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Practicum Product Design Specification (PDS)

Short Descriptive Name
Posture Pad (Pressure Transducing Ergonomic Standing Mat)

Executive Summary with Concept of Operations
The project is a smart standing mat that measures and visualizes how a user distributes weight across their feet. Embedded roughly 1–2 inches below the foam surface are force-sensitive resistors (FSRs) or piezoelectric pressure sensors placed under key foot regions—the heels, arches, and toes. These sensors convert applied pressure into analog signals that are read and processed by an ESP32 microcontroller, which transmits the data wirelessly to an application. The app acts as the actuator, displaying a real-time, color-contoured map of pressure distribution so users can monitor balance and improve posture while standing. This would be used in an office environment, as an ergonomic and informative standing mat, ideally helping contribute to improved standing posture over time for the user.

Brief "Market" Analysis
The Posture Pad is designed for individuals who spend extended periods of time standing, such as office workers using standing desks, gamers, and professionals in environments that promote ergonomic wellness. These users often are seeking solutions to reduce fatigue, improve their posture, and enhance comfort during long work sessions. Additionally, physical therapists and wellness coaches may find value in the device for monitoring their patients' balance and encouraging proper posture and stance.

Existing products such as smart insoles and commercial pressure mats (e.g., Tekscan, BodiTrak) provide similar data but are typically expensive, bulky, and designed for clinical or research settings. Our design focuses on affordability, wireless connectivity, and real-time visualization, making it accessible for everyday personal or ergonomic use.

This product could be sold in the $200-500 dollar range. Typical clinical pressure sensing mats are sold for $2000 and up, while unconnected basic ergonomic foam standing mats cost from $30-150.

Requirements
<u>Must</u>
- The system must measure pressure distribution across both feet.
- The system must display a real-time visualization of foot pressure on a graphical interface.

- The system must not overheat during normal operation or under fault conditions.
- The mat surface must safely support an adult user weighing up to 120 kg (≈265 lbs).

Should
- The system should operate continuously for at least 1 hour on a full charge.
- The system should maintain accuracy across varying user weights.

May
- The system may be portable and operate without being tethered to a power outlet.
- The app may include analytics, such as daily posture summaries or fatigue alerts.
- The system may include a learning algorithm to track long-term balance patterns.

System Architecture
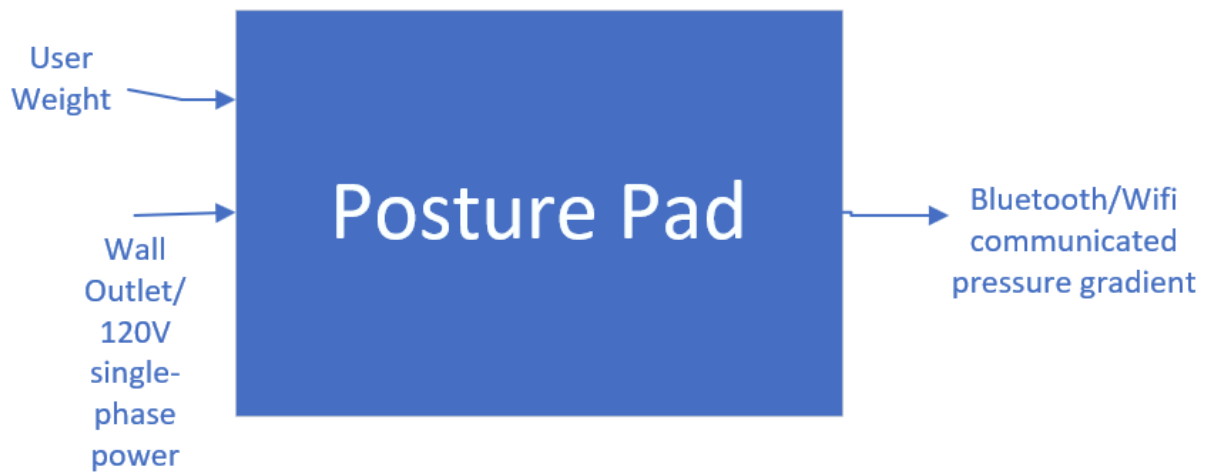
Module	Posture Pad
Inputs	-120VAC single-phase wall outlet power -Weight from user
Outputs	Bluetooth/Wifi communicated pressure gradient
Functionality	Detects force distributed across users feet and transmits sensor data via Bluetooth or Wifi to companion app

Level 0 Block Diagram
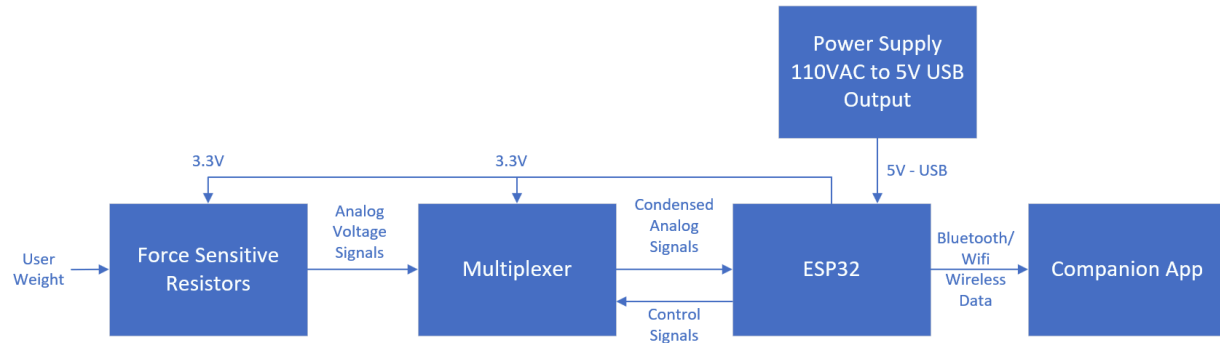
Level 1 Block Diagram

Design Specification
- Sensors: Force-sensitive resistors (FSRs) or piezoelectric pressure sensors for localized force detection.
- Processor: Arduino-compatible MCU (e.g., ESP32 for built-in Bluetooth and ADC channels).
- Wireless: Bluetooth Low Energy (BLE) for data transmission.
- Power: Standard AC wall adapter.
- Firmware: Written in C/C++ using Arduino IDE or PlatformIO; handles data acquisition, calibration, and BLE communication.
- Mechanical Design: Foam mat with embedded sensor array. Sensor PCB or flexible circuit encapsulated for durability.
- Actuator: Mobile or web application displaying a live contoured pressure mat.