

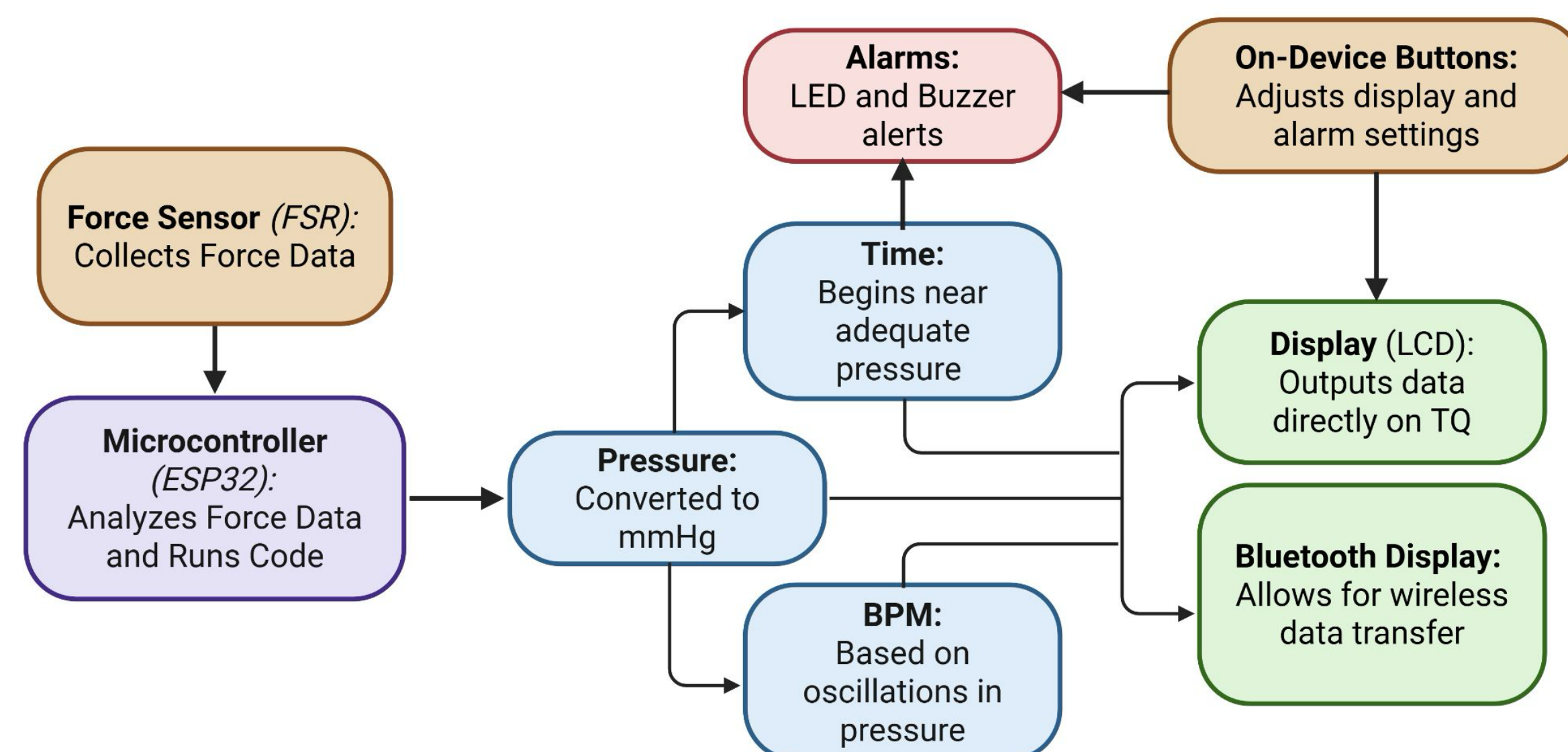
Clinical Problem

Tourniquets (TQ) are crucial for stopping life-threatening limb bleeding, especially in combat settings. However, prolonged use can cause severe complications. After a few hours, restricted blood flow can lead to tissue damage or organ failure, sometimes requiring limb amputation. Because these risks depend heavily on how long the tourniquet is applied, inconsistent time tracking in emergency settings limits intervention and worsens outcomes.

Our Goal

Design a tourniquet that can accurately record application time and pressure, alert medics to reassess patients, and relay this data to a centralized external system.

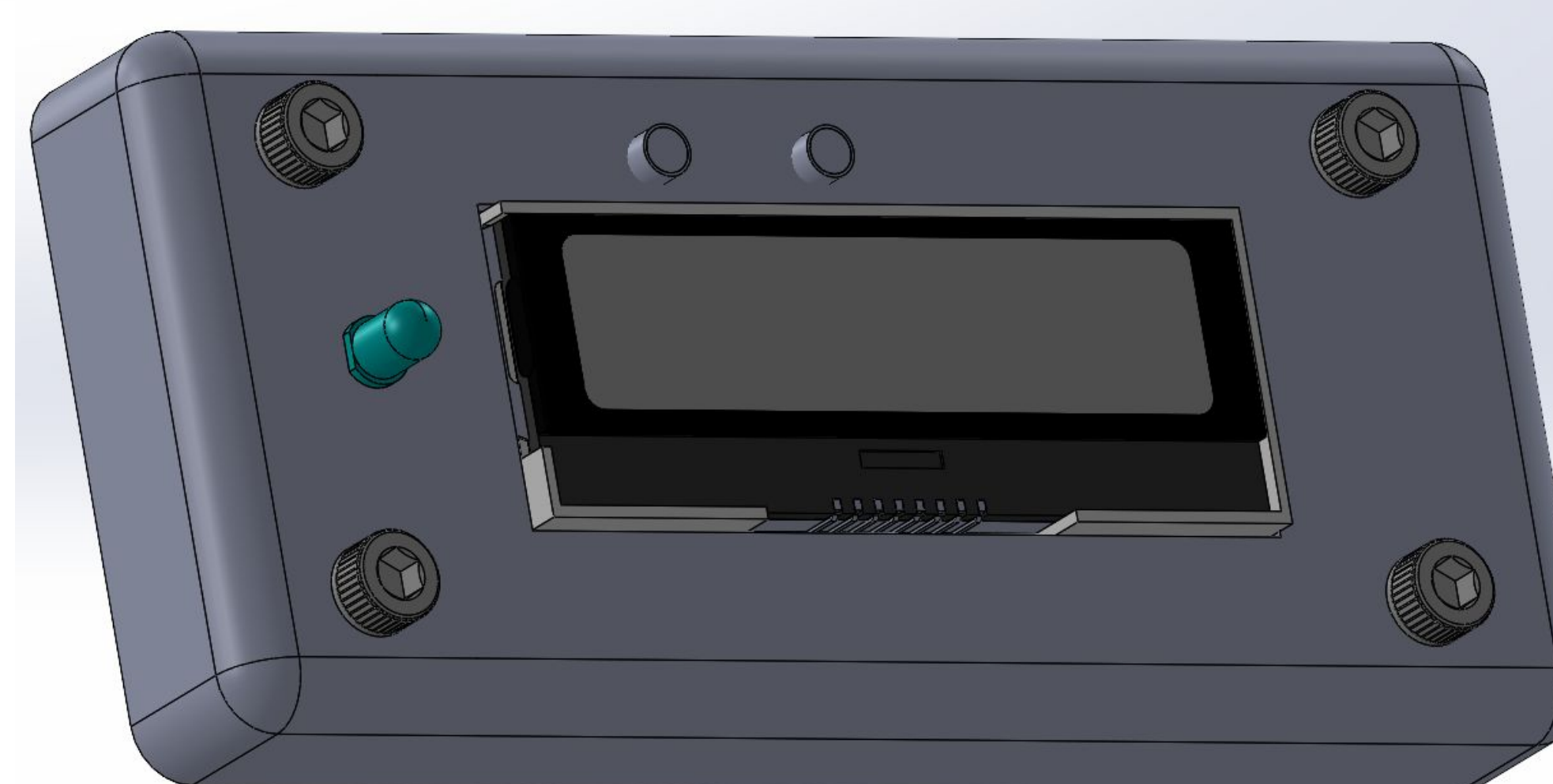
Design



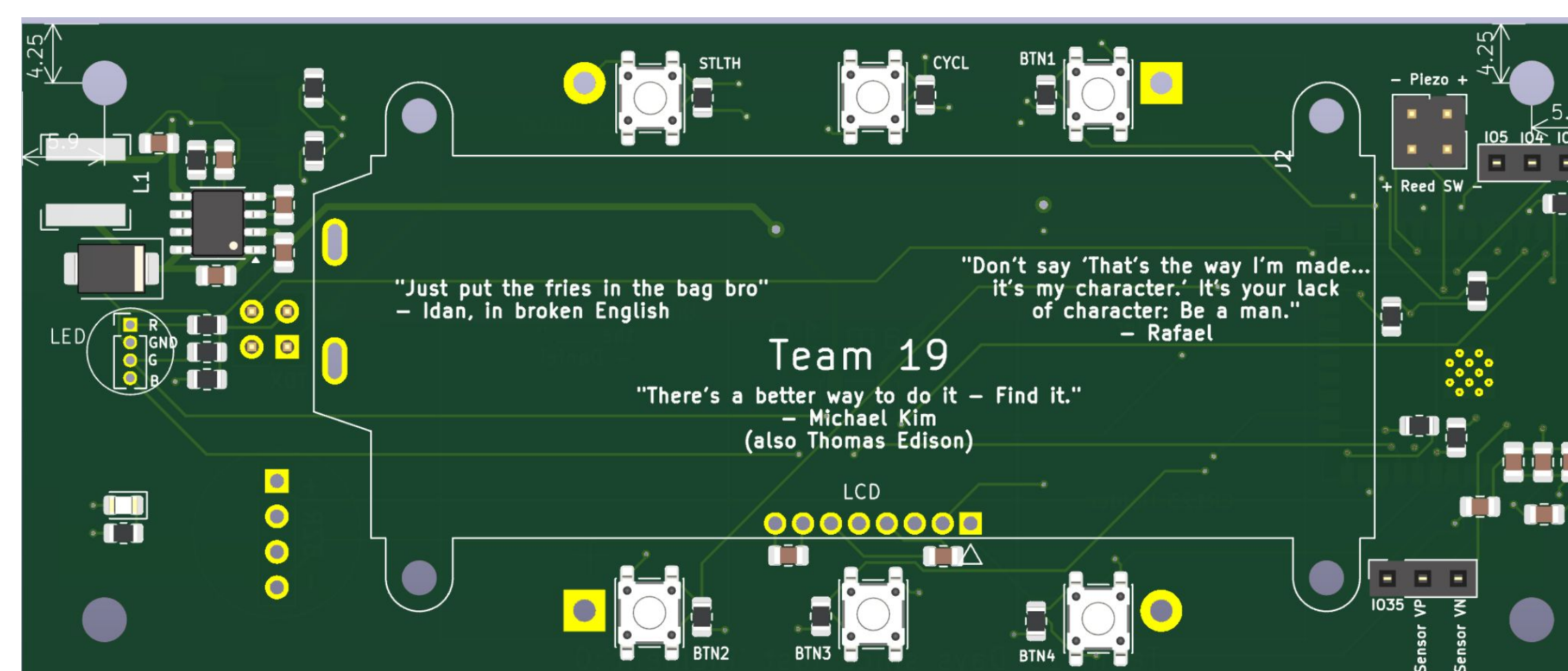
Flow Diagram of Data Processing and Display

Design Goals:

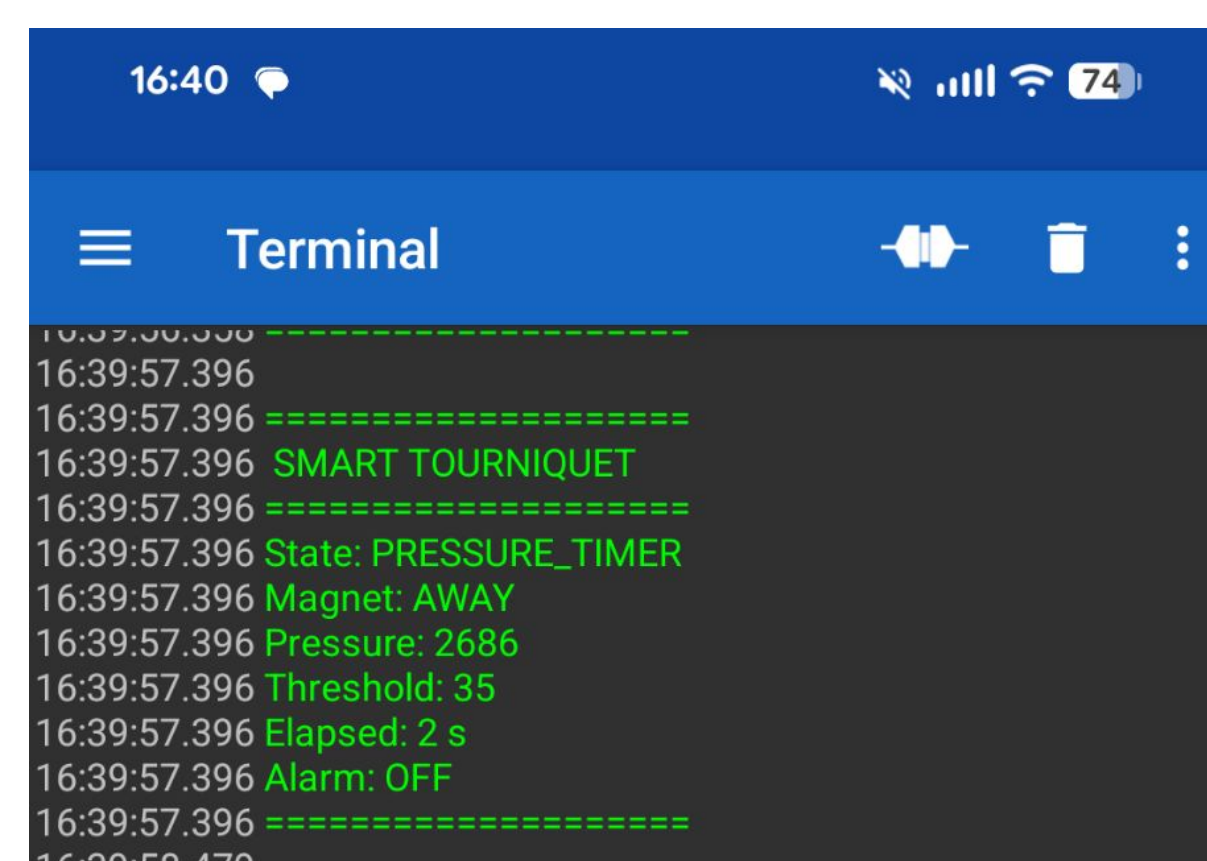
1. A timer that reliably starts and records duration once applied
2. On-device alarms (both visual and audible) can be triggered at appropriate times, but are disabled by default.
3. An on-device force/pressure reading that acts as a proxy for internal vessel pressures
4. A Bluetooth interface that can connect to the Military BATDOK System and reliably transfer data to a centralized system
5. **100% capability of achieving clinically relevant pressures to occlude blood flow in variable limbs**
6. **Little to no reduction in application pressure, time, or ease.**
7. Long-lasting battery life (for 5+ years)
8. Waterproofing and weather resistance



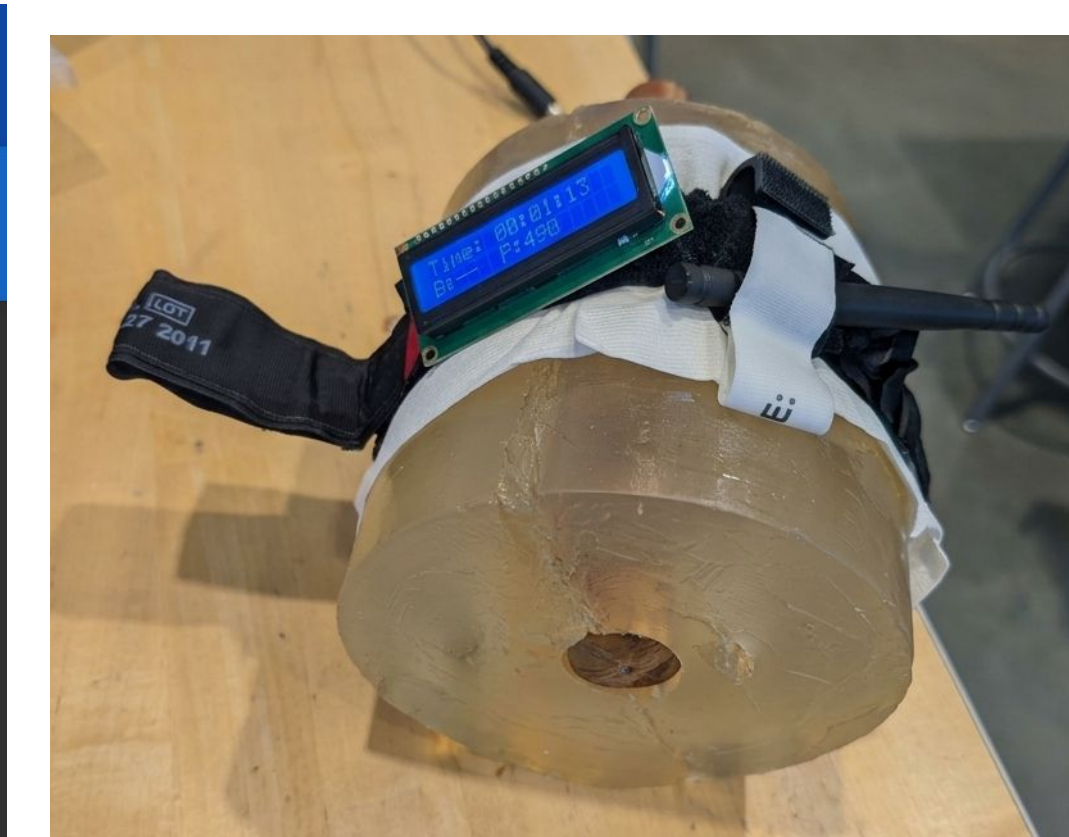
Component Housing



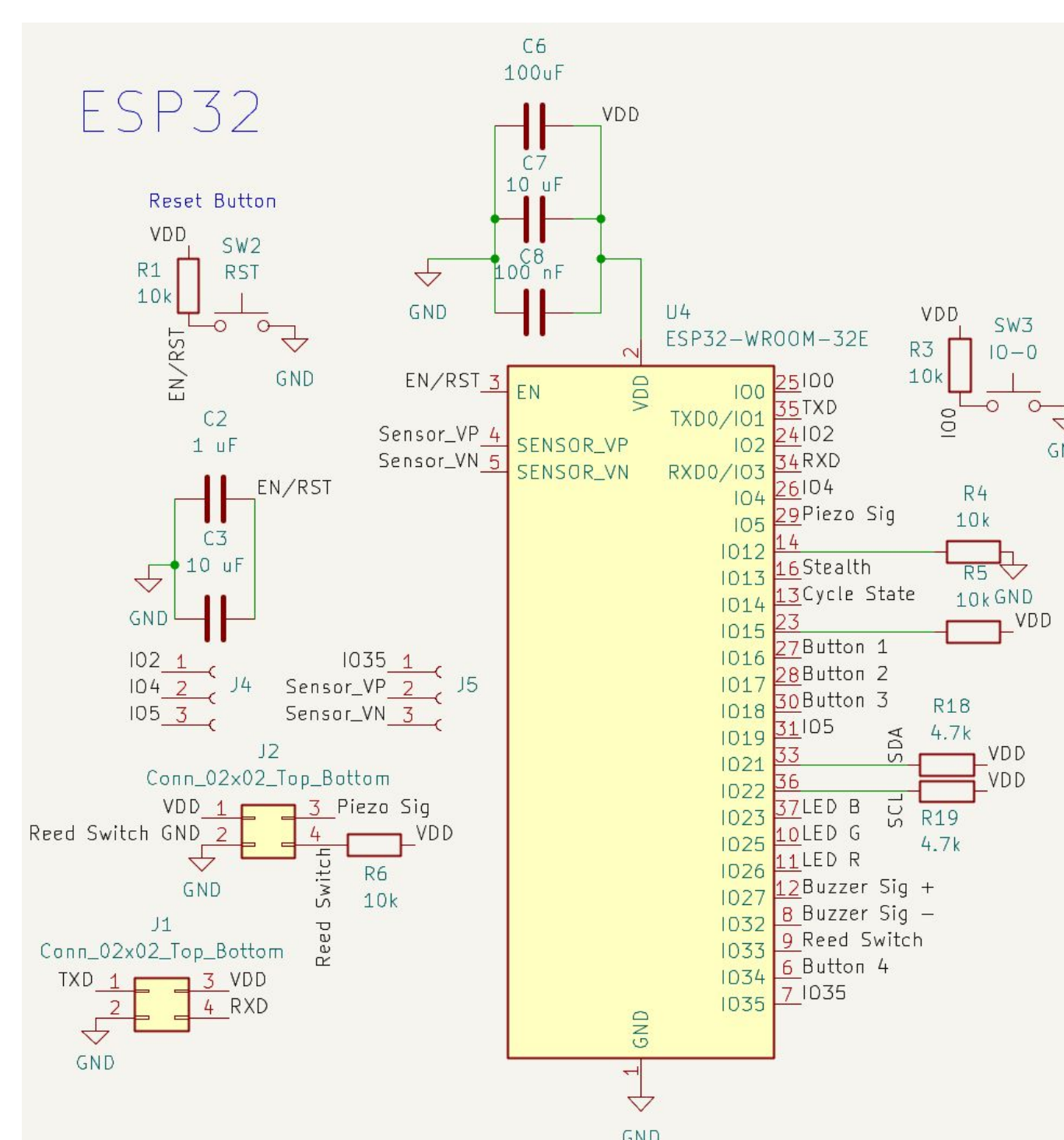
Smart Tourniquet PCB



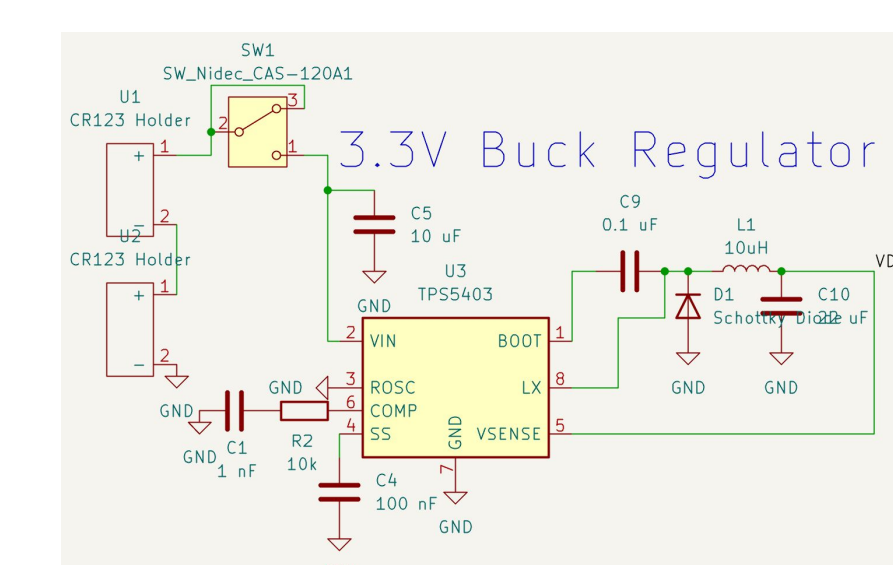
Bluetooth Interface



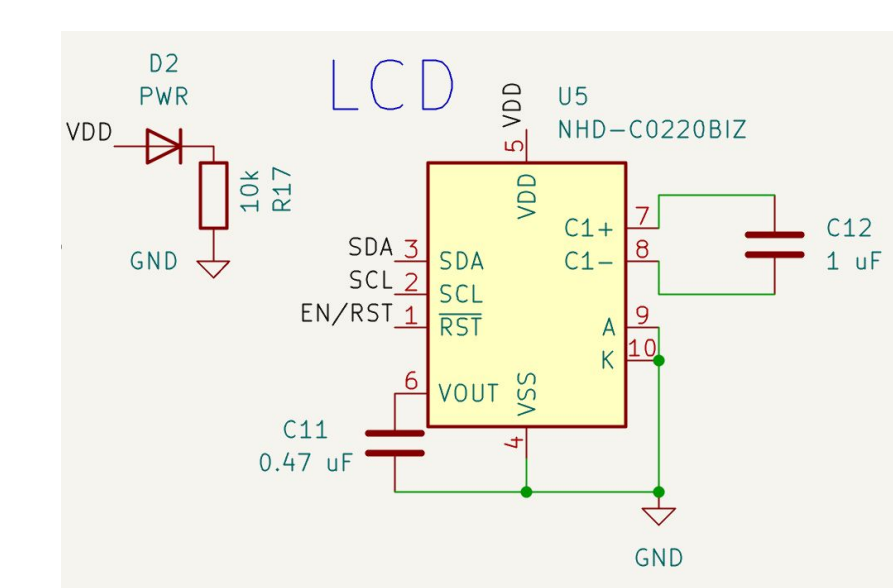
Tourniquet Assembly on Ballistic Gel



Microcontroller Schematic



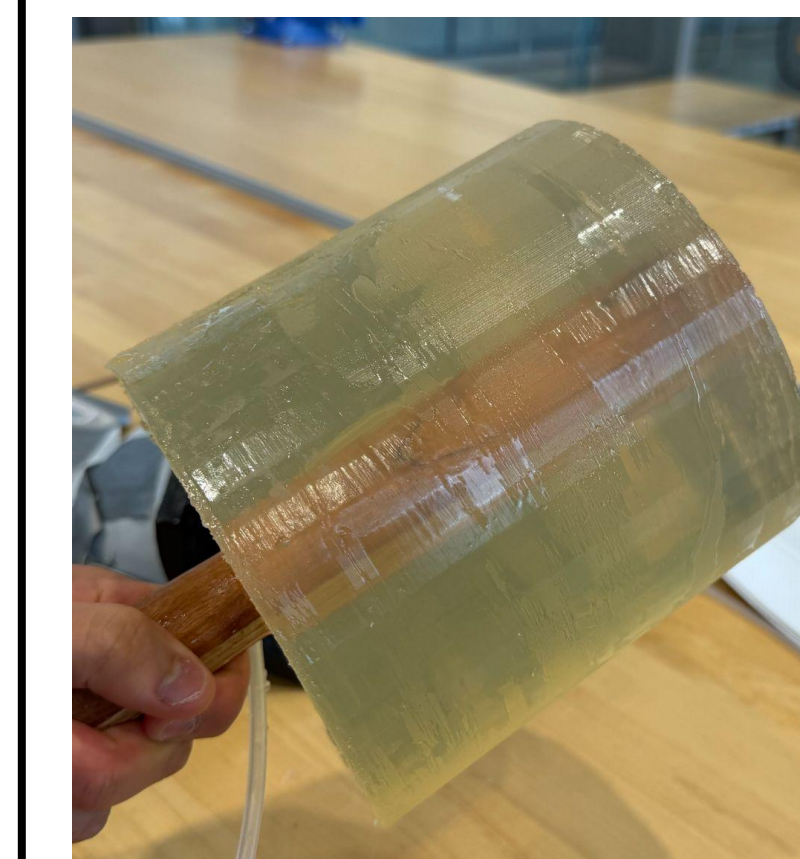
3.3V Buck Regulator Schematic



LCD Schematic

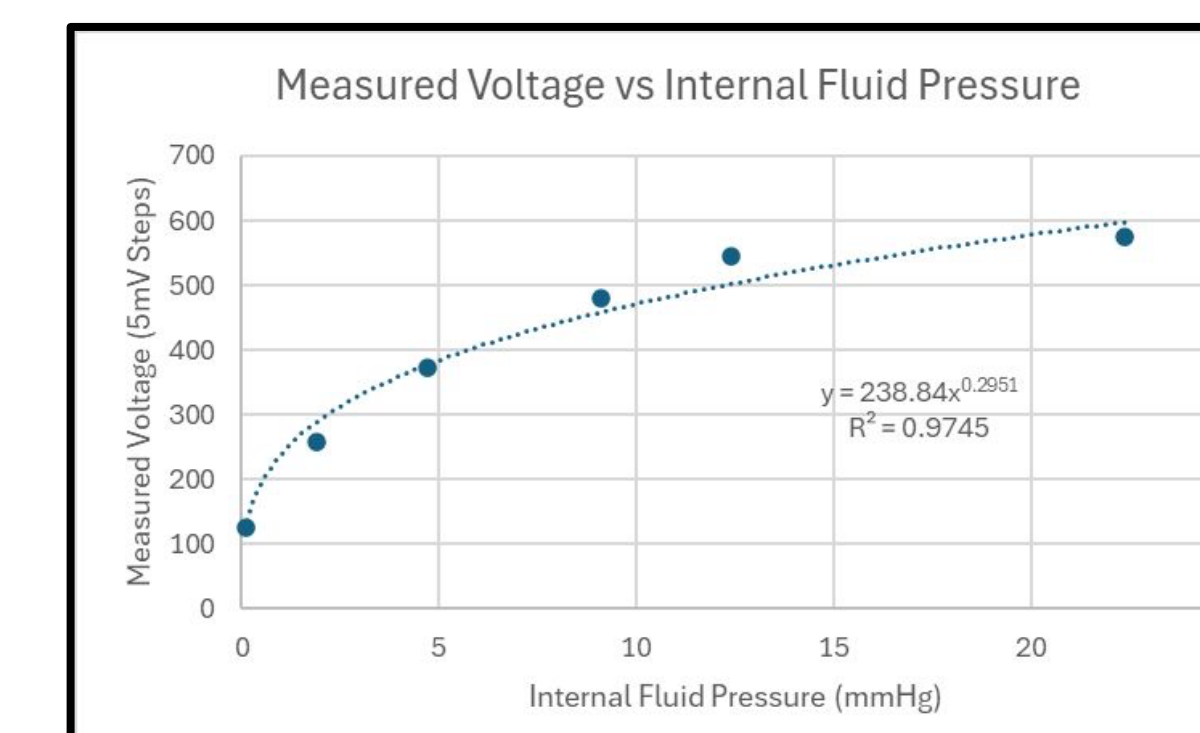
Conformational Methods

Ballistic Gel Thigh Model: To measure the efficacy and precision of the pressure measurement, we developed a 10% Ballistic Gel model of an average to lean adult thigh. The model included model femur and femoral artery, which could be attached to a fluid pressure sensor to measure the internal vessel pressure achieved by the tourniquet.



Results

1. The Smart TQ is able to record pressure, time, and transfers data wirelessly via bluetooth
2. The Ballistic Gel Thigh Model demonstrates a working prototype in order to validate internal atrial pressure to achieve occlusion
3. The compact footprint and next-generation capabilities of the Smart TQ offer best-in-market performance



Bioethical Considerations

- The Smart TQ has the potential to reduce complications for soldiers, reducing unnecessary injuries caused directly by TQs.
- Smart TQ's will likely increase costs, and require distribution efforts and increased training
- The device may complicate tourniquet application and care, and may contribute to alarm fatigue among medics
- The device may be useful for civilian care as well, and thus, should not be restricted to military capabilities.

Future Work

- Confirm BATDOK connectivity, and create digital user interface
- Validate model on blood loss models
- Improve FSR circuitry and accuracy
- Conduct tests with real medics and soldiers
- Make water/blood proof



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