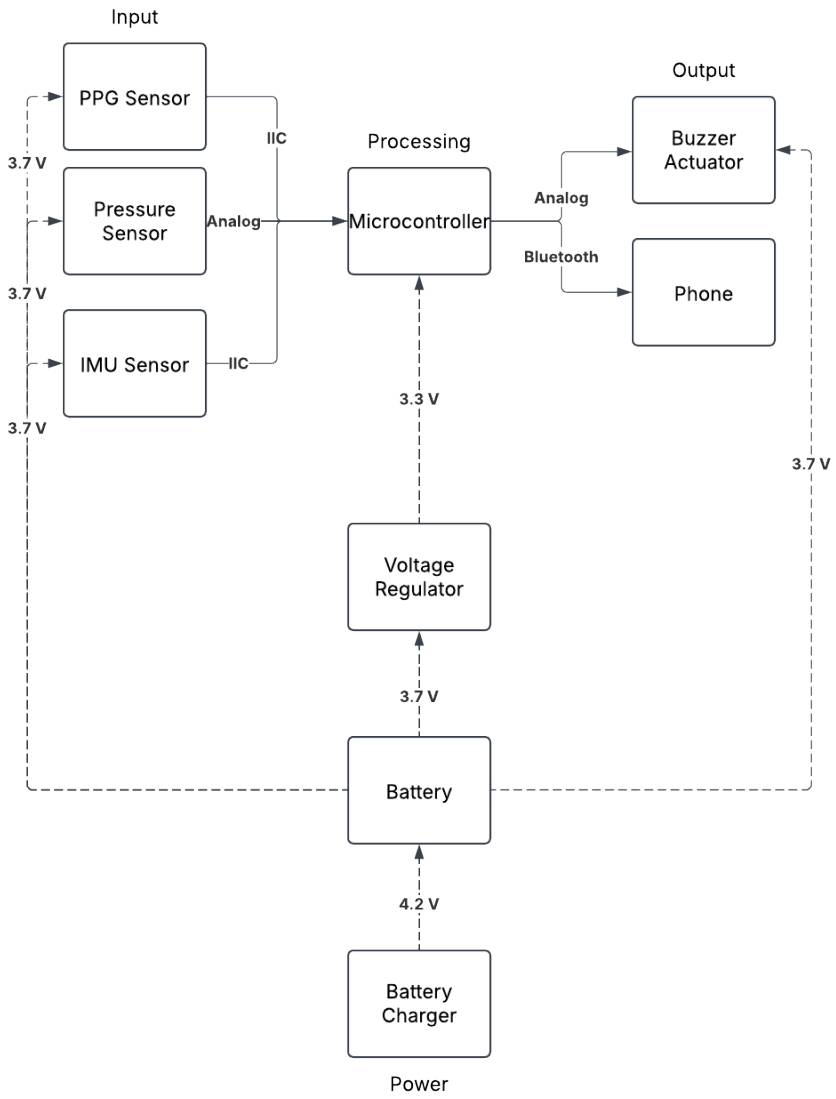
Kaylyn King
CSCE 5612
Anxiety Symptoms Detector Wrist Band Project

Milestone 2

System Architecture Diagram

Anxiety Symptoms
Detector Wrist Band
Block Diagram



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Hardware Component Selection

Parts	Specs	Justification	Alternatives	URL
IMU: HiLetgo 3pcs GY-521 MPU-6050 MPU6050 3 Axis Accelerometer Gyroscope Module 6 DOF 6-axis Accelerometer Gyroscope Sensor Module 16 Bit AD Converter Data Output IIC I2C for Arduino	• **Communication Mode**: standard IIC communication protocol • **Power supply**: 3-5V • **Gyroscope Range**: +/- 250 500 1000 2000 degree/sec • **Acceleration Range**: +/- 2 +/- 4 +/- 8 +/- 16g • **Dimensions**: 20 X 16 mm	• A more affordable IMU that comes with multiple sensors. • Seems to have decent reviews and is relatively compact.	https://www.digikey.com/en/products/detail/dfrobot/SEN0142/6588492 More expensive option for an IMU. Good backup in case other sensors do not work.	https://www.amazon.com/dp/B00LP25V1A?ref=ppx_yo2ov_dt_b_fed_asin_title&th=1
PPG: MAXREFDES117#	• **Input Voltage**: 2 to 5.5 V • **Input Current**: 1.5mA • **Communication Mode**: IIC • **Dimensions**: 0.5 x 0.5 in	• Best PPG sensor I could fine within a reasonable price. • The sensor is compact and seems reliable.	https://www.amazon.com/dp/B09784YPLB?ref=ppx_yo2ov_dt_b_fed_asin_title&th=1 https://www.amazon.com/dp/B09LQDW27N?ref=ppx_yo2ov_dt_b_fed_asin_title	https://www.digikey.com/en/products/detail/analog-devices-inc-maxim-integrated/MAXREFDES117/6165562

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			These options did not have good specifications and seemed to have bad reviews. It would be difficult to figure out how to integrate it into my device.	
Pressure: 2Pcs RP-L Film Pressure Sensor Pressure Detector Flexible	• **Pressure Sensing Range**: 20 g to 10 kg • **Communication**: Analog output	• This sensor is flexible and thin so that it can be formed into a wrist band. • Easy to integrate it into the device.		https://www.amazon.com/dp/B0BLGT1F5F?ref=ppx_yo2ov_dt_b_fed_asin_title

sEMG: MyoWare 2.0 Muscle Sensor	• **Voltage Input**: 2.2 – 5.47V
	• **Input Current**: 250 pA
	• **Analog Outputs**:
	  ○ *RAW Output*: Direct muscle signal
	  ○ *RECT Output*: Absolute value of EMG signal
		• The only sEMG sensor I could find that does not require long cables.
		• **Decided to not incorporate this because of the price, its accuracy, and the size.**
				https://learn.sparkfun.com/tutorials/getting-started-with-the-myoware-20-muscle-sensor-ecosystem/myoware-20-muscle-sensor

	○ *ENV Output*: Processed Signal • **Size**: 37.57 x 35.90 mm			
Microcontroller: Seeed Studio XIAO ESP32C6- 2.4 GHz WiFi 6, Bluetooth 5.3, Zigbee, Thread (802.15.4), ESP Rain Maker, AWS IoT, Support Microsoft Azure, Smart Home	• **Operating Voltage**: 3.3V • **Power Consumption**: ○ *Active Mode*: 150 – 200 mA ○ *Low Power*: < 10 uA • **Wireless Communication**: Wi-Fi 6, Bluetooth 5.3, Zigbee & Thread • **Wired Communication**: IIC, SPI, UART, USB-C, GPIO • **Size**: 23.5 x 17.5 x 3.9 mm • **CPU**: ○ *High-Performance Core*: 160 MHz ○ *Low-Power Core*: 20 MHz • **Memory**: ○ *SRAM*: 512 KB ○ *Flash Storage*: 4 MB	• This is a microcontroller that I am used to since we use it in class, therefore I know it is reliable. • Relatively compact and offers Bluetooth.		https://www.amazon.com/dp/B0D2NKVB34?ref=ppx_yo2ov_dt_b_fed_asin_title&th=1

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Buzzer: GT-0903A	• **Rated Voltage**: 2.0 V • **Operating Voltage**: 2.0 – 4.0 V • **Mean Current**: 80 mA • **Coil Resistance**: 15 +- 15% • **Dimension**: 9.0 mm diameter, 5.0 mm height • **Communication**: analog drive signal	• The smallest buzzer that I can find so it can fit in a compact wrist device. • Comes from a reputable site as well.	https://www.amazon.com/dp/B07VRK7ZPF?ref=ppx_yo2ov_dt_b_fed_asin_title Bigger buzzer but cheaper option. Less reputable brand with fewer specifications.	https://www.digikey.com/en/products/detail/soberton-inc/GT-0903A/1245334
Battery Charger: 333014	• **Max output current**: 1 A • **Logic Voltage Level**: 5V • **Operating Voltage**: 4.5 – 5.5 V • **Dimensions**: 27 x 17 mm • **Connector Type**: JST-PH 2.0 mm 2-pin • **Input Type**: USB-C port	• Allows for recharging of li-ion battery from USB-C port. • Has correct connector type. • Provides safe powering of the battery.		https://mm.digikey.com/Volume0/opasdata/d220001/medias/docus/5858/333014%20Li-ion%20charger%20with%20protection%20datasheet.pdf?_gl=1*cmu3iz*_up*MQ..*_gs*MQ..&gclid=Cj0KCQjwqIm_BhDnARIsAKBYcmsS8N61UKvoNMVUbZ36dtyF7lVAyKlNHCbFUO1Iv066HlyFTVCyPoMaAl4LEALw_wcB&gclsrc=aw.ds

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Battery: PRT-13854	• **Connector**: JST-PH 2.0 mm 2-pin • **Nominal Voltage**: 3.7 V • **Capacity**: 1000mAh • **Discharge Rate**: 1A • **Dimensions**: 50 mm length, 34 mm width, 5.5 mm thickness, 20 g weight	• Compact enough to fit on a wrist device. • Supplies enough power for all parts. • Allows for recharging of device.		https://www.digikey.com/en/products/detail/sparkfun-electronics/PRT-13854/6605201
Voltage Regulator: AMS1117-3.3	• **Output Voltage**: 3.3 V • **Input Voltage Range**: 2.5 – 6 V • **Output Current**: up to 600 mA	• Within range for input and output power for my device • Needed for microcontroller		https://www.digikey.com/en/products/detail/diodes-incorporated/AP2112K-3-3TRG1/4470746?gclsrc=aw.ds&&utm_adgroup=Integrated%20Circuits&utm_source=google&utm_medium=cpc&utm_campaign=Dynamic%20Search_EN_Product&utm_term=&utm_content=Integrated%20Circuits&utm_id=go_cmp-120565755_adg-9159612915_ad-

				665604606680_dsa-112117096155_dev-c_ext-_prd-_sig-Cj0KCQjwqIm_BhDnARIsAKBYcmv2jHWw6owGQuNUc_Iift3kdAaoqbgi55JR9JYN83RpTiEKo_8g0VYaAnpJEALw_wcB&gad_source=1&gclid=Cj0KCQjwqIm_BhDnARIsAKBYcmv2jHWw6owGQuNUc_Iift3kdAaoqbgi55JR9JYN83RpTiEKo_8g0VYaAnpJEALw_wcB&gclsrc=aw.ds

Power Consumption Analysis

Power Consumption (excluding sEMG sensor)

Part	Voltage (Assume Avg)	Current	Power Consumption
IMU	3.7 V	3 mA	11.1 mW
PPG	3.7 V	1.5 mA	5.55 mW
Pressure	3.7 V	Assuming .27 mA	Assuming 1 mW
Microcontroller	3.7 V	175 mA	577.5 mW
Buzzer	3.7 V	80 mA	296 mW

Total (Active): 891.15 mW

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(Passive): 33 uW

Power Source

Rechargeable Li-ion battery: Allows for the device to be rechargeable for continuous use.

Charger: Will charge the Li-ion battery with USB-C port since it is the most universal port and allows for safe powering.

Power Efficiency Strategies

Bluetooth Low Energy: More efficient when compared to Wi-Fi for wireless communication.

Light Sleep: This will be the main mode of the device. The peripherals and memory will remain active while CPU sleeps, allowing a wake up time faster than deep sleep. When the device is worn, it only needs to actively respond when anxiety symptoms are present. The device will fully wake up when a threshold is met on the pressure, PPG, and IMU sensor signaling anxiety.

Deep Sleep: The device will go into deep sleep when it registers that the device has been taken off. This will be done through the PPG sensor by detecting there is “no pulse”.

Other: The buzzer will only go off when the device detects anxiety symptoms, therefore the average power drawn from the buzzer will be less.

Communication and Data Flow

Communication Between Components

IIC Protocol: IMU, PPG -> Microcontroller

Analog: Pressure (output -> Microcontroller), Buzzer (Microcontroller -> input)

Wireless: Microcontroller -> phone

Data Processing

1. Data will be gathered from the sensors while the person wears the device
2. Data will be sent to the microcontroller for processing
3. Microcontroller sends data to phone via Bluetooth, and sends signal to buzzer if algorithm detects anxiety

Data Retrieval and Logging

Local Storage: Microcontroller will save data in Excel format to easily process data on the computer.

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Mobile Application (if time allows): Save data to a mobile application to visualize data and show trends in behavior.

System Integration Challenges and Solutions

1. **Maintaining small size for wrist device**
    a. Chose devices that are small and lightweight
    b. Utilized a multi-layer PCB to manage space
    c. Decided to not use sEMG sensor to keep device small and wearable
2. **Accurately predicting anxiety symptoms**
    a. May have to use sensor fusion algorithms to minimize noise and combine data
    b. Make sure sensors are calibrated
    c. Replace faulty sensors
3. **Software Complexity**
    a. Use modular software design to make it easier to maintain
    b. Remove the application idea if it takes too much time, and just giving the phone a notification when the device notices symptoms.