Acceleration Detection Knee Pad

Senior Design II - The Raiders

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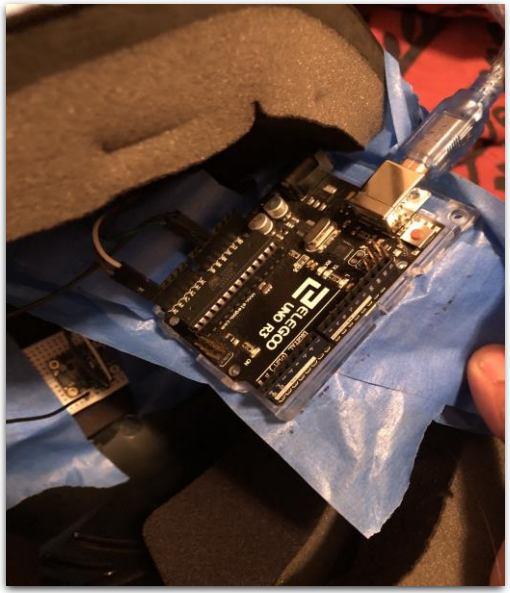
Background

Initial Idea: A collision detection helmet that would detect the acceleration of a player when they collide and determine whether it was concussive

Issue: Manufacturer defects for sensors severely limited our progress



Julian
Tee

Pivoting the Project

- **Keep core idea of measuring acceleration of the body**
- Unable to find sensor with large enough range and sensitivity for concussion
- Lower the acceleration we need to measure => Acceleration of the knee

Acceleration of the head	Acceleration of the knee
- Wide sensitivity range (needs high max) - Requires high precision and accuracy - Large area to cover	- Lower detection range - Requires less precision and accuracy* - Smaller area to cover

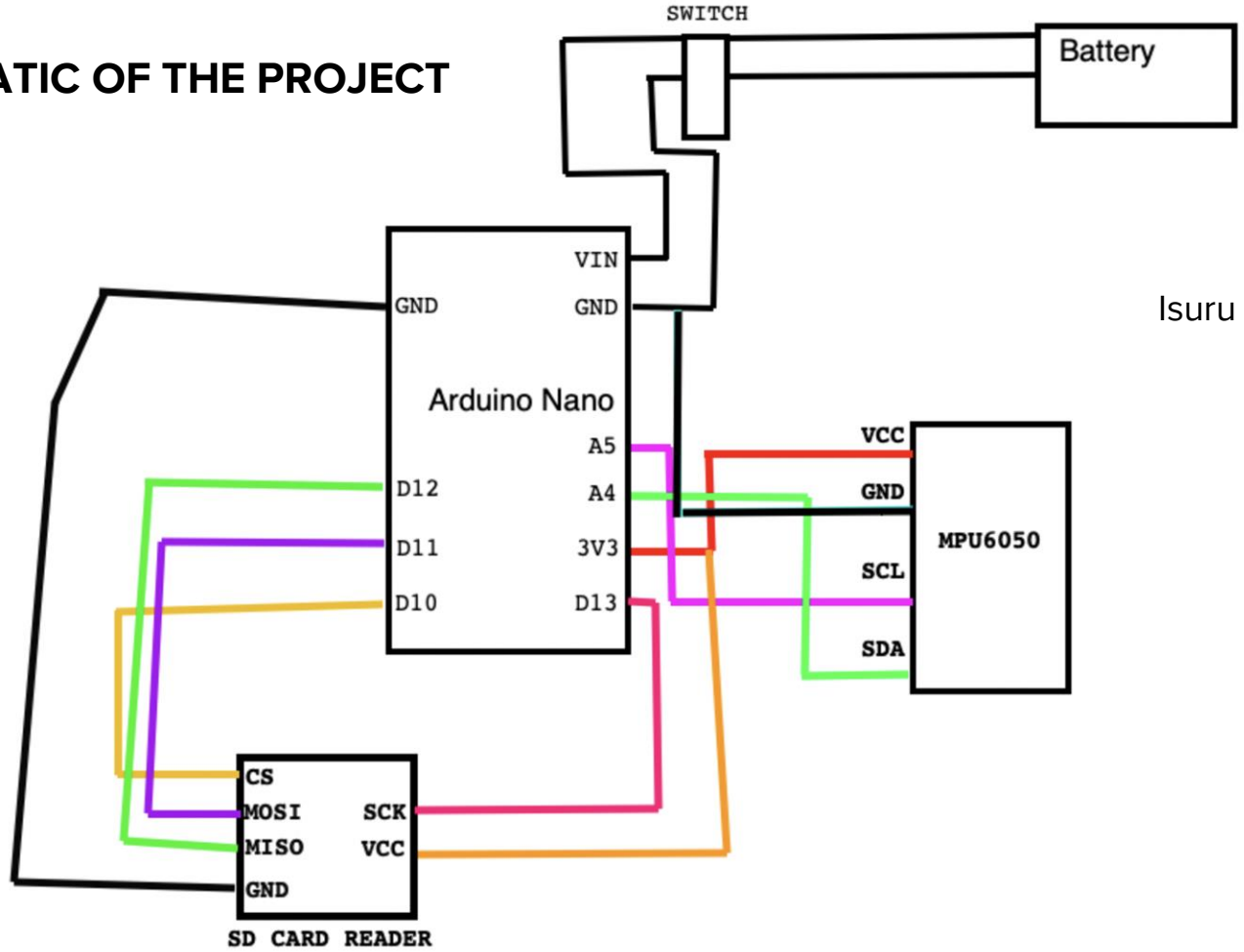
Solution: Acceleration detection knee pad

- Our project aims to help detect walking imbalances by measuring and comparing the acceleration of the knee.
- The device that is attached to the knee is an accelerometer
- The device will be utilized to detect the measuring and comparing the acceleration of the knee.

Features

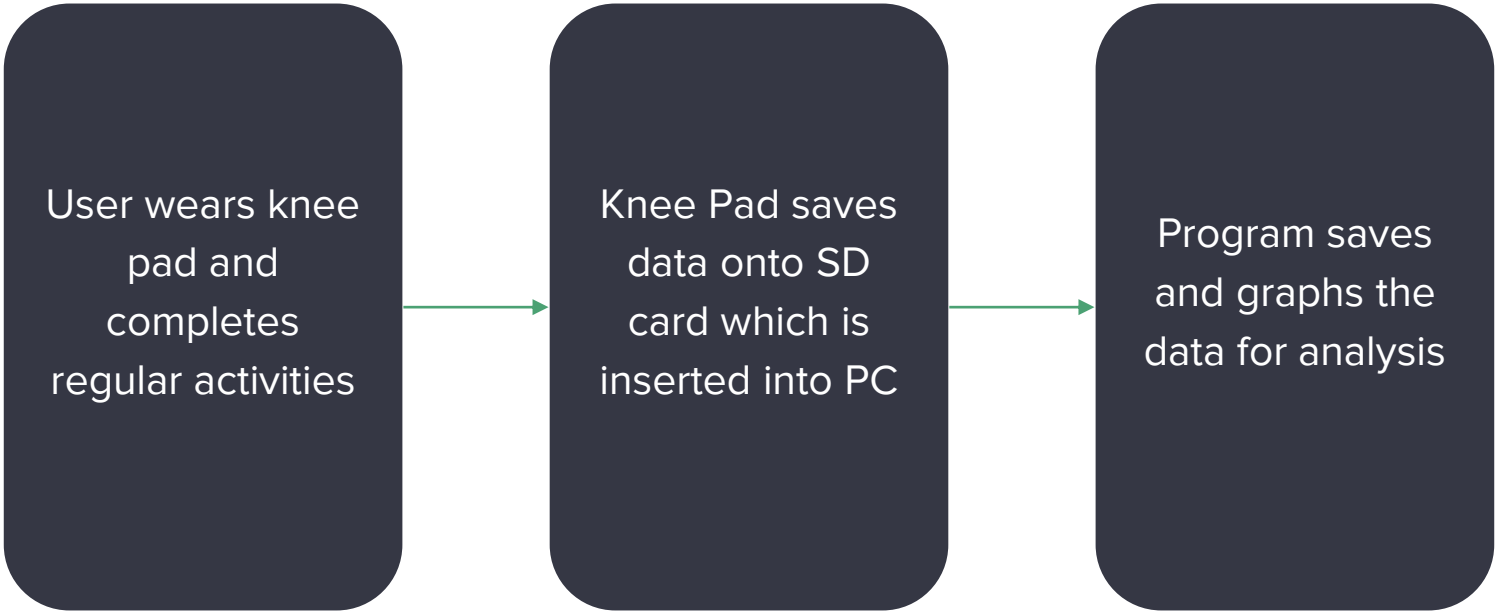
- Battery Power
- SD Card reader
- Data analysis
- Portable Device

THE SCHEMATIC OF THE PROJECT

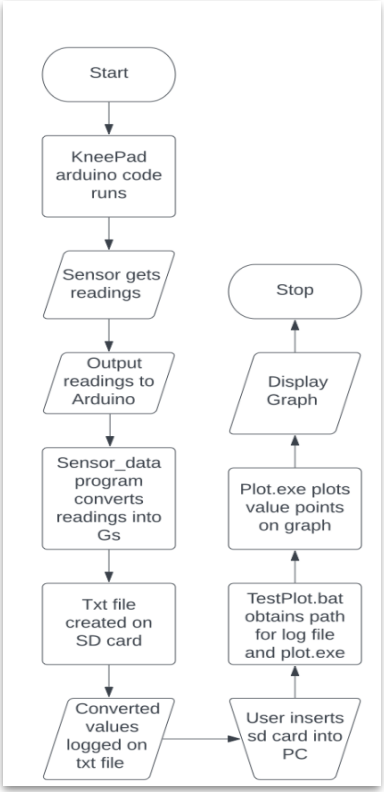


Isuru Yapa

How it’s used


User wears knee pad and completes regular activities
Knee Pad saves data onto SD card which is inserted into PC
Program saves and graphs the data for analysis

Implementation



Knee Pad Flowchart

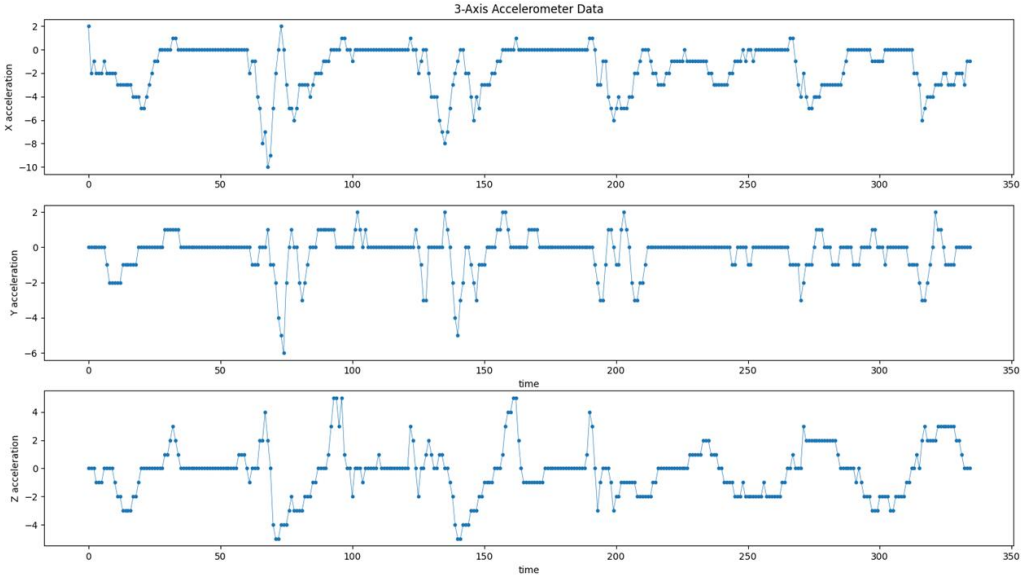
Storing the Data

In order to record the acceleration data, the device has a MicroSD card to store the log of (x,y,z) data values

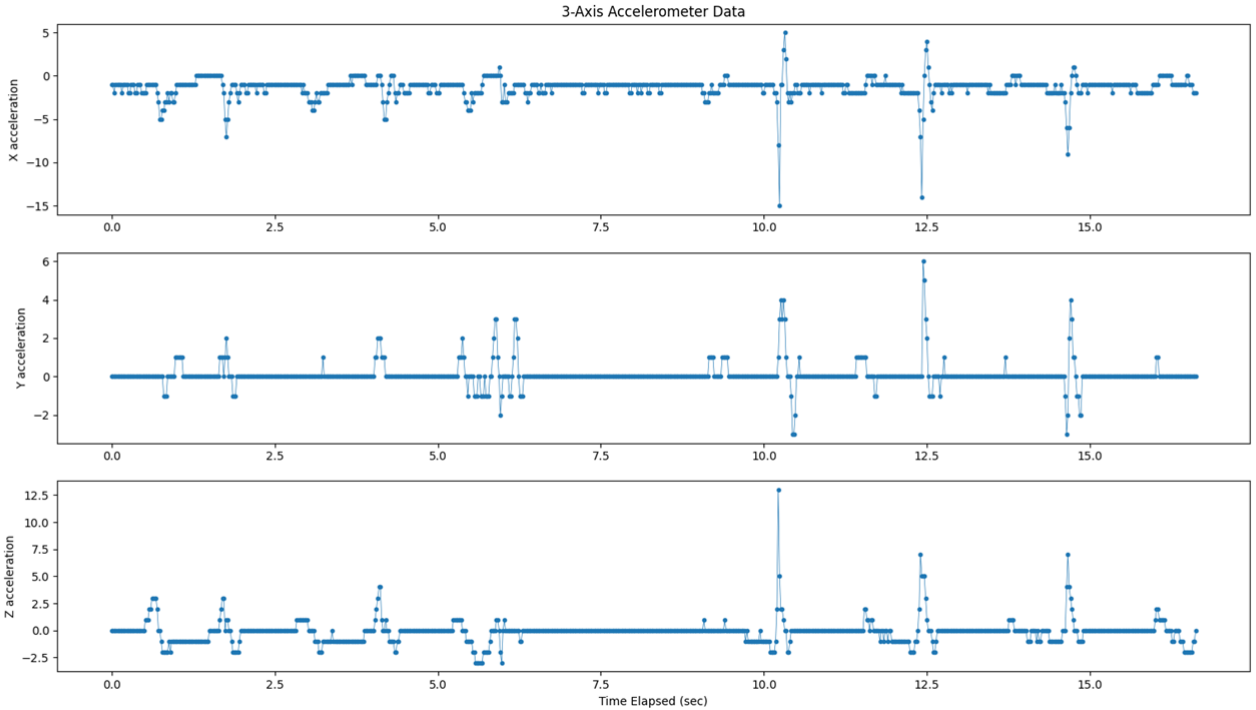
```
-8.00 0.00 2.00
-7.00 0.00 4.00
-10.00 1.00 2.00
-9.00 -1.00 0.00
-5.00 -1.00 -4.00
-2.00 -2.00 -5.00
0.00 -4.00 -5.00
2.00 -5.00 -4.00
0.00 -6.00 -4.00
-3.00 -2.00 -4.00
-5.00 0.00 -3.00
-5.00 1.00 -2.00
-6.00 0.00 -3.00
-5.00 0.00 -3.00
```

Representing the Data

In order to visually represent the acceleration from the knee pad, a program was created to plot the acceleration in 3 separate graphs

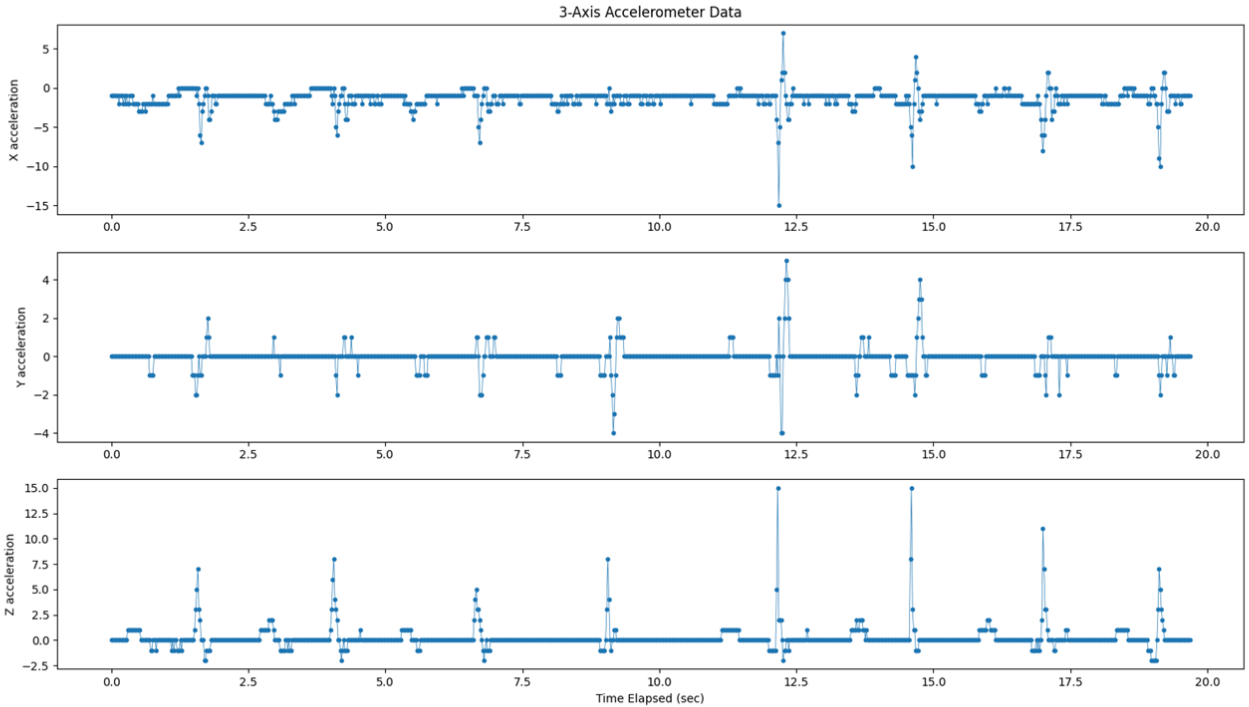


Testing Real Data from the Left Knee

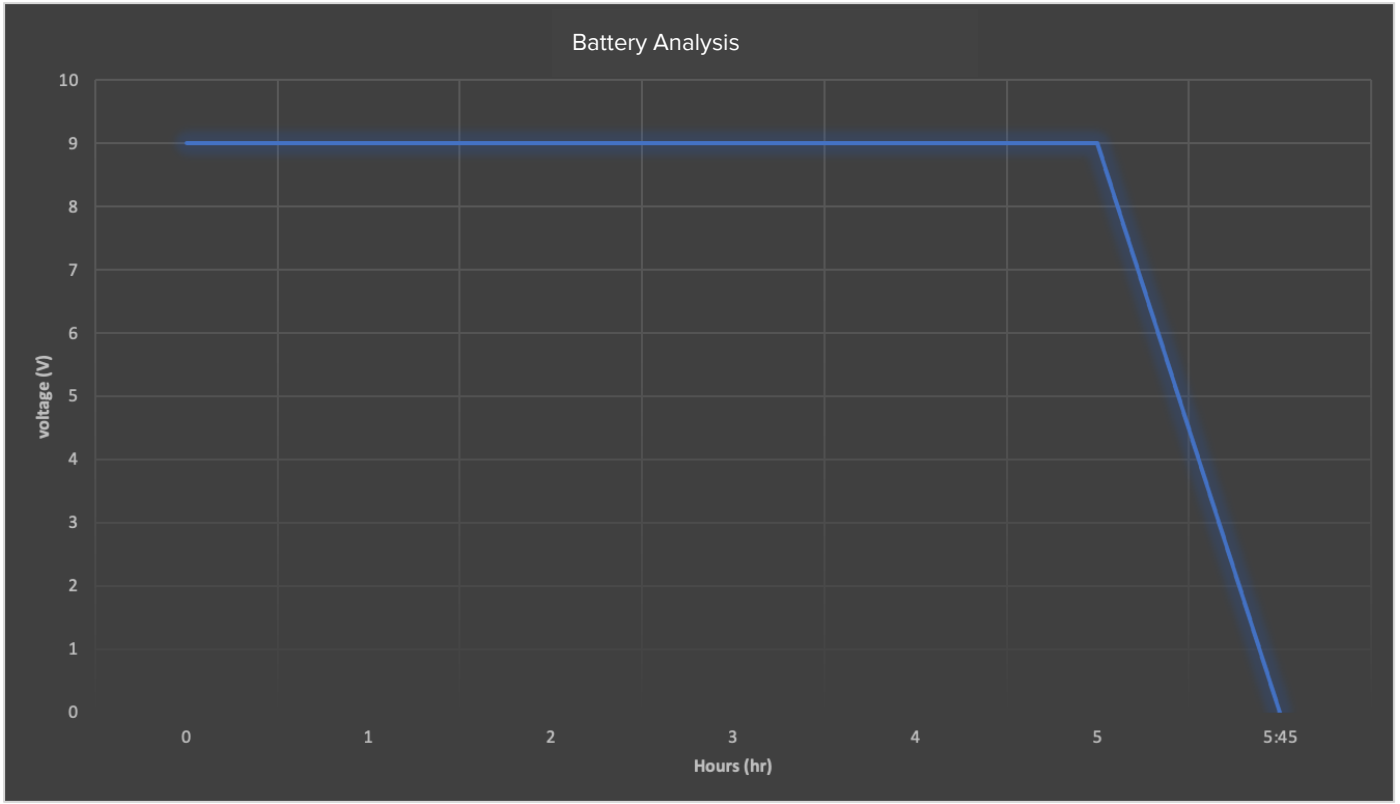


Testing Real Data from the Right Knee

Dallas Stroud



Battery analysis



Potential Applications

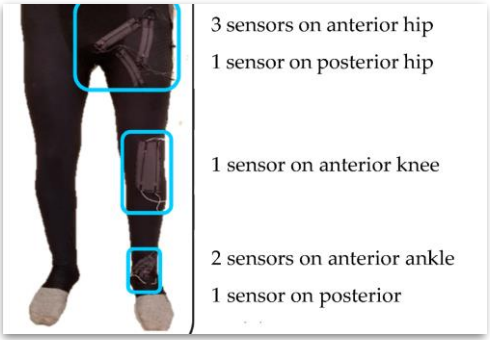
- Data is key for analysis and diagnosis
- Knee Pad is a tool for data to be collected
- Potential applications:
  - Tracking pace and explosiveness of runners
  - Gait analysis
  - Analysis of load on knee joint for athletes

"Prospective Epidemiological Study of Basketball Injuries During One Competitive Season: Ankle Sprains and Overuse Knee Injuries" - National Center for Biotechnology Information

Key points

- Ankle sprains are the most common acute injuries in basketball with the inciting event being landing on an opponent's foot or changing direction.
- Anterior knee pain is the most common overuse injury. Etiologic factors are well described in literature, but prevention strategies are lacking.
- Acute knee injuries account for the highest inactivity and should therefore also be prevented.
- Most of the injuries are due to contact mechanisms and therefore the definition of basketball as a non contact sport is questionable.
- Highest injury risks are found in women and in the lower levels.

"Fatigue Monitoring in Running Using Flexible Textile Wearable Sensors"



References

Cumps, E., Verhagen, E., & Meeusen, R. (2007). Prospective epidemiological study of basketball injuries during one competitive season: ankle sprains and overuse knee injuries. *Journal of Sports Science & Medicine*, *6*(2), 204–211. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3786241/#:~:text=Forward%20players%20sustained%20less%20knee

Gholami, M., Napier, C., Patiño, A. G., Cuthbert, T. J., & Menon, C. (2020). *Fatigue monitoring in running using flexible textile wearable sensors.* MDPI. Retrieved May 6, 2022, from https://www.mdpi.com/1424-8220/20/19/5573/htm