Practicum Product Design Specification (PDS) Outline

—Version 2
2024/10/31
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- **Short Descriptive Name**
  - M.I.A.O. System (Muscle Intelligent Analyzing and Optimization)
- **Executive Summary with Concept of Operations (2 pts)**
  - Our products can be used in monitoring the condition of people's muscles by collecting the electric signals from the muscle, then it will calculate the variance and maximum value of the EMG signal captured by the sensor within 5 seconds and then compare it with the initial variance and maximum value. When the variance and maximum value of the signal reach the set value (such as the initial 80%, the device will judge that you have completed the training), the motor will give a vibration cue when the user's muscle power declines to a setting value and the screen will show the muscle strength and exercising time during the process of exercising.
  - When exercising, usually people don't know the condition of muscles, then, they'll exercise too much or less, which makes them feel sick after the exercise or feel nothing. In this condition, we come up with an idea that we can make a device to monitor the condition of muscle, this device can also encourage the user to exercise more or prevent the user from harm by over-exercising.
  - Sports lovers and Fitness enthusiasts will use it.
  - When the user use it, he can just stick it onto the user's arm, then turn it on, then the device will monitor the electrical signals from the user's arm, and the microprocessor will analyze the signal and give the user a suggestion for the user's exercising through the screen, like "Your muscle signal shows that you're stronger than yesterday! Keep going!", or it can stop users from over-exercising, like "You are suggested to finish your work, otherwise hurt!" with the vibration cue given by the motor.
  - Users can just stick the sensor onto their skin,tap "start", then do their exercise. When they finish a group of training, the device will tell them if they have met the scientific fitness requirements through the vibration cue provided by the motor and the screen on the device.
- **Brief "Market" Analysis (2 pts)**
  - The device targets fitness enthusiasts and athletes who want real-time feedback to improve workouts. Personal trainers and physical therapists could use it to track clients' progress.
  - Our products are more portable than many professional equipment used to analyze muscle strength. This device can also come with a music playback function, providing a relaxing atmosphere for fitness. It can be equipped with a dedicated user-friendly design app if there are any follow-up requirements. Most importantly, due to its relatively simple structure, the product cost is much lower than that of similar professional equipment.
  - This product can be sold for approximately $80, as it is mainly aimed at most ordinary fitness enthusiasts and has low research and development costs. If successfully developed, it will be a widely popular affordable product.

- **Requirements (4 pts)**

Must:
1. The M.I.A.O. system must filter and amplify the input EMG signal, removing noise effectively.
2. The LCD must display the intensity curve of the amplified EMG signal over time.
3. Voltage peak protection must be implemented to ensure that the input voltage does not exceed 5.5V.
4. The circuit must be protected by a housing.
5. The recommended current for continuous contact must be below 10 microamperes (μA), and it must not exceed 1 milliampere (mA) during transient conditions.
6. The user's skin must be cleaned before the sensor comes into contact with it.
Should:
1. The material should be elastic to ensure comfort, and the equipment should not influence the user's sports performance when worn.
2. The system should trigger the rotor motor when the amplified EMG signal exceeds the specified threshold.
3. The product's rotor motor delay should be less than 0.5 seconds.
4. The product should function properly within a temperature range from -10 to 50 degrees Celsius.
5. The M.I.A.O. system should include enclosures around sensitive components to minimize interference from ambient electromagnetic fields.
6. The product's weight should be less than 50g to minimize user discomfort.
7. The system should allow users to set different sampling frequencies to meet various needs.
May:
1. The system may be equipped with a Wi-Fi module for app connectivity.
2. The sensor may use optional external cables as an alternative to the embedded electrode snaps on the sensor board.
3. The system may use raw or rectified signals as input to extract signal features using machine learning in the future.

- **System Architecture (4 pts)**

M.I.A.O System
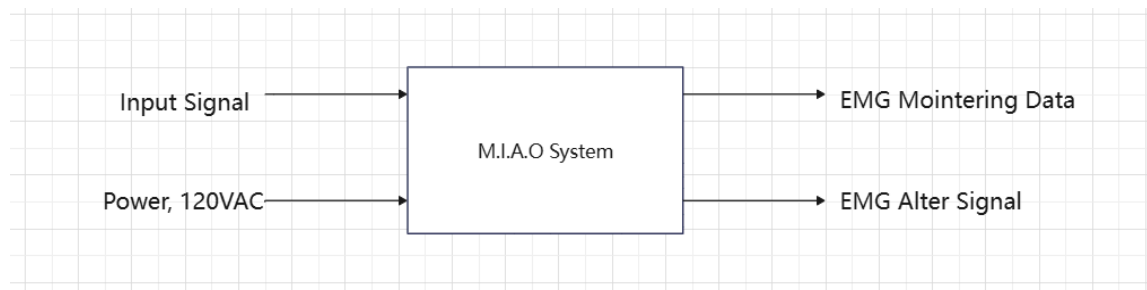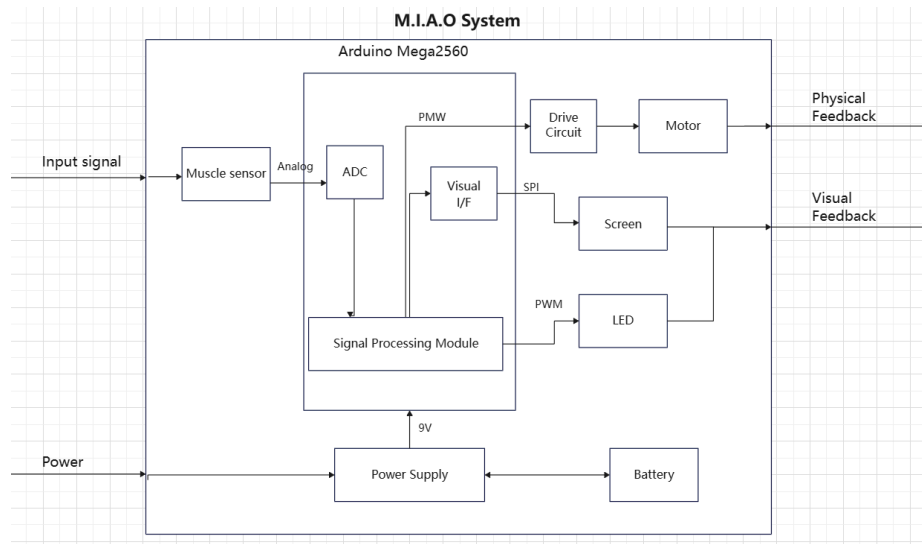
- **Design Specification (4 pts)**
  - Sensor: Myoware 2.0 Muscle Sensor
  - Processor: Arduino Mega 2560
  - Actuator: rotor motor, Screen
  - Power: lithium battery（Adafruit PowerBoost 500/1000）
  - Mechanical: Use blender to simulate, a tie to tie the device on shoulders
  - Firmware: MATLAB, Arduino IDE, KiCAD, Blender
  - Arduino or not: Yes.
  - Development environment：VScode