INNOVATION ROUNDS:

Developing Low-Cost Wearable for Monitoring of Knee Brace Active Wear Time

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FHS
MSK-IF

Problem

Knee osteoarthritis.

- Leading cause of pain and disability

Unloader knee braces.

- Can potentially help people with knee OA, but their effectiveness is unclear
- Adherence is a key factor in the success of interventions

Challenges of self-reported data on brace wear.

- People may not always accurately recall their wear time or use the brace consistently

Can we objectively track brace wear time over an extended period?

Technical Requirements

Limitations of current commercially available wearable devices:

1) Expensive hardware (+ service and hosting costs)
2) Configured for specific location (e.g., wrist)
3) Proprietary software for data analysis/offer limited data formatting flexibility
4) Often require Bluetooth or Internet connectivity
5) Need to be regularly charged to gather data over longer periods of time

Solution → fabricate wearable device from the latest commercially available components in IMU technology that:

1) Is resource-effective (i.e., low cost)
2) Enables configuration for use at different joints/ limbs (e.g., hip, knee, shoulder)
3) Provides flexible solutions for data formatting and storage
4) On-board data storage (doesn't require Bluetooth or internet)
5) Is programmable in a manner that maximizes battery life (e.g., to collect data over 3-month intervals between study visits)
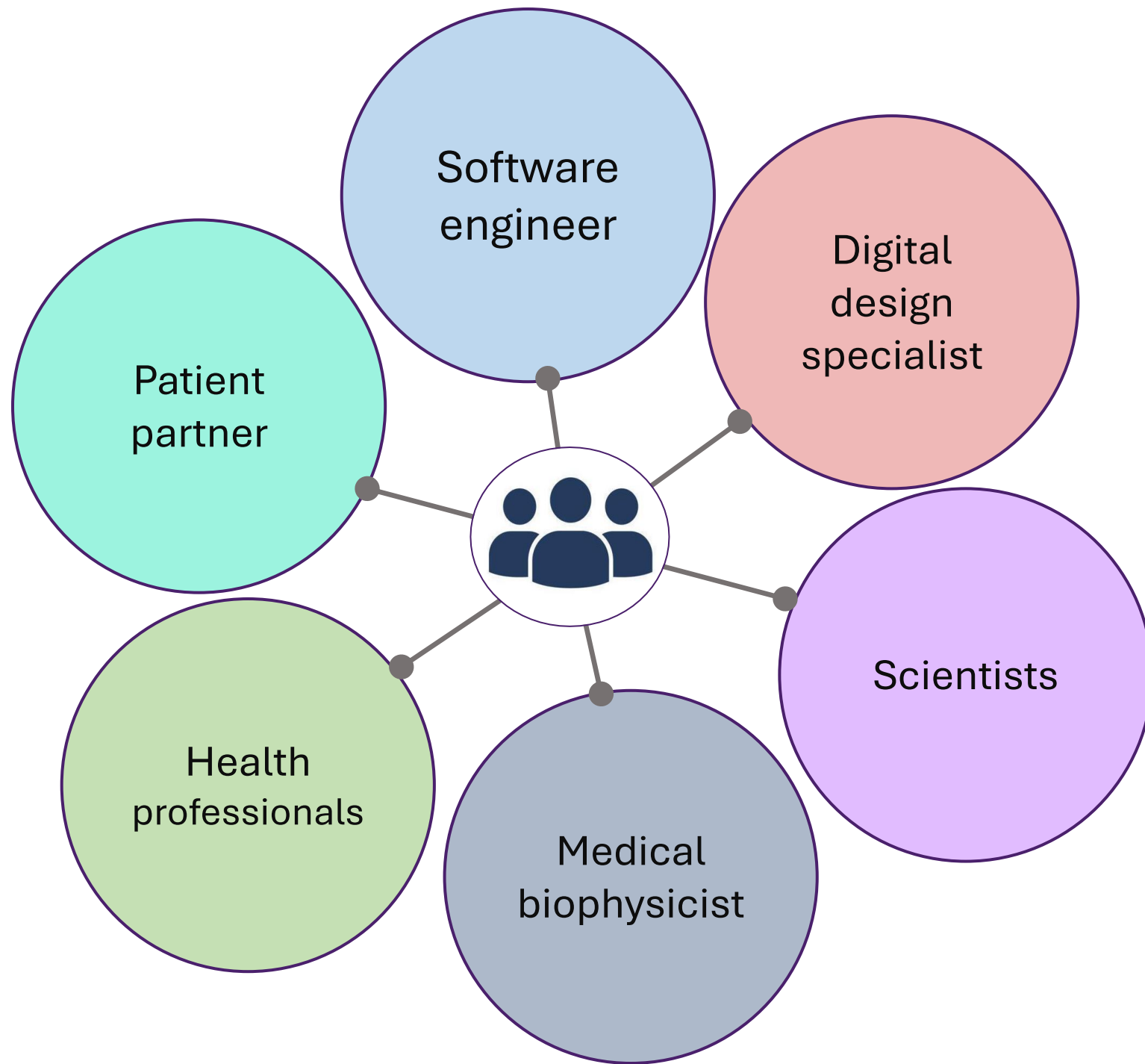
Project Objectives

Objective 1

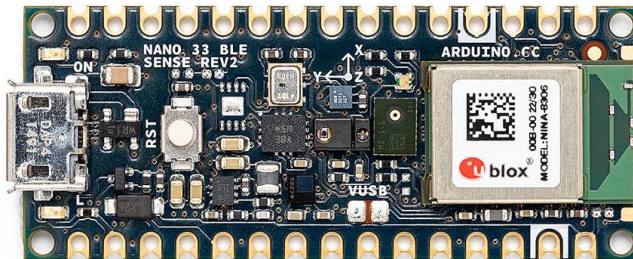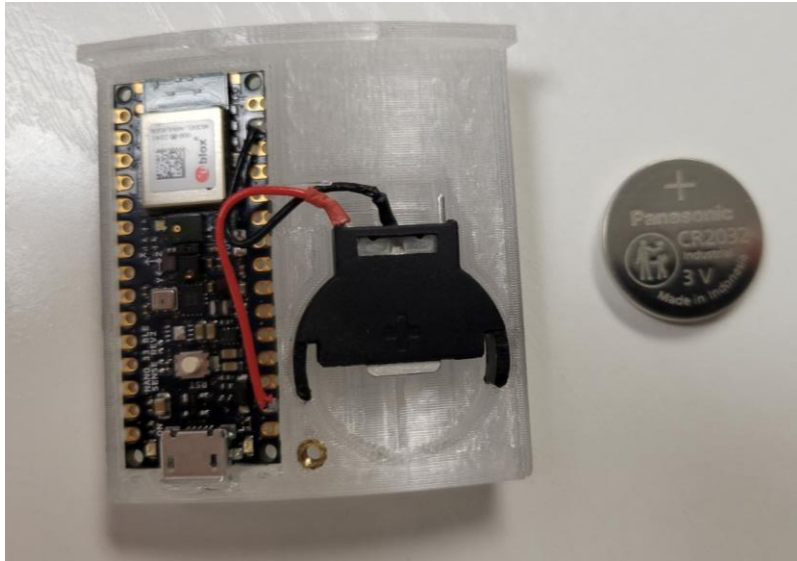Develop low-cost, low-power wearable sensors to track steps and active brace wear time

Objective 2

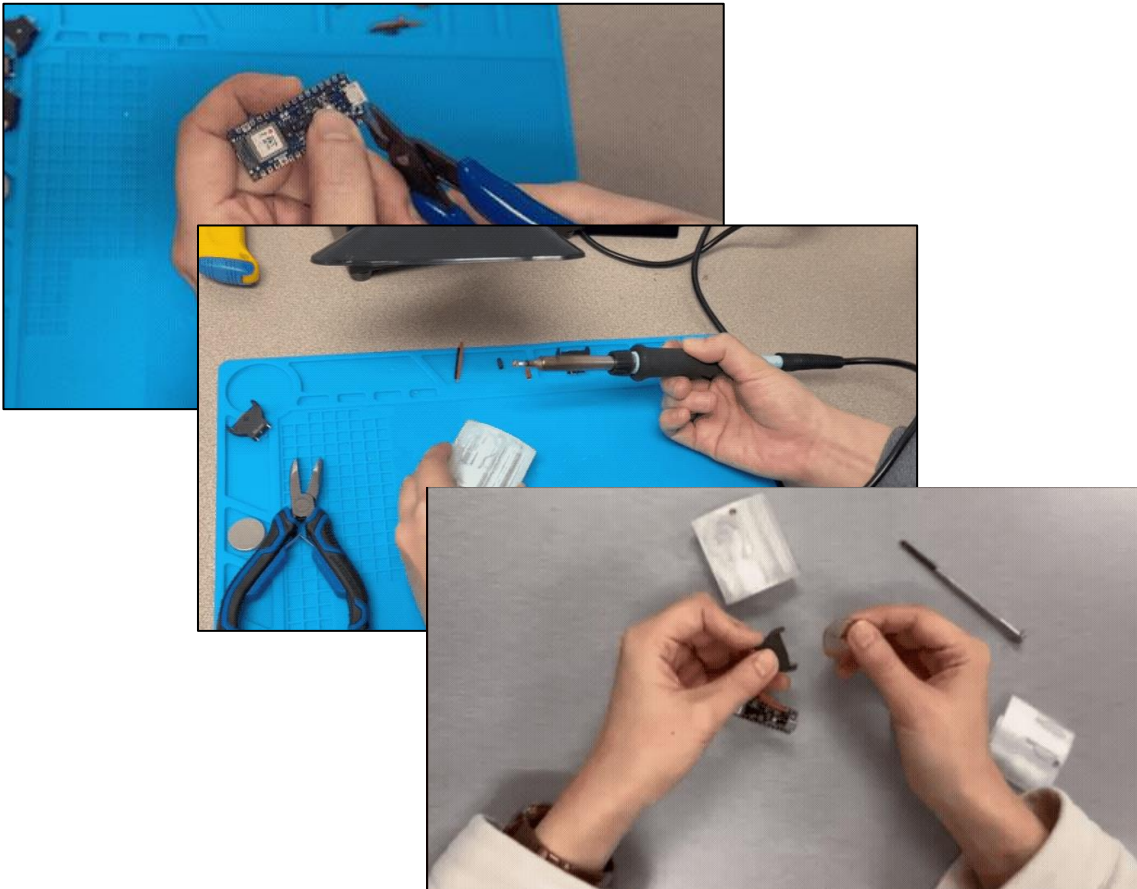Determine the long-term adherence to brace wear in patients with knee OA
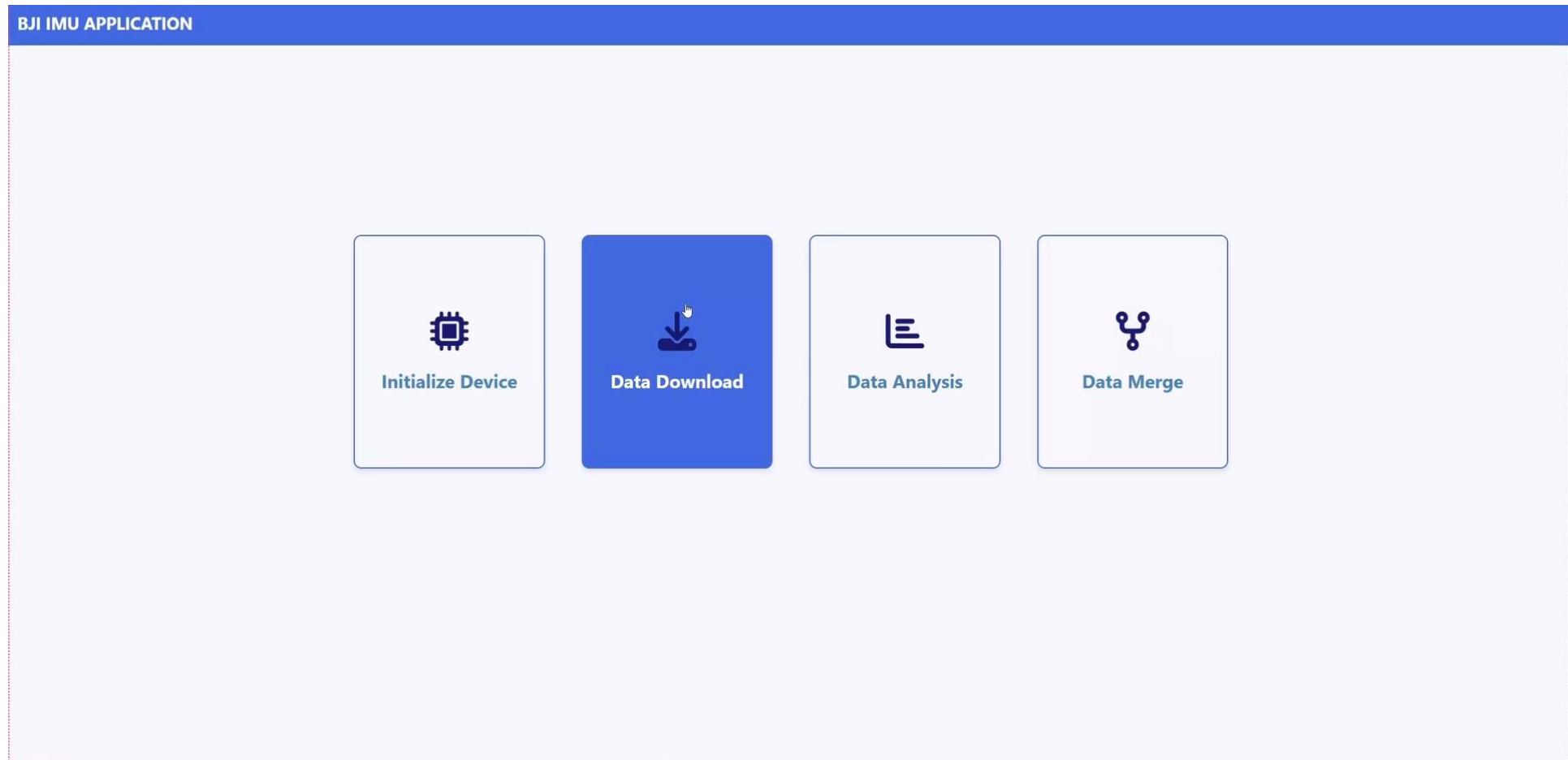
2021

2022

2023

Design Solution – Assembly & Delivery

- Arduino Nano 33 BLE - based wearable designed by PI & Team
- Collects step counts every 5 minutes
- Lasts for 3 months, enabled by low power mode
- 2 Designs: Knee brace & sleeve
- Cost-effective & Scalable
  - $60 per Arduino vs $600+ for commercial solution

Design Solution – Graphical User Interface

Project Status

Project Execution –

Implementation/Scale Up

- 90+ participants currently enrolled in the study

- Baseline completed for over 70 Participants

Challenges

Low Power Consumption

Need the device to last for 3-month with a coin cell battery (CR2032)

Low-level programming to optimize Arduino's performance

Case Design

Reported incidents for case being brittle for certain types of knee braces

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Changed the case material to TPU, known for high elasticity and flexibility

Data Management

Need for easier data inspection & handling as study progresses

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Designed interface offers preliminary data inspection & merge features

Future Opportunities

More Objective Metrics

- Not just wear time and step count but other gait characteristics

Data-driven Motion Analysis

- Combine wearables data with machine learning to infer kinematics & kinetics

Mobile App Development

- Allow brace-smart phone interaction

Applications in Hand & Upper Limb

- Trace adherence / other measurable metrics at other body locations

Custom Printed Circuit Board Design

- More compact & efficient form factor

Does this spark any ideas on how you might use MSK-IF?

THANK YOU!

How can I seek support from MSK-IF to develop my idea further?

Reach out to mskif@uwo.ca if you have an idea you would like to develop further!

Please feel welcome to reach out to *Trevor Birmingham* if there is anything you would like to further discuss!