TournIQ: Smart Tourniquet for Real-Time Pressure & Time Monitoring in Austere Environments

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The Problem

- Tourniquets are critical, life-saving interventions but are **frequently misapplied** in real-world and austere settings.
- **4-9% of tourniquets in combat casualties are applied with slack**, reducing hemorrhage control effectiveness.
- Current systems provide **no real-time feedback** on pressure or duration, requiring reliance on subjective judgment.
- Improper application, including under-tightening or prolonged use, can result in **continued bleeding, tissue damage, and fatal complications.**

Objectives

- Develop a **reusable, sensor-integrated tourniquet system** optimized for austere and resource-limited environments.
- Enable **real-time monitoring of applied pressure and duration** to improve consistency, safety, and decision-making under high-stress conditions.
- Explore integration of **novel sensing modalities** (e.g., temperature or blood flow) to assess occlusion and **further differentiate from existing solutions.**

Solution Concept

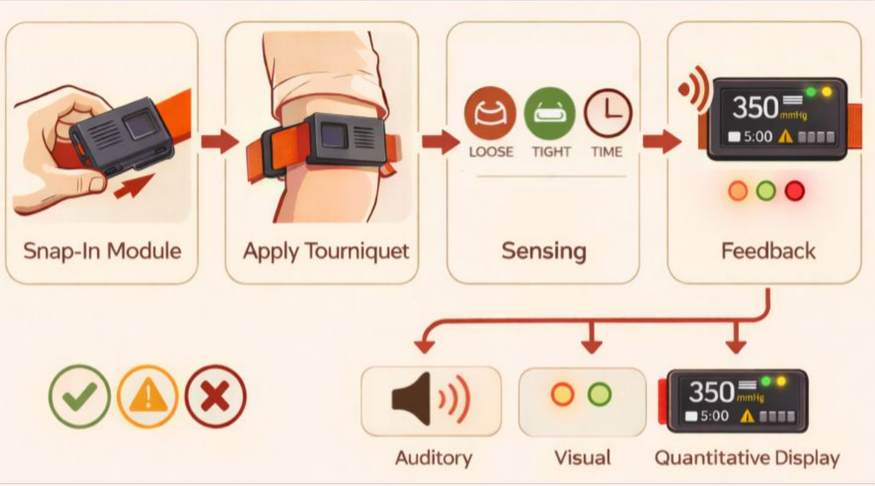

Figure 1. Overview of the smart tourniquet system: a snap-in sensing module is applied to the strap, continuously measures applied pressure, and provides real-time feedback through visual, auditory, and quantitative displays to guide proper tightening and prevent under- or over-application.

Methods

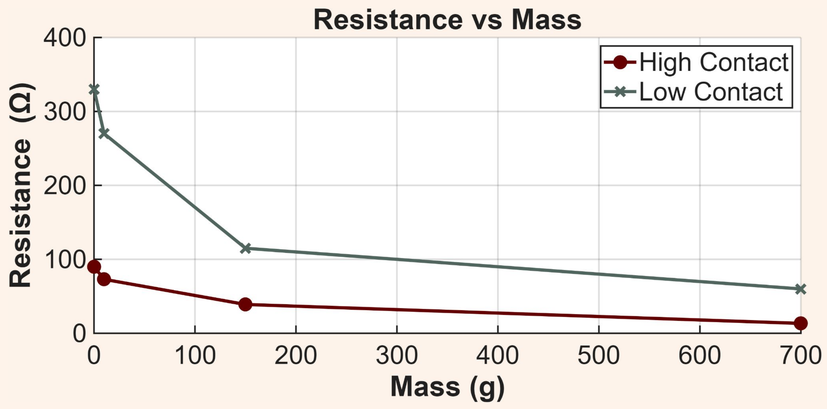

Figure 2. Resistance vs. Applied Mass for High and Low Contact Area Velostat Sensors. The high-contact sensor showed more stable and predictable resistance changes under load, supporting its selection for the tourniquet.

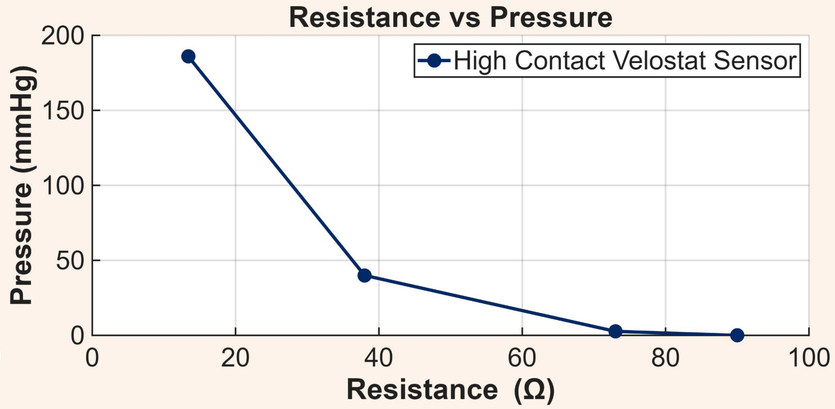

Figure 3: Resistance Response of High Contact Velostat Sensor as a Function of Applied Pressure. The nonlinear response provides a calibration curve for converting resistance into pressure in the tourniquet system.

Results

- Developed a sensor-integrated system using Velostat to measure pressure under a tourniquet with consistent, reliable performance
- Created a calibration method to convert resistance into real-time pressure data
- Implemented streamlined multimodal feedback (visual, auditory, quantitative) for use in austere environments
- Explored novel sensing modalities; temperature sensing showed greater feasibility than acoustic blood flow sensing

Conclusion

- Demonstrates a novel, practical method for real-time pressure measurement in tourniquet use.
- Provides intuitive feedback to improve decision-making in high-stress settings.
- Temperature sensing shows promise, though integration of additional modalities remains challenging.
- Represents a feasible, field-ready approach to improving hemorrhage control outcomes.