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*Spine*Sense: Wearable For Prevention of Low Back Injury

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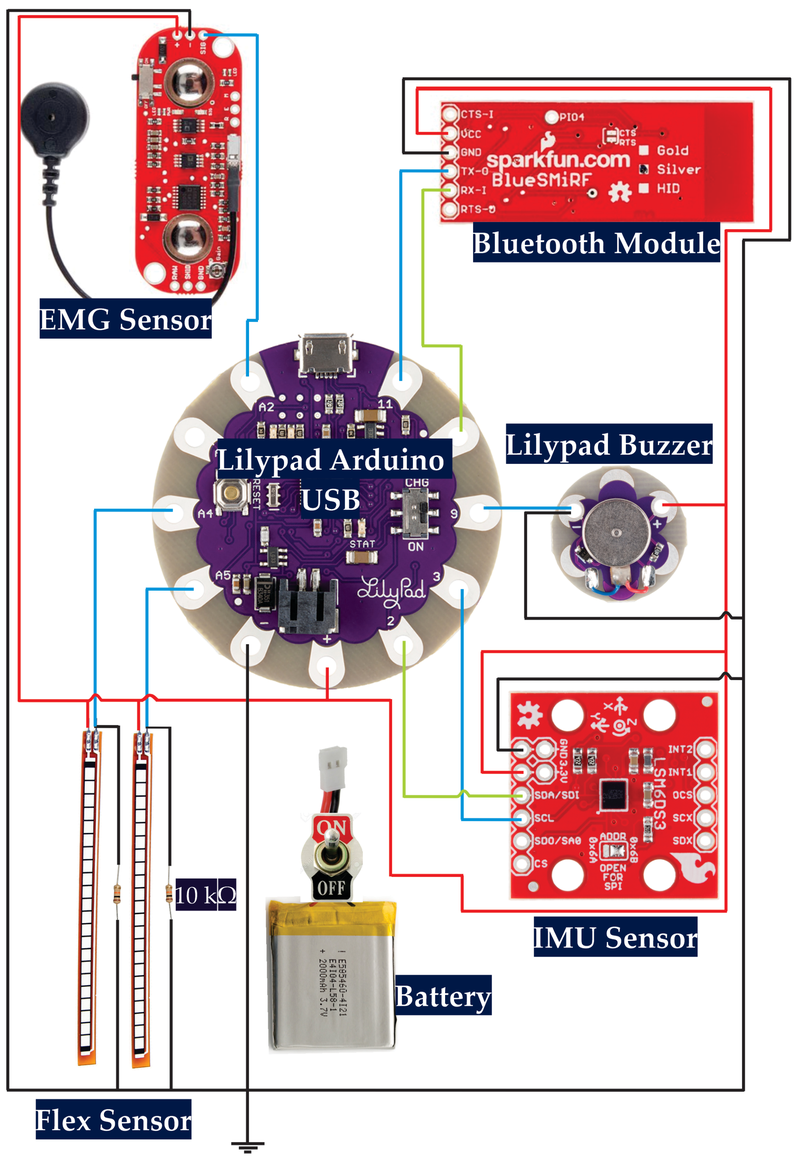
Problem Statement

Athletes and military personnel are at higher risk of developing low back pain and/or injury during strenuous exercises. Setbacks in training can be detrimental to this population, potentially resulting in an early career end. The aim of this wearable device is to monitor back motion and activation to provide user feedback for injury prevention.

Background

- Lower back pain (LBP) is one of the most common medical problem experienced by many, specifically athletes & military personnel.
- Musculoskeletal injuries are the root cause of 97% of all LBP cases [1].
- In military personnel, back pain is experienced by approximately 47% of soldiers, where 50% of them have hindered ability to perform expected tasks [2].
- In athletes, back pain is present in 27% of college football players, 50% artistic gymnasts , & 86% of rhythmic gymnasts [3].

Hardware



Our Design

A wearable device to track spine motion during exercises (squats, deadlifts, and general exercises)

Provide real-time feedback through a user-friendly phone application

Software

1 Calibrate Device: Full Flexion and Extension

- Obtain user's maximum range of motion
- Compute individualized thresholds to determine motion of risk

2 Choose Exercise: Squats or Deadlifts

3 Sensor Data: Run Algorithm

- **Flex Sensor**: Lumbar Flexion & Extension
- **EMG Sensor**: Back Muscle Activation
- **IMU Sensor**: Acceleration of Activity + Torsion of the Back + Spine Bending
- **Risk of injury**: predicted above 70% of the user's maximum range of motion
- **Higher risk factor**: computed when multiple high risk parameters are acquired at once

4 Real Time FeedBack: Vibration

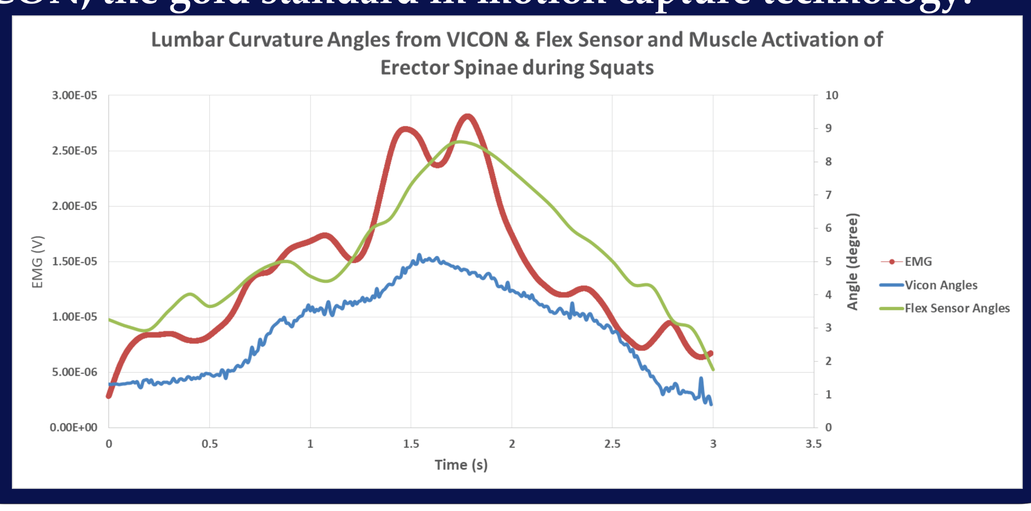
When risk is predicted, instant buzzing is stimulated to notify the wearer

5 Post-Exercise FeedBack: Application

A phone application will be utilized to convey risk level instantly and exact cause of risk post exercise

Results

- Data obtained from the device was compared to data from VICON, the gold standard in motion capture technology.



Conclusion & Next Steps

Successful Proof of Concept

- Able to measure the flexion and extension of the lumbar spine
- Able to measure the bending and torsion of the spine
- Able to measure the muscle activation & acceleration of activity.
- A user friendly app designed to warn user of injury

Next Steps

- Include workout options
- Measure muscle fatigue during exercise

[1] E. Castillo and D. Lieberman, "Lower back pain", *Evolution, Medicine, and Public Health*, vol. 2015, no. 1, pp. 2-3, 2015.
[2] A. Halvarsson, I. Hagman, M. Tegern, L. Broman and H. Larsson, "Self-reported musculoskeletal complaints and injuries and exposure of physical workload in Swedish soldiers serving in Afghanistan", *PLOS ONE*, vol. 13, no. 4, 2018.
[3] L. Purcell and L. Micheli, "Low Back Pain in Young Athletes," *Sports Health*, May-2009.
[4] https://medicalxpress.com/news/2016-02-antibiotics-effective-pain.html

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