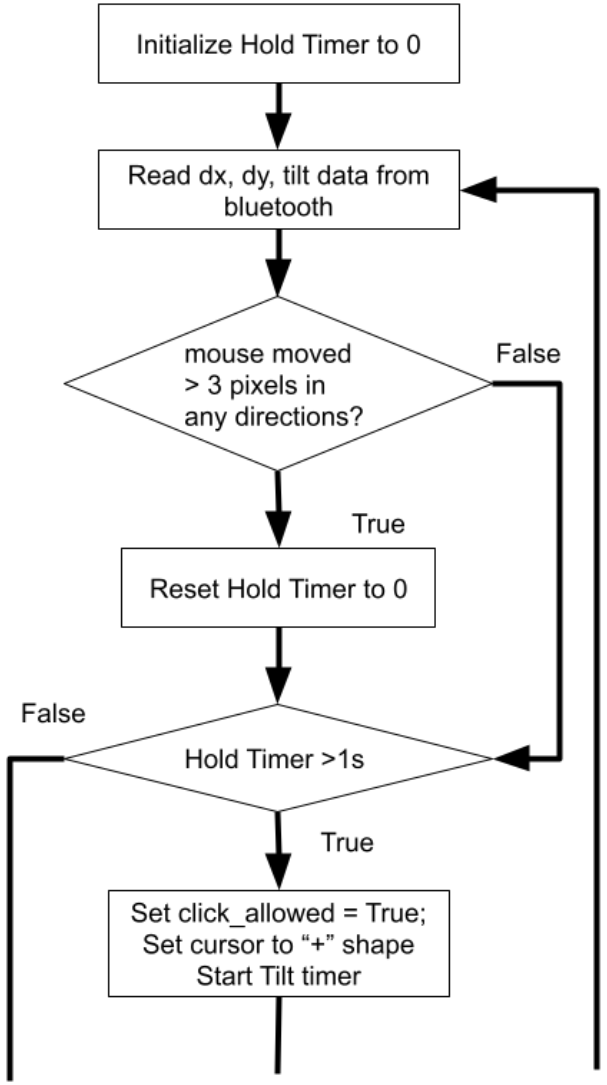
Calibration:

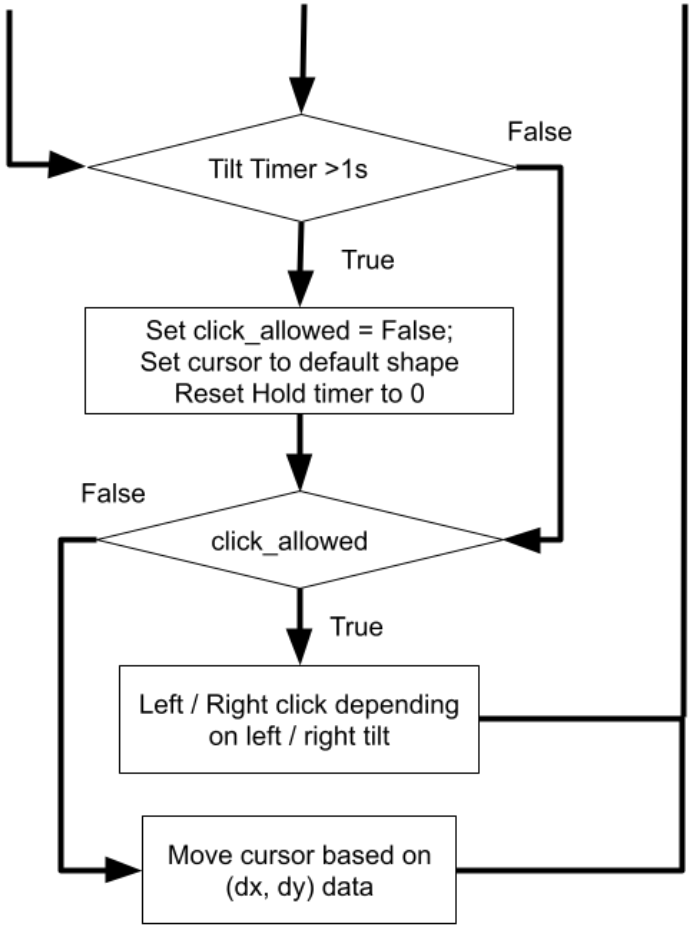
Microcontroller

ATMEGA328



Core Size	8-Bit
Speed	20MHz
Connectivity	I²C, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	23
Program Memory Size	32KB (16K x 16)
Program Memory Type	FLASH
EEPROM Size	1K x 8
RAM Size	2K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V

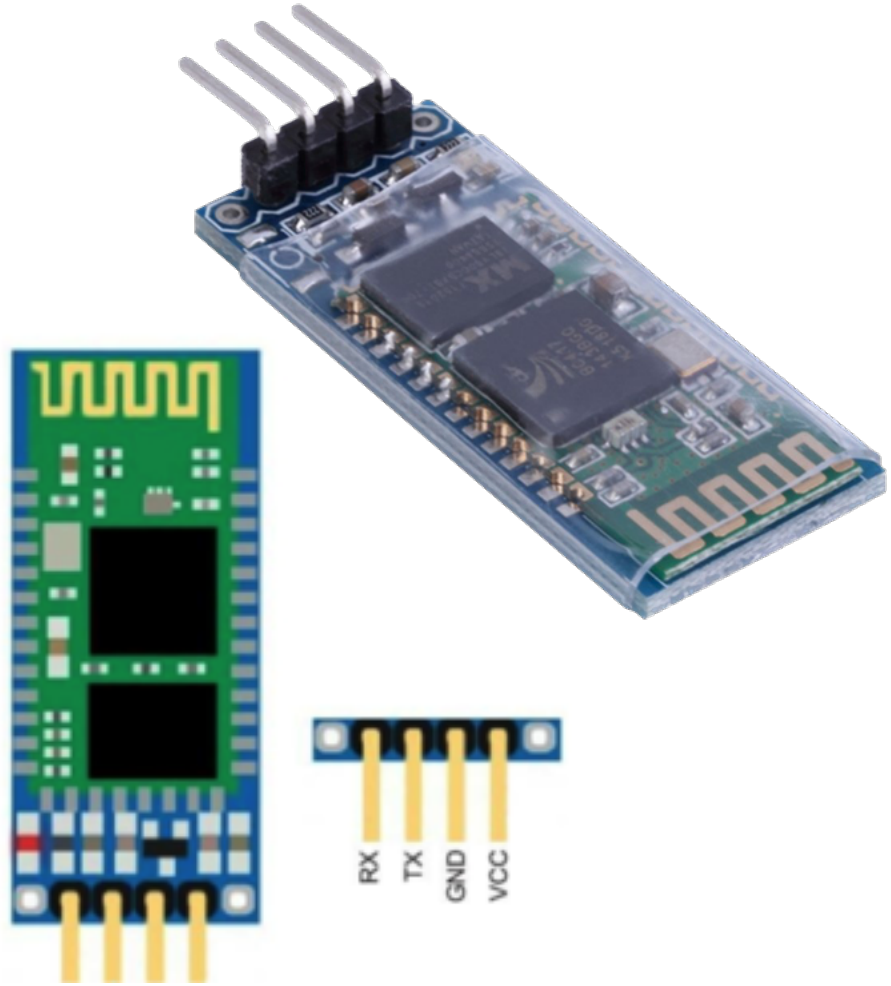




Bluetooth Transceiver

HC-06

- 3.6V to 6V
- Connects via Bluetooth with Mac, PC and Android devices
- Communicates via Serial Bluetooth port
- Can easily send and receive simple strings and integers
- Has a range of up to 9 meters (30 ft.)



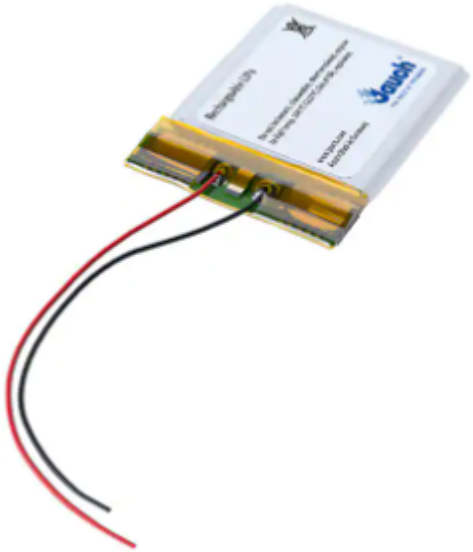
LDK120M33R (Voltage Regulator)

- 1.9 V – 5.5 V Input Voltage
- 3.3 V Output Voltage
  - 3.33 V verified w/ Voltmeter
- Used in soldering assignment

Power Supply

LP523450JU

- 3.7 V Nominal Voltage
- Rechargeable
- 20 g weight
- -20°C to +60°C operating temperature
- Lithium-Ion battery



Power Supply

USB4105

- 5V Nominal Voltage
  - 4.9 V verified w/ Voltmeter
- Alternative power source
- User cannot connect backwards
- -40°C - +85°C operating temperature

Conclusions

Considerations

- Certain head movements can cause discomfort
- The weight of the hat can cause discomfort
- Safe battery pack
- Camera-free design for privacy

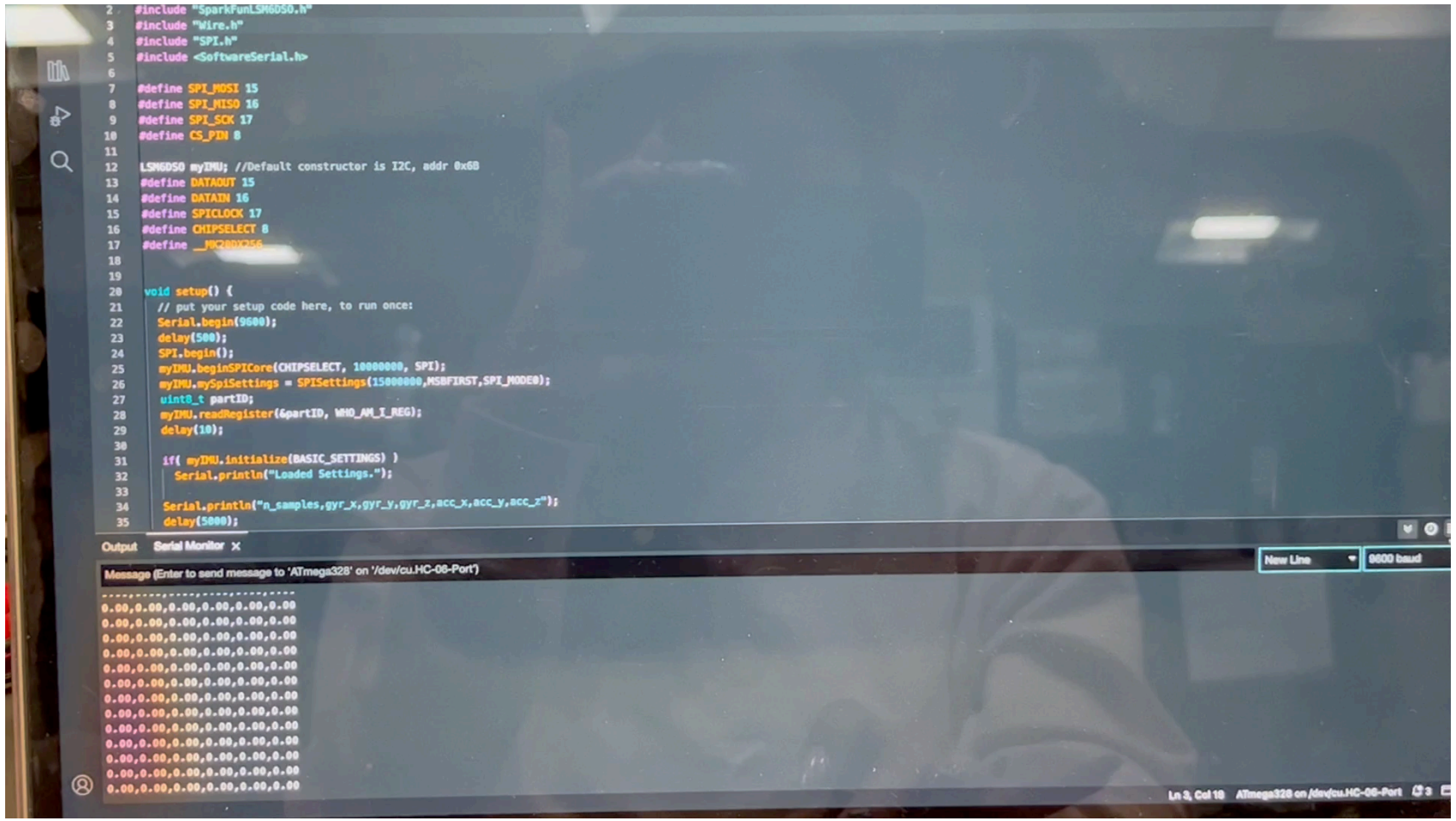
Challenges

- Soldering the IMU was difficult due to size and obscurity of pin layout
- Selecting components is a crucial part of the process
- Implementing Bluetooth and SPI communication protocols
  - Deep research of examples and documentation
- Clicking mechanics implementation
  - Implemented the crosshairs feature and use of accelerometer data
- Choosing sensitivity of movement to control cursor
  - Changed the mapping of degrees to pixels

Failures

- PCB was not fully functional
  - IMU communication could not be implemented
  - SPI Chip Select pin for IMU to microcontroller was mis-wired
- Unable to program transceiver as HID mouse
- The need of Python script prevents the mouse from being used on Tablet devices

PCB Verification



Successes

- Able to accurately move cursor on screen in relation to head movements
- Implemented user friendly left and right click functionality
- Works on both Mac and PC
- Rapid data transfer throughout subsystems
  - Total mouse speed measured at 25 Hz

Conclusion

Takeaways

- PCB design is iterative and full of delays
- Detailed design work and project scheduling will help eliminate problems down the line

Future Work

- Implement keyboard shortcuts
- Eliminate need for a program
- Scrolling and click/hold features

Questions?

The Grainger College of Engineering

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN