EMG Computer Interface

MDR - SDP Team 12

University of Massachusetts Amherst BE REVOLUTIONARY™

Refresh of SDP Team 12

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EE

Team Coordinator
Circuit Lead

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Budget Lead
Signal Processing Lead

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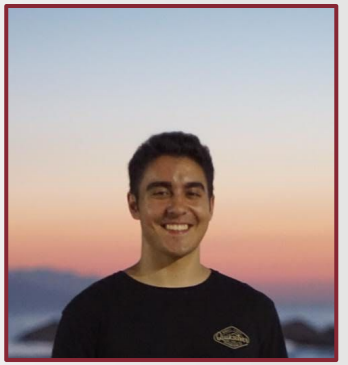
CompE

PCB Lead
Software



Berke Belge
CompE

Interface Lead
Software

Team 12 Advisor: Eric Polizzi

All parts of the project are worked on in collaboration

Revised Problem Statement

We want to emphasize touchless options for computer interfaces

While there are many products that allow for **touchless interactions** with computers, there are no comprehensive and easily customizable gestures interfaces that allow the user to **navigate and interact with a computer** without touching any common screens or buttons.

WHERE?

Academic, Company, Organization Campuses

WHAT?

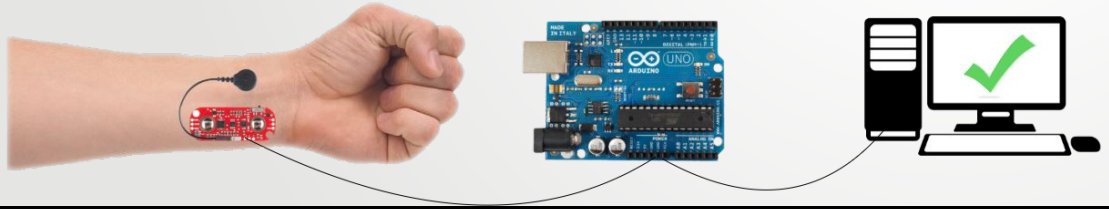
Presenting, Transactions, Lecturing

Our MDR Deliverables

- **Create custom analog EMG circuit that functions using electrodes** [Sam]

  Sense distinct, basic muscle movements using custom EMG circuitry and generate corresponding analog output

- ✓ **Convert MyoWare input into distinct keystrokes sent to computer through wired connection via Arduino** [Aidas/Berke]
- ✓ **Demonstrate basic wireless subsystem between Arduino and computer** [Ryan]
- ✓ **Demonstrate rechargeable battery subsystem** [Berke]



PDR System Specifications

1. Compatible with **any computer** that has access to wireless serial communication (Potentially add wired compatibility as backup).
2. Utilize human movement and voice to interact with computers, terminals, and kiosks in public settings and **accomplish a task** (order library book, purchase train ticket).
3. Enable customizable profiles for users to choose how to interact with various features and provide accessibility for those with disabilities.
4. Ergonomic enough to be **worn through the workday** and not impede normal writing or typing capabilities.
5. Connection time to an interface shall take less than 1 minute.
6. Battery life sufficient for everyday use (3 hours actively using the device) and rechargeable.

PDR System Verification

1. Interface wirelessly with a computer in M5 to reserve parts or UMass library computers to check out a book.
2. Demonstrate the capability to customize and then switch to another interface profile.
3. Demonstrate writing a simple sentence on paper while wearing the device.
4. Test that the average connection time to the interface takes under a minute.
5. Demonstrate that batteries are rechargeable and sufficient for everyday use by actively using the device for 3 hours.

Updated Interface Specification & Verification Plan

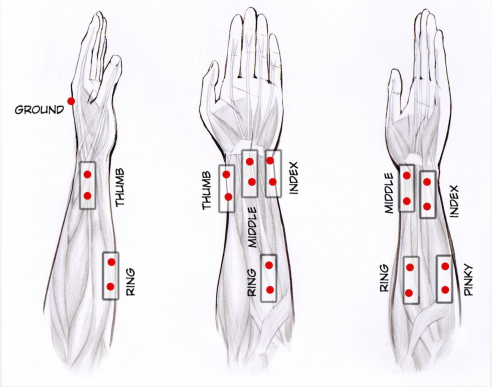
Requirement	Description	Verification
Sensing Accuracy/Gesture Recognition	Sensing system will translate and transmit inputs with better than **90% true positive/negative** and less than **10% false positive/negative** rate for **10 distinct gestures**. I.e. Fist, thumbs up, pointing	Test that the sensing system can meet true positive/negative and false positive/negative percent specifications over 100 trials for each gesture
Reliability	Performance of the device must be consistent regardless of changes in between use	Demonstrate that **Sensing Accuracy** verification holds when pads are intentionally misplaced and across three different users
Pre-Input Time	The time between stepping in front of an interface and inputting commands **will be less than 1 minute**	Test that pre-input connection time is on average less than a minute over 100 trials
Power Consumption	The device should have sufficient battery life to last throughout a work day and be in **active use for three hours**	Demonstrate that device can be actively used for at least three hours by measuring current draw

Updated Physical Specification & Verification Plan

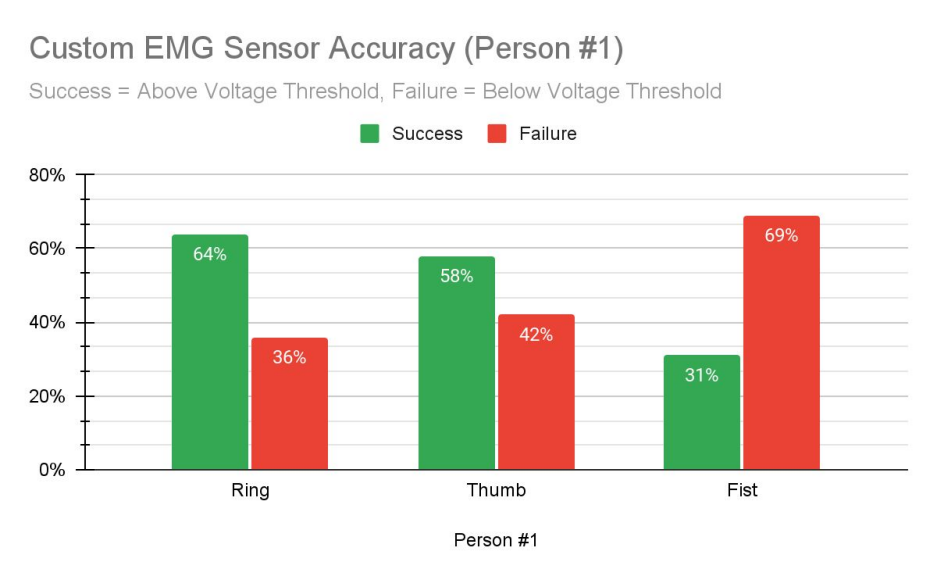
Requirement	Description	Verification
Ergonomics	User must be capable of writing on paper and utilizing phone while wearing device	Demonstrate the ability to write a paragraph and utilize a cellphone to make a call
Interface Distance	User must be capable of utilizing device to interface with a computer **up to 10 meters away**	Demonstrate the ability to connect device and use from multiple distances (10 increments) up to 10 meters away from the computer
Customizability	Allow **custom mapping of up to 10 human movements to distinct inputs**	Verify that all keyboard inputs can be custom bound to distinct movements (each finger and any finger combination)

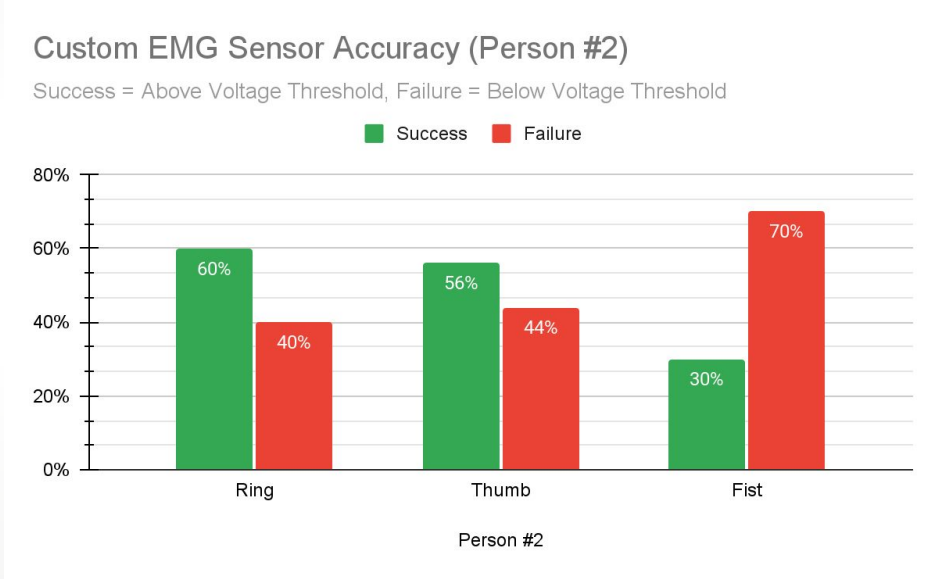
MDR Deliverable: Custom EMG Circuit

1. Minimum Voltage Threshold → Detect Muscle Activity
2. Accuracy of the Sensor → Consistent Voltage Readings
3. Tested using one sensor to take 100 readings of the thumb, ring, and fist locations



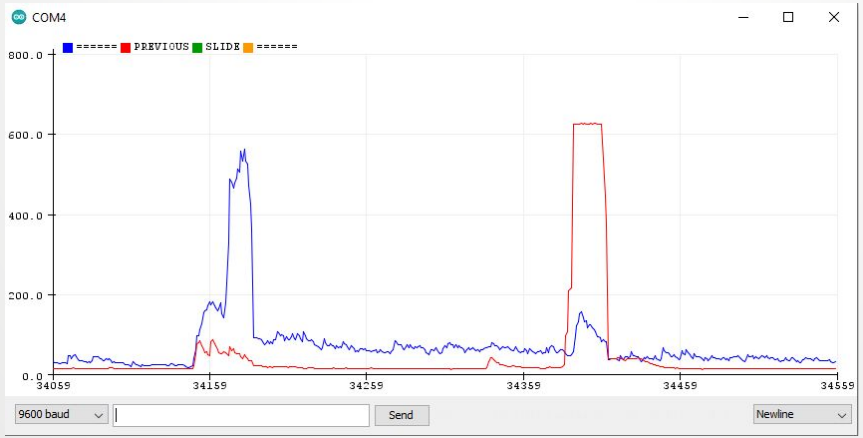
Verification: Custom EMG Circuit



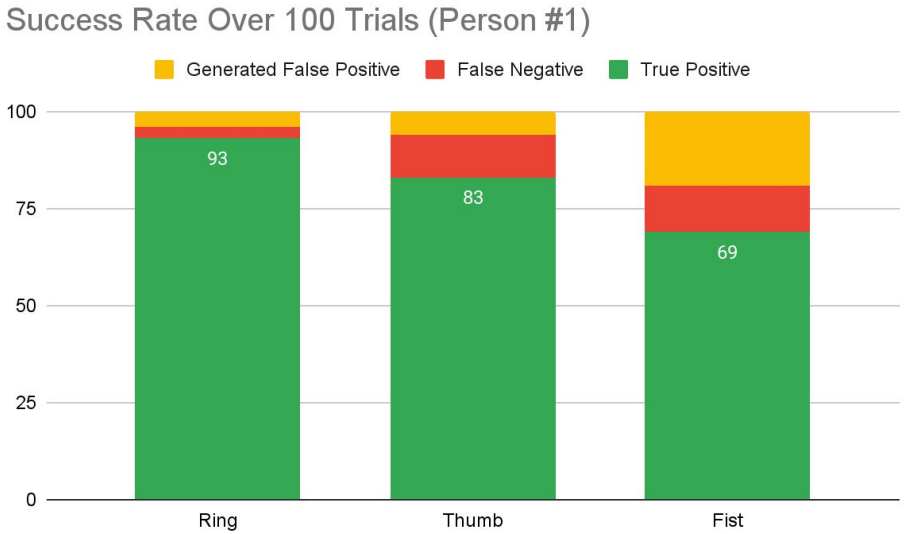


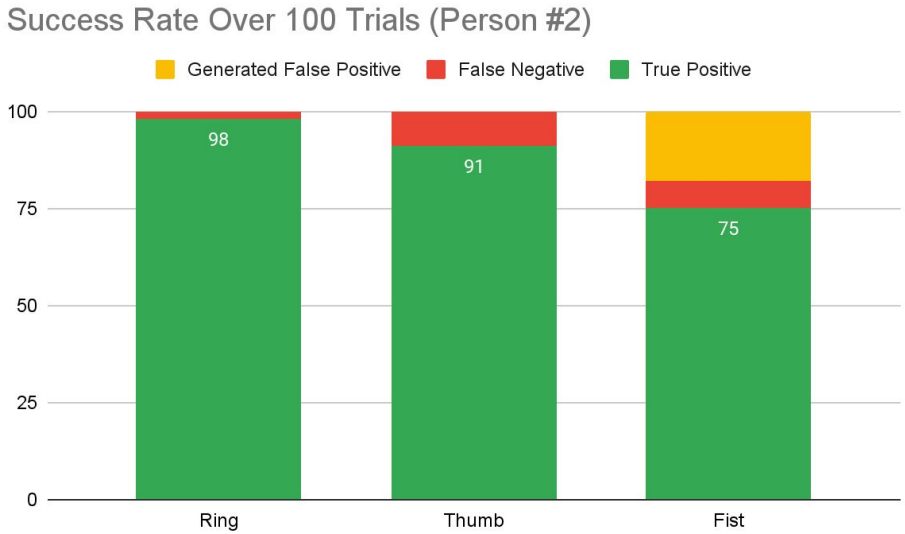
MDR Deliverable: MyoWare & Arduino to Keyboard Input

1. Thresholds Detection → Recognize Muscle Contractions
2. Falling-Edge Detection → Ensure Only One Gesture Is Processed
3. Two Sensors → Three Gestures (Ring Finger, Thumb, Fist)



Verification: MyoWare & Arduino to Keyboard Input

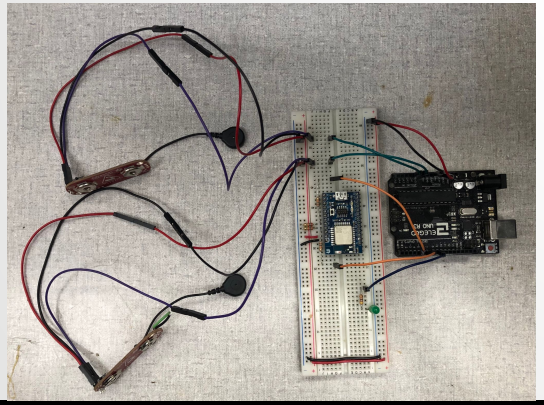




Hand Gestures over Bluetooth

MDR Deliverable

- HID GATT profile, custom hardware configuration, BGscript flashed to BLE112
- Script sets up I/O pins to wait for IRQ from Arduino
- Sends keystroke dependent on activated pin



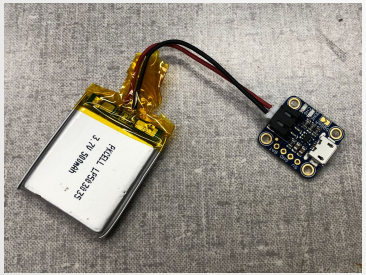
Verification

- Success rate dependent on threshold detection
- BLE link layer protocol uses ACKs
  - Resistant to lost packets
- 100% transmission rate in our trials
- Latency was negligible

Battery System

MDR Deliverable

- LiPoly 2124 backpack battery charging system to recharge via micro-usb
- Li-Polymer 503035 500mAh 3.7V battery to store energy
- One battery will power all four MyoWare, BLE112 Bluetooth module, and ATmega328P microcontroller



Verification

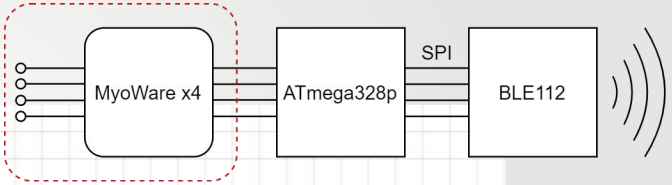
Total 4xMyoWare Current Draw:
14mA at max draw * 4 sensors = 56mA

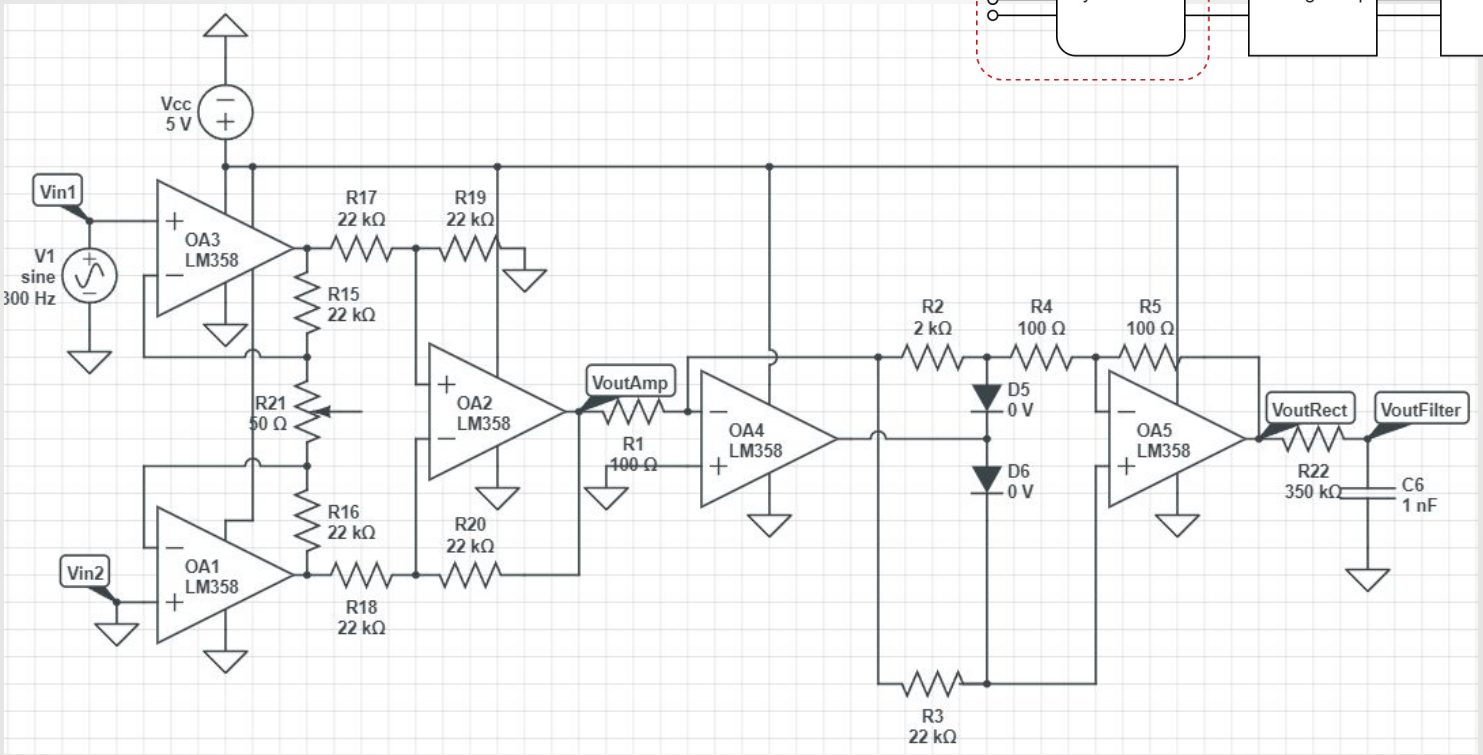
BLE112 Bluetooth Module:
Max 36mA, typical 25mA
ATmega328P: Typical 0.5mA

Total Current Draw: 56mA+25mA+0.5mA = 82mA

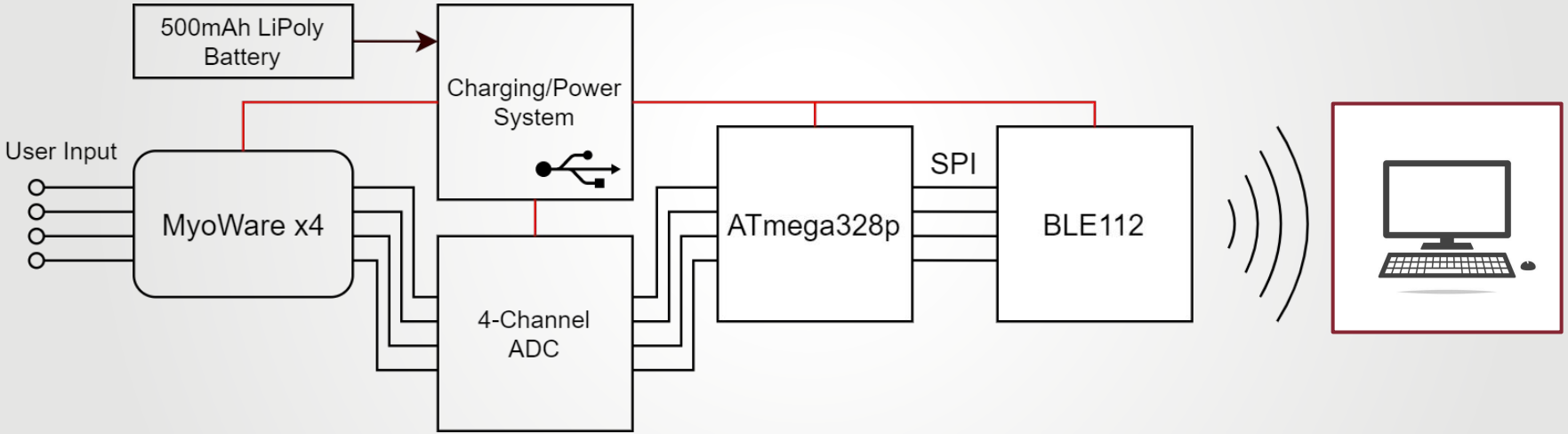
Total Hours of Power: 0.5A*hours / 82mA = 6 hours

Updated EMG Circuit Diagram

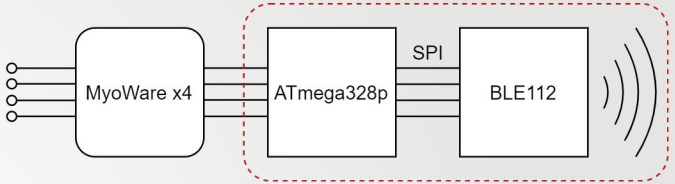


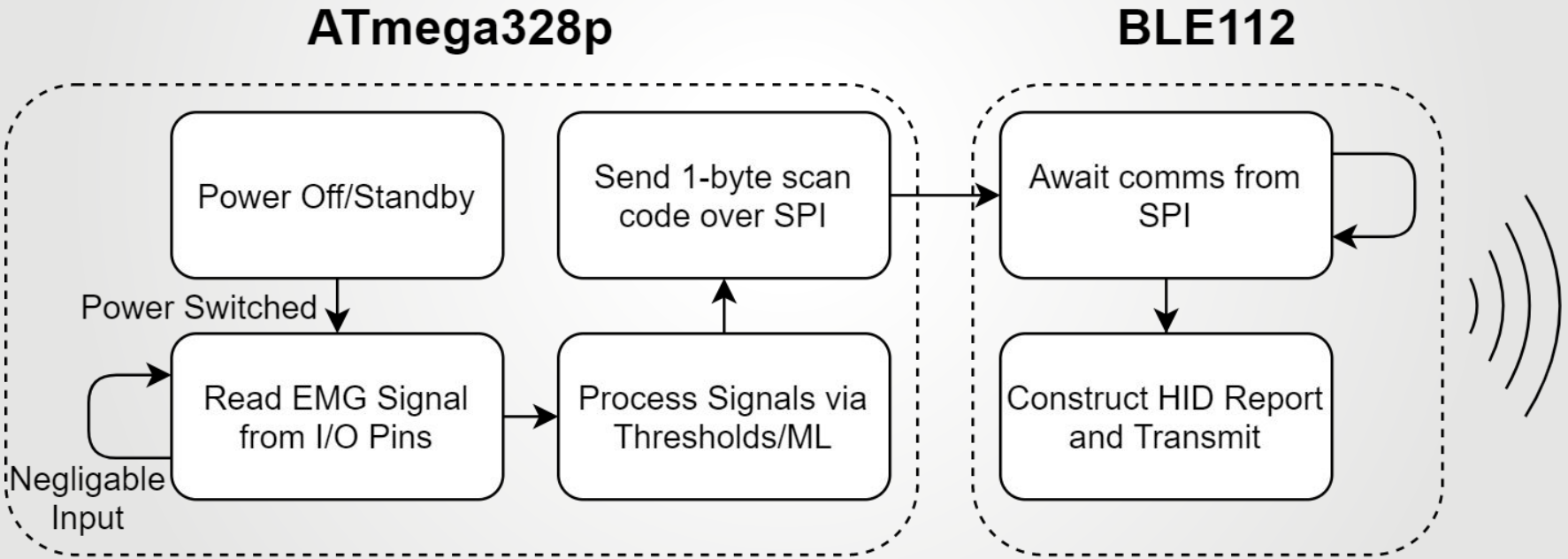


Updated Hardware Block Diagram

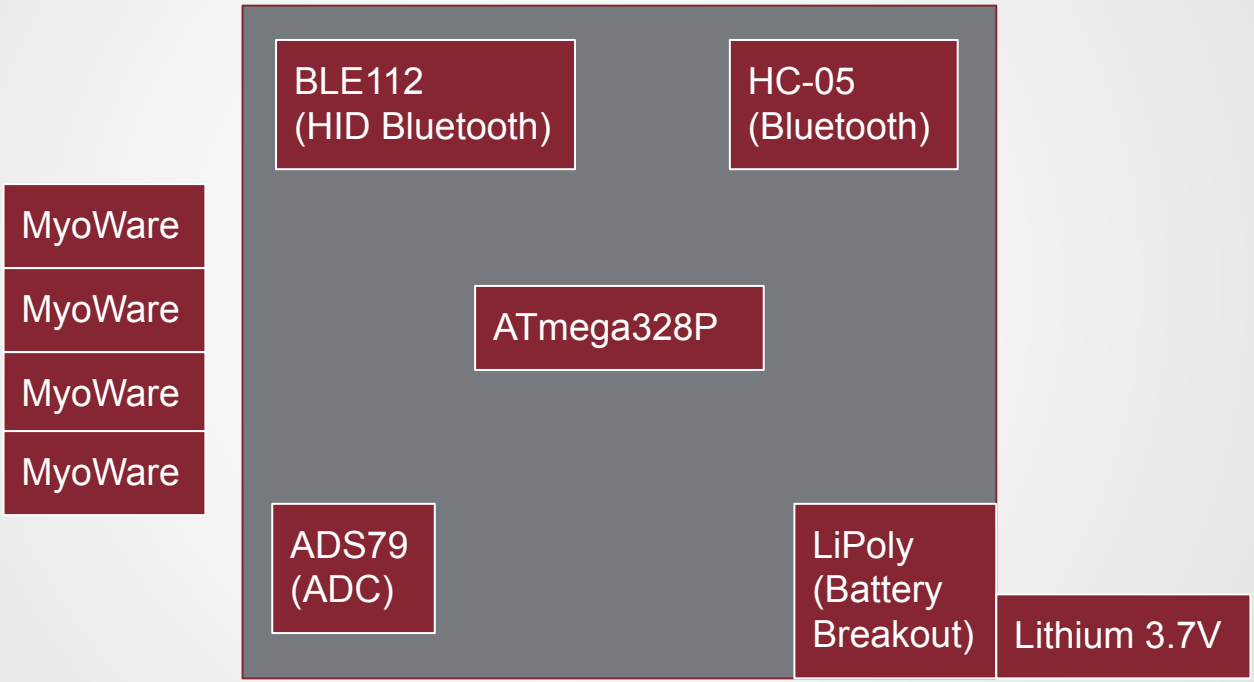


Updated Software Block Diagram





Custom PCB Plan



Budget Breakdown

Generic Name	Specific Name	Cost	MDR or FDR
Analog to Digital Converter (2 count)	ADS79	$10	Both
Microcontroller	ATmega328P	$15	Both
Bluetooth Module (2 count of each)	HC-05	$10	Both
	BLE112 Breakout Board	$24	MDR
	BLE112-A-V1	$54	FDR
USB-to-Serial Breakout	FT232RL	$25	MDR
Rechargeable Battery Setup	2124 Battery Backpack	$20	Both
MDR Components (Op Amps, Resistors, Capacitors, etc.)	Misc.	$30	MDR
Myoware Sensor (4 count)	Sparkfun Myoware Sensor	$160	Both
Electrodes (120 count)	Versa-Trode Electrodes	$36	Both
Onboard Components (Op Amps, Resistors, Capacitors, etc.)	Misc.	$30	FDR
PCB	TBD	$40	FDR
TOTAL COST		**$454.00**	

Gantt Chart

				Wk 1					Wk 2					Wk 3					Wk 4					Wk 5					Wk 6					Wk 7					Wk 8 - CDR				
MDR Subsystem Review	**TASK OWNER**	**START**	**END**	1/17	1/18	1/19	1/20	1/21	1/24	1/25	1/26	1/27	1/28	1/31	2/1	2/2	2/3	2/4	2/7	2/8	2/9	2/10	2/11	2/14	2/15	2/16	2/17	2/18	2/21	2/22	2/23	2/24	2/25	2/28	3/1	3/2	3/3	3/4	3/7	3/8	3/9	3/10	3/11
Hardware		**01/17**	**03/11**																																							
EMG Sensor Array PCB	Sam	01/17	02/04																																							
ADC, Microcontroller PCB	Ryan/Aidas	01/17	02/11																																							
EMG Sensor Array PCB Verification	Berke	02/07	02/25																																							
ADC, Microcontroller PCB Verification	Sam	02/14	02/25																																							
Ergonomic Electrode Setup	Aidas	02/14	03/04																																							
Software		**01/17**	**03/11**																																							
Microcontroller Programming	Berke/Ryan	01/17	01/28																																							
Machine Learning Algorith	Aidas	01/17	02/04																																							
Bluetooth SPI Setup	Ryan	01/31	02/11																																							
Machine Learning Training	Sam	02/07	02/25																																							

Thank you

Questions?

Backup Video for MyoWare, Arduino, and Bluetooth Combined Deliverables