AR-520 DESIGN PRACTICUM OF MECHATRONIC SYSTEMS

Group 3

Pressure Monitoring Aid for Bedsore Prevention

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Revisiting the Problem Statement

Background

- Bedsores (pressure ulcers) develop when continuous pressure on the skin reduces blood flow, leading to tissue damage.
- They commonly affect bedridden or immobile patients.
- Caregivers often rely on manual repositioning to prevent ulcers, but pressure hotspots can go unnoticed for hours.
- There is a need for a low-cost, real-time monitoring system that alerts before injury occurs.

The threshold pressure resulting in pressure ulcers varies from patient to patient, but it can be approximated as follows:

30-40 mm Hg	Capillary Closure	4-6 Hours
50-60 mm Hg	Moderate Risk	2-3 Hours
>70 mm Hg	High Risk	1-2 Hours
>100 mm Hg	Very High Risk	<1 Hour

Proposed Solution: Pressure Monitoring Aid

1. Force-sensor strip placed at clinically vulnerable pressure points on the patient's bed.
2. Continuously measure the force applied and time the duration of the force.
3. Alert is triggered if the force is higher than the thresholds beyond a safe time limit. (Real life: about 7 hours, for quick demo: 10 seconds)
4. After the patient has been repositioned (force measured drops) the timer resets automatically, allowing continuous monitoring of force within safe limits.

Working of the FSR as pressure monitoring aid

FSR is used as a high resistance (>10M ohm standoff resistance) in a voltage divider circuit with R_{pull}=47kOhms.

$$R_{fsr}=R_{pull}(V/Vcc-1)$$

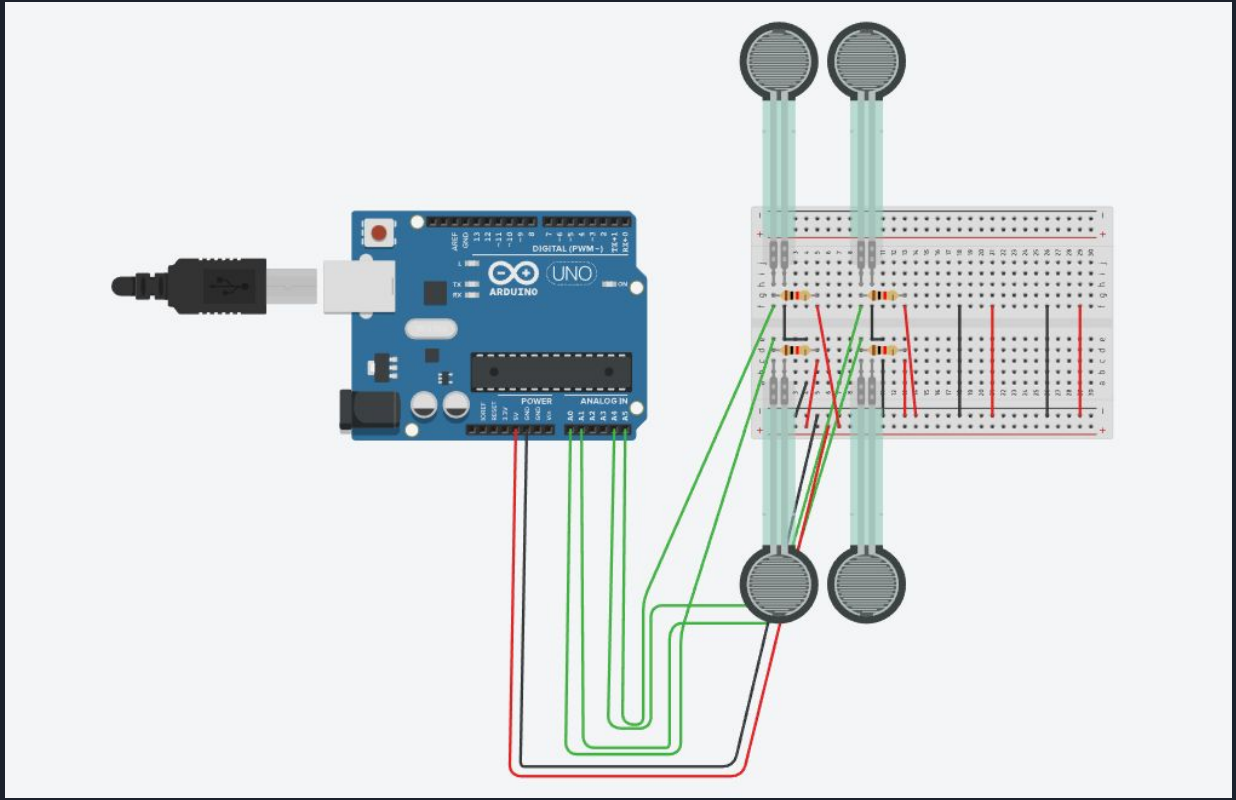
From the sensor datasheet, a corresponding force can be found for each R_{fsr} value.

In the absence of datasheet, we have practically estimated thresholds from the measured V from the FSR.

The values we see in our demo, is proportional to voltage across R_{pull}.

Core logic: When pressure applied on FSR, R_{fsr} drops thus V_{r_pull} increases.

System Architecture



Novelty of the Proposed System

Existing solutions to bedsore prevention aid are expensive and thus inaccessible to the patient.

Existing options include pressure adjusting air/water mattresses. These devices redistribute pressure but lack an active monitoring system to assure prevention of pressure ulcers.

Mattresses with embedded sensors are very expensive and not affordable for the majority, hence a critical medical aid is inaccessible to most of the patients who are at high risk of developing pressure ulcers.

We devised a system in which the active monitoring system is included in strips embedded with sensors, that can be put on any regular cushion/mattress, making the pressure sensing aid much cheaper.

Non Linearity of the Sensor

Responsiveness Transform (for LED reaction time):

$$t_{\text{response}} = \max\left(\frac{1023 - \text{ADC}_{\text{FSR sum}}}{100}, 5\right)\ \text{ms}$$

Contributions : Memberwise

Kusum: Developed and tested the core Arduino logic for pressure monitoring, threshold detection, and alert generation.

Akshat: Designed the sensing circuit and integrated the FSR sensors with the Arduino to ensure stable and accurate readings.

Harsh: Configured the microcontroller, handled non-linear behaviour and calibrated sensitivity.

Satyawrat: Managed the logistics of components used and handled the hardware integration by embedding sensors in the cushion (hankerchief), securing wiring and LEDs.

References

Ghosh, P., & Raj, P. (2024). Advances in technology-driven strategies for preventing and managing bedsores: A comprehensive review. Archives of Gerontology and Geriatrics Plus, 1(9), 100029.

https://doi.org/10.1016/j.aggp.2024.100029

Thank You...