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Jointelligence

Wearable Sleeve for Growth Modulation Monitoring

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Phoenix Children's

SBHSE | School of Biological and Health Systems Engineering

Background

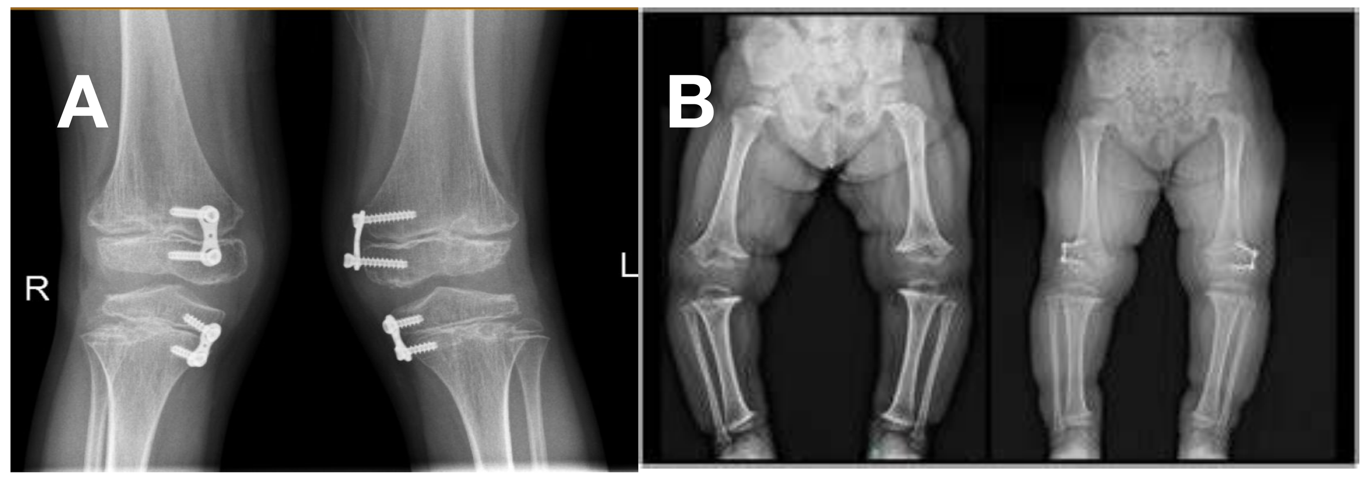

Fig 1. X-ray images of patients with knocked knees with implants (A) and bowed knees without implants (B).

Genu Valgum and Genu Varum (known as knocked and bowed knees) are conditions in which the knees angle inward and outward, respectively. They require surgical implants to correct knee alignment in a procedure known as growth modulation surgery. Follow-up procedures include X-ray imaging to assess bone correction, requiring frequent in-person visits to orthopedic surgical specialists. As a result, around 15% of patients miss post-surgical implant removal, citing high costs, issues with transportation for patients in rural areas, and an unawareness of the importance of implant removal. This leads to overcorrection and further complications.

Mission Statement

Jointelligence aims to lower patient input dependence by developing non-invasive methods to monitor real time bone growth that can alert professionals and assess the efficacy of the 8-Plate implant in proper knee alignment.

Digital Prototype

House of Quality

Product Architecture

Gantt Chart

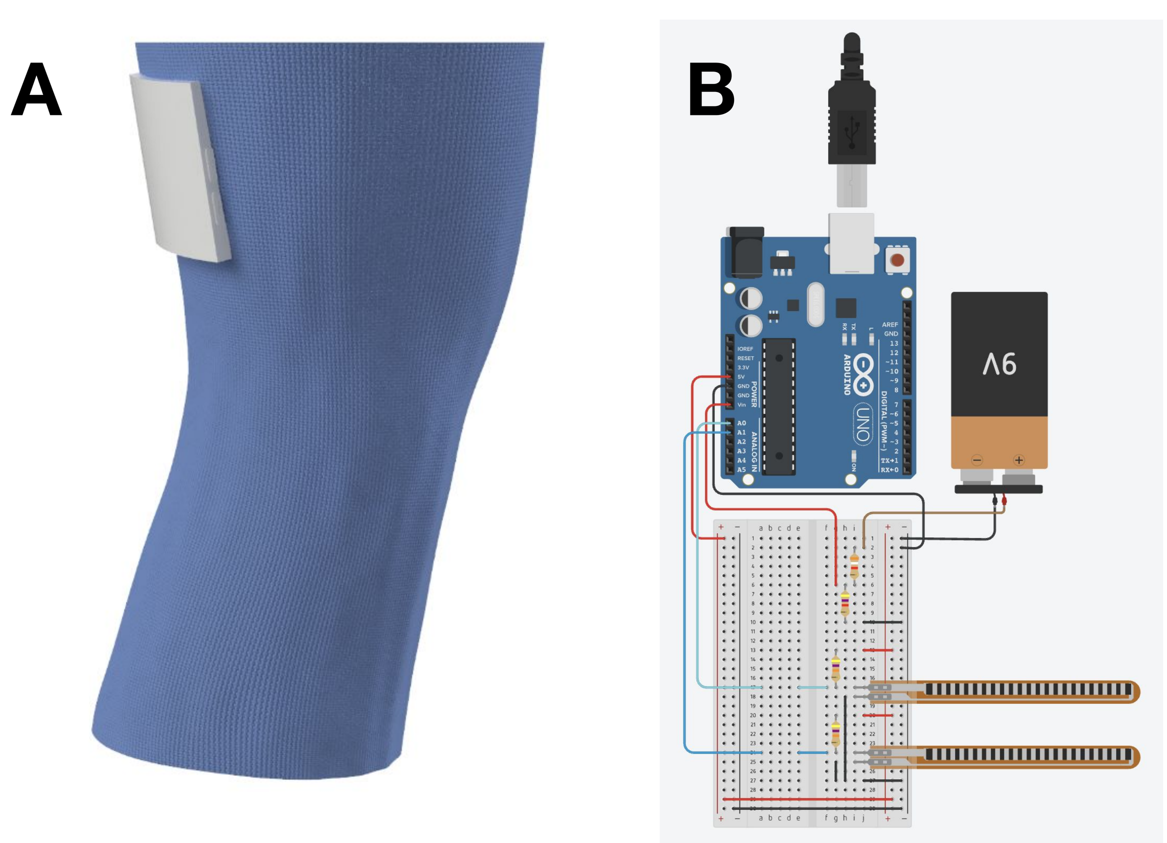

Fig 2. (A) CAD rendering of the sleeve device and (B) simulated flex sensor circuit used to build the physical prototype.

Prototype

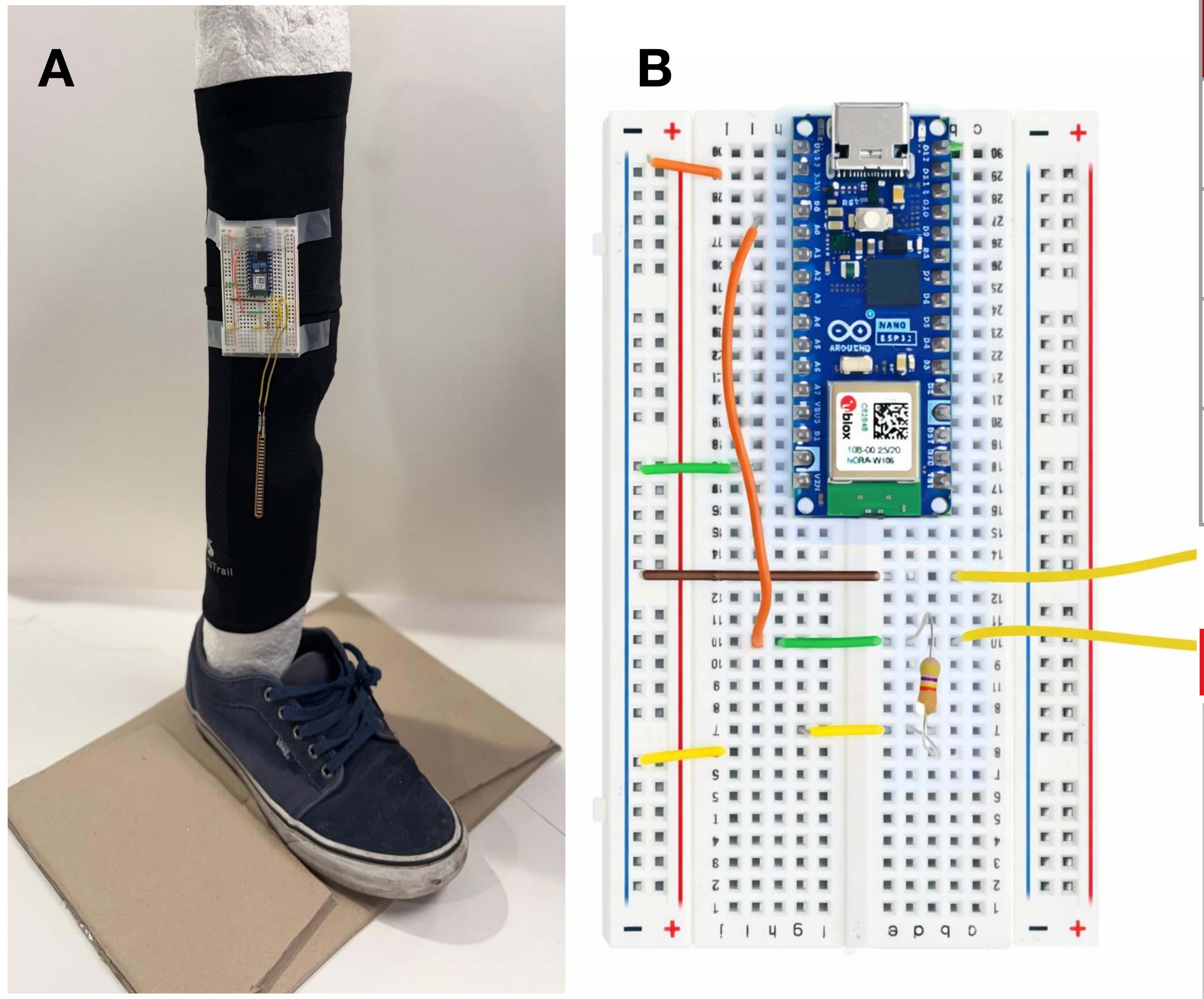

Fig 3. (A) final built-prototype showcasing the circuit and strain gauge attached to a model leg. (B) Close up photo of the circuit board used to determine the voltage change as the strain gauge is bent that is attached to the knee sleeve

Final Technical Models

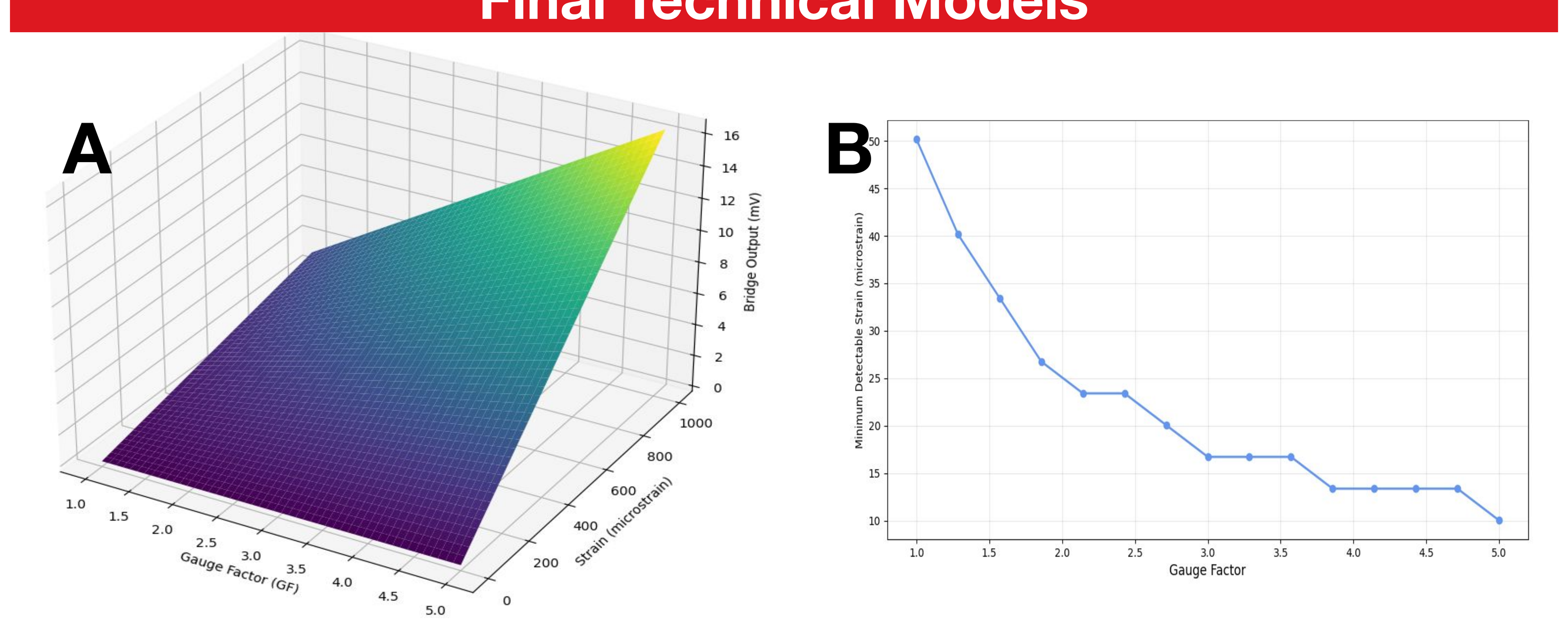

Fig 4. (A) Python generated 3D plot testing both strain gauge factor (GF) and a range of strain detected on the voltage output before digitization, with higher voltages indicating further sensitivity to small strain. (B) Graph showing minimum detectable strain from a digitized voltage output along a value of usable strain gauge factors.

Final Product Specifications

Specification	Target Value
Flex Sensor Accuracy	+/-10%
Sampling Rate	Bi-Weekly (Bi-Monthly at Minimum)
Battery Life	>20 hours
Sizes	Standardized sizings (S, M, L, etc.)

Table 1. Product specifications to ensure a user-friendly, cost-effective, and accurate method of monitoring bone alignment.

Verification Results

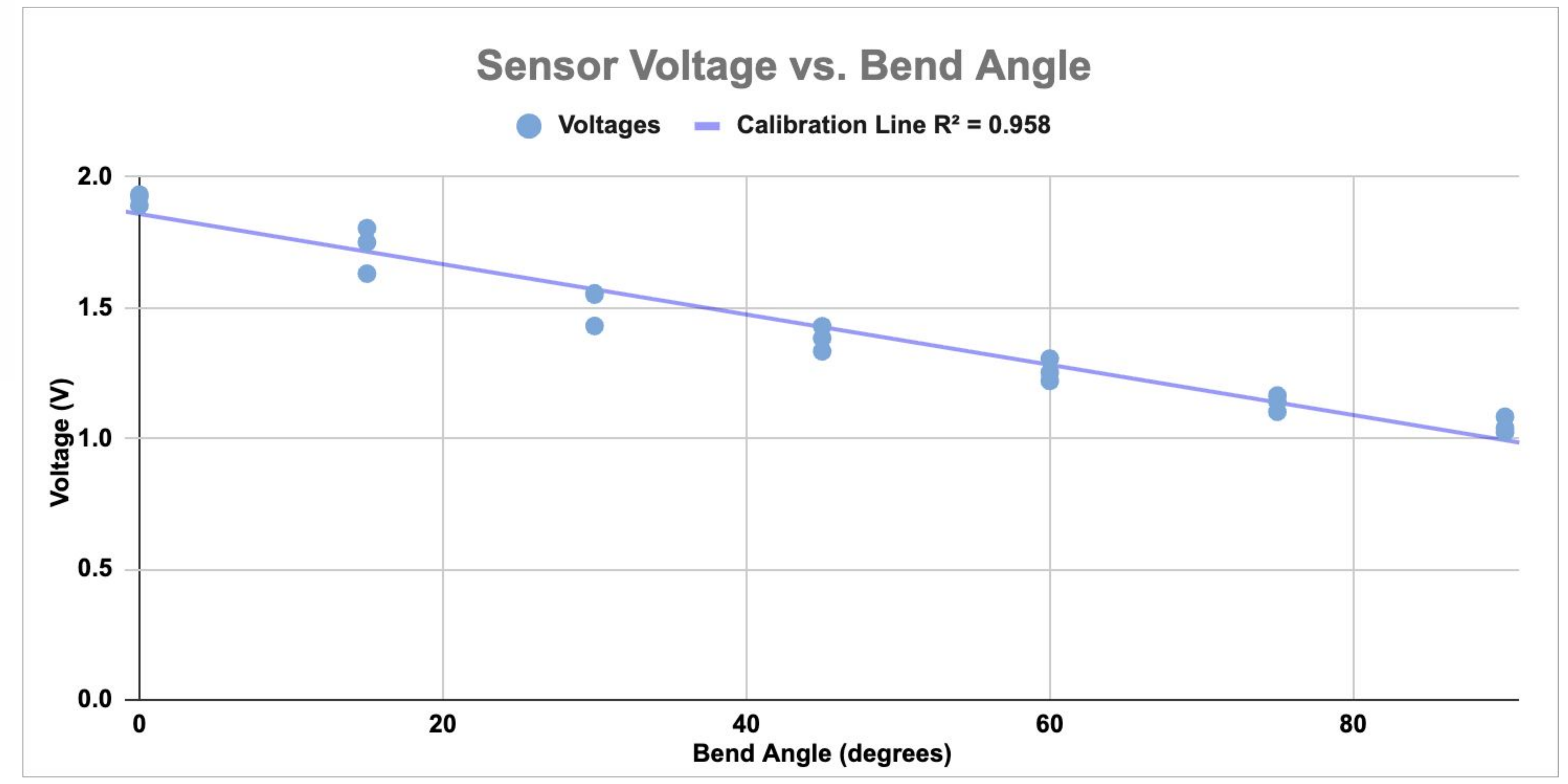

Table 2. Flex Sensor Voltage relationship to Sensor Bend Angle showing a linear regression of 0.958. This shows that the Flex Sensors are a verified method of detecting the bone growth overtime due to the relationship of voltage to angle being a linear progression.

Design Status/ Future Steps

- Refining Prototype to fully function without constant monitoring of components
- Research into implementing sensors and wires embedded in fabric.
- Combine all components into cohesive device

Acknowledgements

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