

Running Form Sensor

Final Project Presentation

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Wearable Devices and Computer Vision
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HARVARD
Summer School

Concept

Challenge: Poor running form is not good for muscles, joints and performance

Objective: Classify Optimal vs Suboptimal Running Form

Data: X, Y, Z coordinates SensorTile;
Accelerometer, Magnetometer, Gyroscope

Approach: Fix programmed SensorTile to optimal position of the leg for monitoring changes in cadence, q-angle, stride

Use case:
Provide Biofeedback to Runners
Track, Analyse and Improve Progress



Hardware

Macbook Pro

STM SensorTile

Nucleo F303RE

*Mobile power bank



Custom Protective Case for the Cradle Expansion Board

- Used the original plastic packaging slot of the board cut in half
- Covered with tape so that the tile does not fall out during running
- Using the micro-USB to connect to a mobile power source while running
- Alternatively, connect to phone or laptop in a backpack for power source

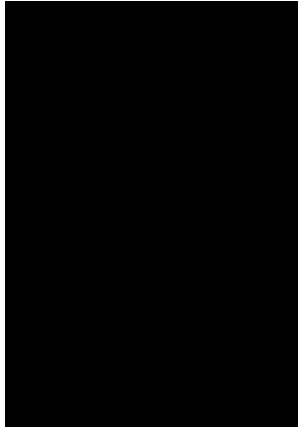
Video showing battery powered set up

Example of the Data Collection using ST BLE Mobile App

10 second intervals

Form evaluated by Physical Therapy
Consultant - “good” vs “bad”

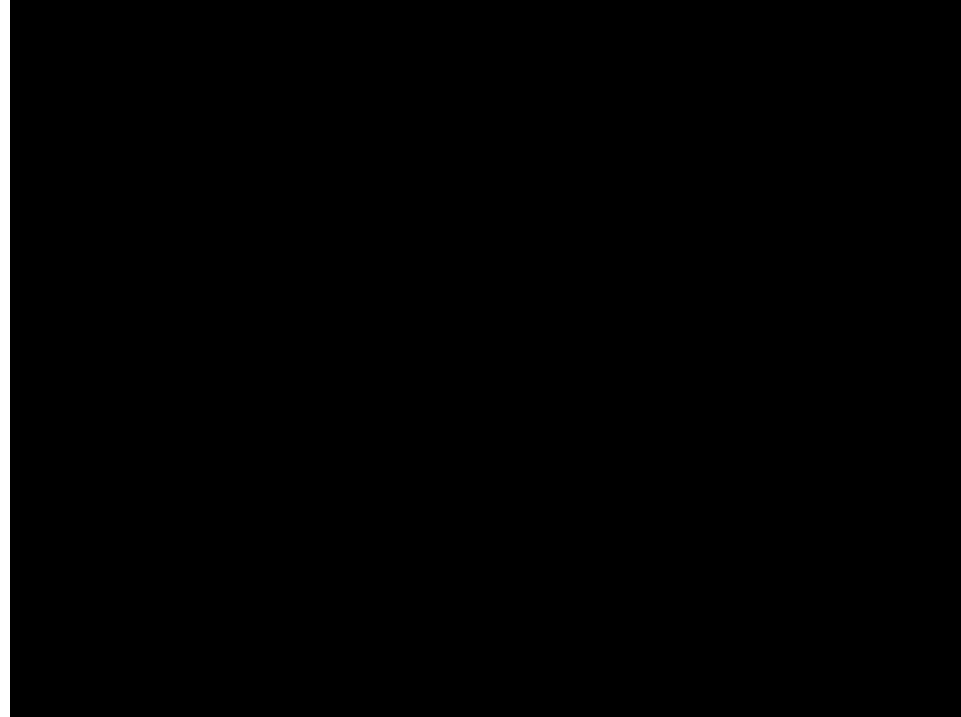
Bluetooth connection sends data



Power Bank in Pocket

SensorTile Cradle
attached to
Anteromedial Knee

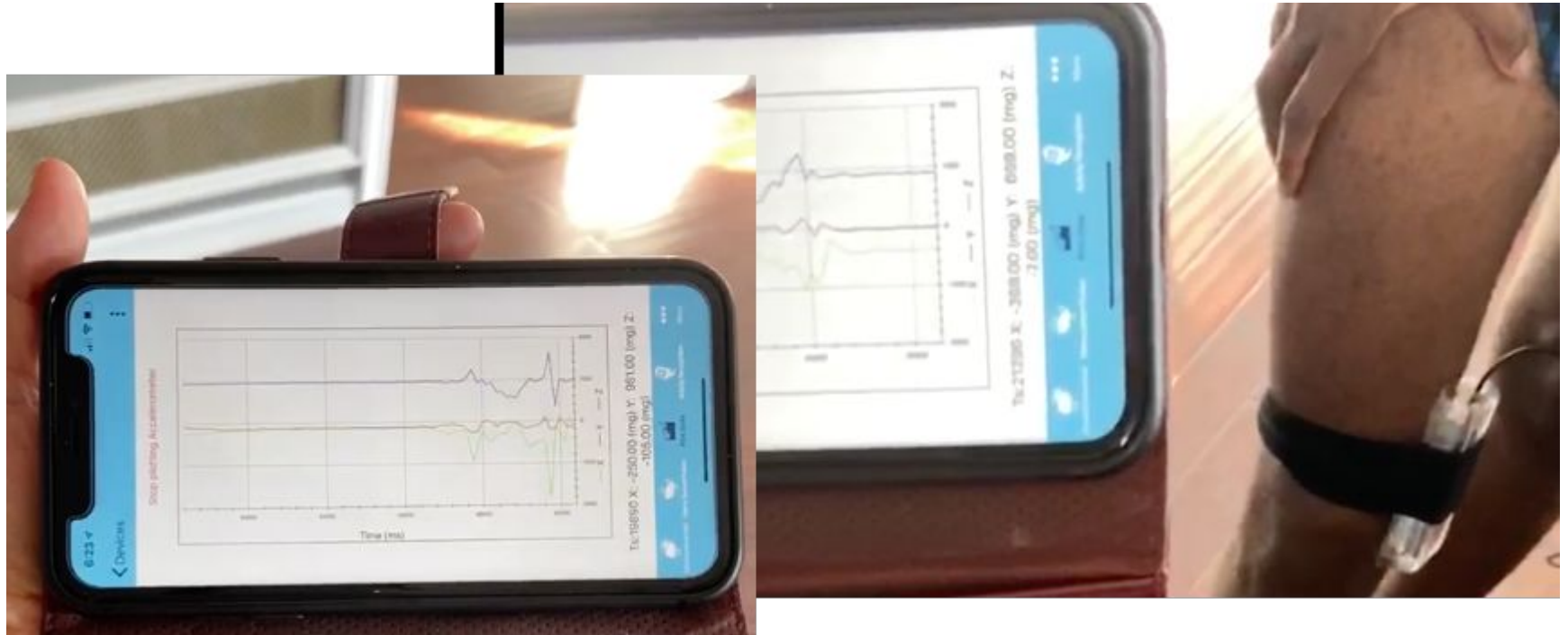
Video showing knee attached
device connected to power source



Video showing running form data collection

Example of Accelerometer Data

Sent to ST BLE Sensor mobile app via Bluetooth, logging the detected motion in CSV files.



Data Collected

Accelerometer, Magnetometer, Gyroscope

~70 samples of good form per 10 sec

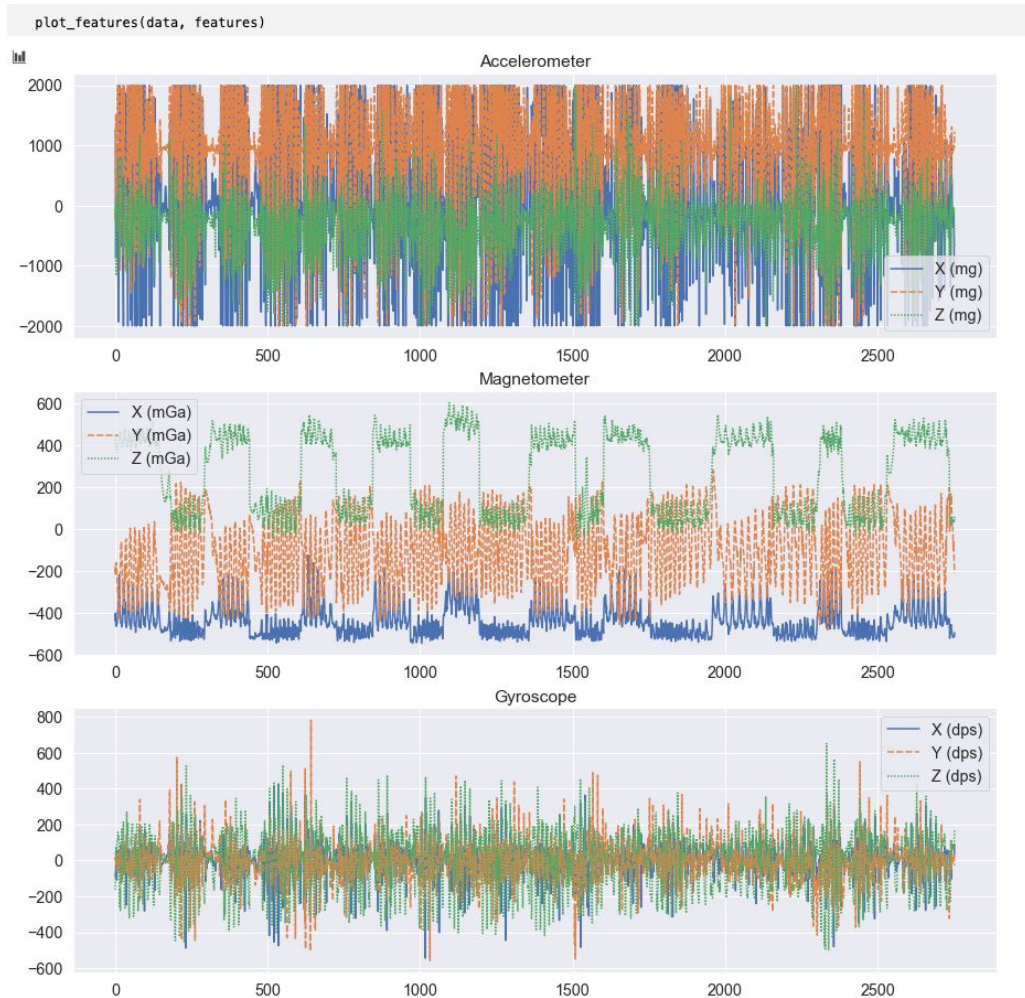
~50 samples of anomaly form per 10 sec

CSV files exported to Jupyter notebooks

Resampled data to even time-steps

Explored Deep Learning Autoencoders for
Dimensionality Reduction

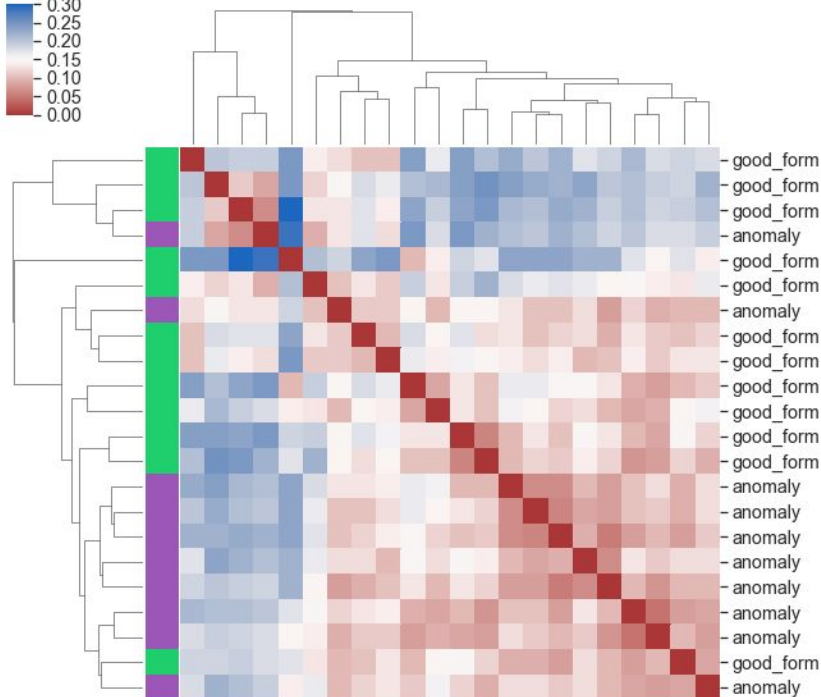
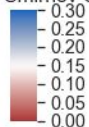
Visualizations and clustering in Python



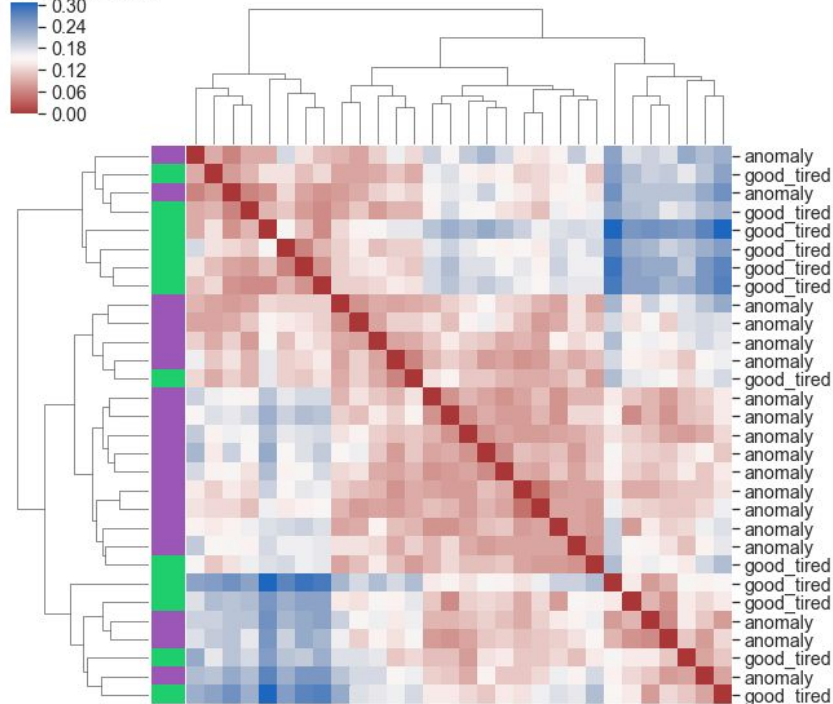
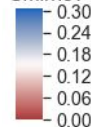
Clustering Results on Test Data

Hierarchical Clustering of Kolmogorov-Smirnov test on time distributed autoencoder reconstruction errors

Kolmogorov-Smirnov Clusters



-Smirnov Clusters



Thank You

- Acknowledgements

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