Mechanical of the watch

The overall appearance of the watch is a rectangular prism with dimensions of 54mm(length)* 50mm(width) * 25mm(height). The goal of the mechanical design of the FITBOT is to ensure all electronic components are positioned appropriately while achieving comfortable wrist wear.

Design Overview:

The FITBOT includes:

- Two button for mode switching
- One power switch for turning the device on and off
- One microspeaker for alarms and other notices
    - An amplifier PAM8302
- Two sensors for detecting health monitoring
    - Pulse sensor for pulse rate
    - Pressure sensor for pressure and temperature
- One 1.5’’ SH1107 OLED screen
- 500 mAH Li-Po battery
    - PowerBoost 500 charger
- Microcontroller Arduino Nano Esp32

To successfully integrate all components within a limited internal volume, We studied the datasheet for each component carefully for mechanical specification and constraints.

- Pulse sensor needs direct contact of leds and photodetector against human skin
- There need to be walls around the edges of the pulse sensor to block outside environments
- Pulse sensor CANNOT directly touch battery to avoid heat and electrical interference
- Speaker need a small acoustic cavity to function effectively
- Space for wire and insulation

After analyzing the component specification, I build simple CAD models for each electronic component with detailed measurement of its sizes. Those models were then assembled within the watch shell to explore an effective internal layout and spatial arrangement.

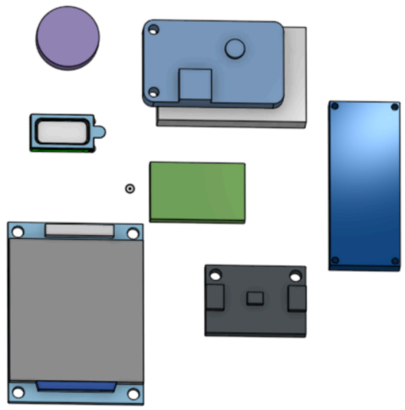

Figure 1: Simple CAD for each component : Purse sensor(purple), Pressure sensor(black), Lipo battery(gray), PowerBoost 500 Charger(light blue), Speaker(light blue and white), Speaker amplifier(green) and the Screen(bottom left)

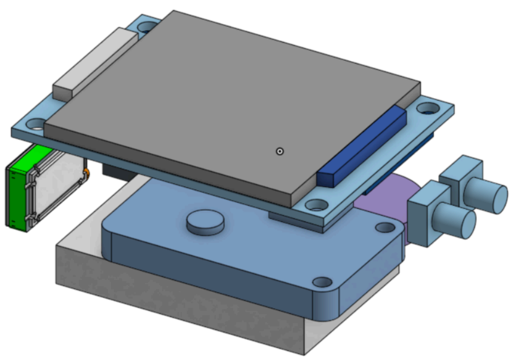

Figure 2: general layout of component with CAD model

Using the finalized component layout, the watch shell was customized to fit all components within the smallest possible internal volume. The general shape of the FITBOT was first defined, followed by detailed design of each internal feature to ensure that all components fit securely and function reliably.
All walls of the watch shell have a uniform thickness of 2 mm and are fabricated from PLA using a 3D printer, providing sufficient structural strength while keeping the device lightweight. Internal supports, cutouts, and mounting features were added to prevent component movement and simplify assembly.

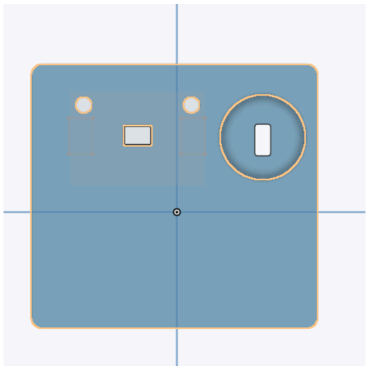

Figure 3 - bottom of the FITBOT with hole that fits the sensor, left for the pressure sensor and the right for the pulse sensor.

The bottom piece of the FITBOT is critical for health data collection. It's the place that located sensors and also batteries.The pressure sensor is located on the top-left area of the bottom plate. It is secured using two circular holes for M2 × 6 mm screws, while the central opening allows direct exposure of the sensing element. The pulse sensor is positioned on the top-right area. A custom circular recess allows the sensor to slide into the wall by 1.8 mm of the 2 mm wall thickness, ensuring close contact with the skin for accurate readings. And the battery placement at the bottom with a small gap with purse sensor.

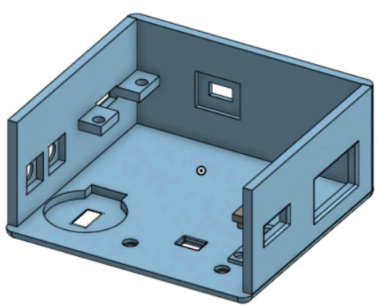

Figure 4 shows the cut out for button placement, the charger port opening and internal support of the Powerbroost charger with screw and the power switch opening on the side of the Powerbroost charger

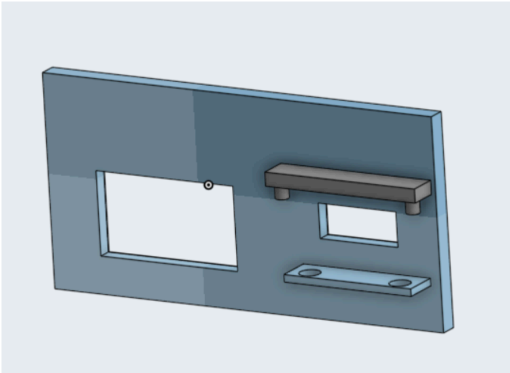

Figure 5 illustrates the inner wall structure designed to support electronic components. An opening is provided for the microspeaker, allowing sound to exit the enclosure efficiently .Integrated mounting features(right) are included to secure the microcontroller and PAM8302 amplifier, preventing movement during use. These supports ensure stable electrical connections and reduce mechanical stress caused by daily wear.

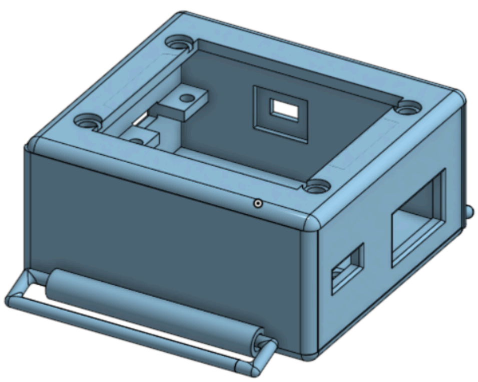

Figure 6 shows the overview of the FITBOT with all the walls

The top of the FITBOT watch features a flat recessed opening designed and mounting holes to house and secure the display module. The surrounding frame incorporates rounded corners with chamfered edges to enhance structural strength, reduce stress concentration, and improve both wearing comfort and safety. And the strap holder is integrated into the watch body as a cylindrical bar structure located at the edge of the case.

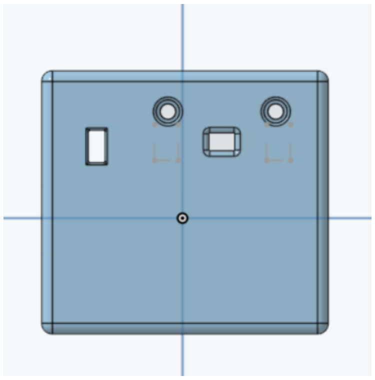

Figure 7 bottom outer surface of the FITBOT

All screw-exposed areas on the top and bottom surfaces were designed with recessed mounting points to prevent screw heads from protruding beyond the enclosure. This design choice improves wearing comfort by eliminating pressure points against the user's skin and reducing the risk of snagging on clothing, resulting in a smoother and safer user experience during daily wear.

The watch strap is made of an elastic material and incorporates a live loop adjustment mechanism, allowing the strap to conform to different wrist sizes without requiring precise manual adjustment. The elasticity distributes pressure evenly around the wrist, reducing localized discomfort during prolonged wear. The live loop mechanism also enables quick donning and removal of the watch, enhancing usability and overall user experience.

Assembly

To ensure reliable assembly and reduce the risk of component damage, all parts were installed following a defined assembly sequence. Electrical components were first placed into the case without soldering to verify correct positioning, component clearances, and sufficient wire routing space between parts.

Sensors were mounted first to ensure accurate alignment with the bottom openings of the case. The speaker was then installed into its designated hole, followed by the amplifier mounted on its internal bracket, which was positioned above the pressure sensor. The Arduino was mounted above the amplifier onto its bracket too. Next, the battery and charging module were installed in their respective spaces, and the buttons were press-fit into the side openings. Finally, the display screen was placed at the top of the assembly.

After several fitting adjustments, all components achieved proper alignment with adequate tolerances and sufficient space for wire routing. Once the layout was finalized, soldering was performed following the same installation order, and the system was fully assembled

Wiring management and Insulation of components

The case design includes dedicated internal supports that provide sufficient space for wire routing and component placement. These supports help organize the internal layout and prevent interference between components.

The wiring layout was developed based on signal and order pin location order to ensure efficient routing and reliable connections. A small PCB was used as a shared power and ground distribution board, allowing all components to connect to a common power and ground reference.

All components were connected according to the circuit diagram, and wire lengths were carefully adjusted to minimize unused space and reduce clutter inside the enclosure. After initial connections, final size adjustments were made to achieve a more compact watch profile while maintaining proper clearances for safe operation.

Once all soldering was completed, electrical tape was applied to insulate exposed metal parts and sensitive components. This insulation prevents short circuits, protects components from accidental contact, and improves the overall reliability and safety of the device.

Improvement :

- Better wiring management
    - Planning wire routes and internal spacing before soldering would help prevent tangled or chaotic wiring, it reduces unnecessary wire length, saves internal space, and simplifies assembly, also reduce wire damage by repeated bending and adjustment
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- Better way to secure the components
    - While screws were effective for securing components, installation became difficult after soldering because the electrical components were closely packed together.
- Long term using design & user experiences
    - Sealing for sensor opening and button
    - Battery or other component replacement
    - Better feature with art design or others.