Abnormal Gait Diagnosis with wearable device

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Outline:

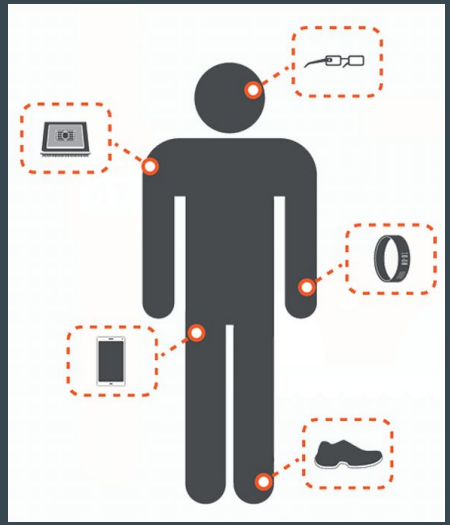
- Background
  - Data from wearable device
  - Importance of gait abnormalities
- Motivation
  - Telemedicine
  - Potential
- Project Components
  - Hardware
  - Algorithm
  - Future work: Interface

Background and Motivation

- Importance of gait

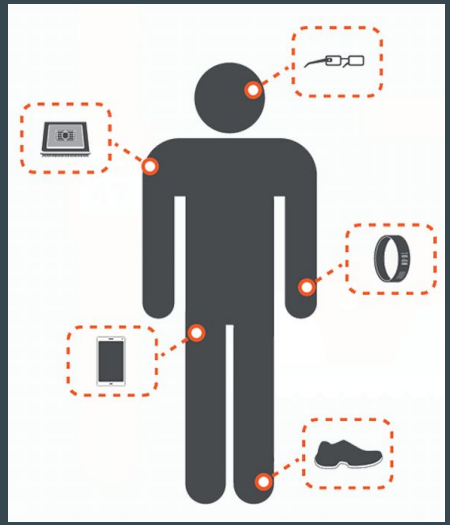
Background and Motivation

- Importance of gait
- Popularity of wearable devices



Background and Motivation

- Importance of gait
- Popularity of wearable device
- Willingness to share data

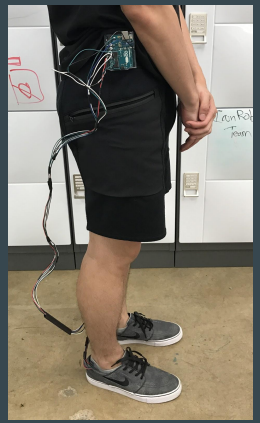


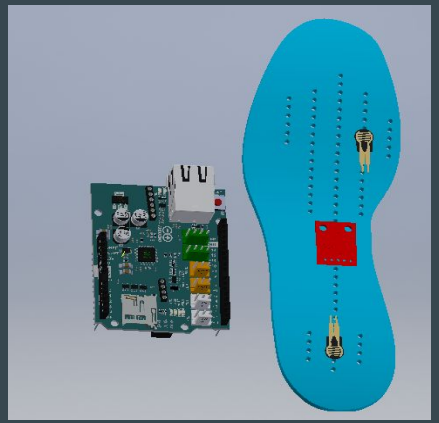
Background and Motivation

- Importance of gait
- Popularity of wearable device
- Willingness to share data
- Project potential influence
  - Shorten diagnosis time
  - Cost saving

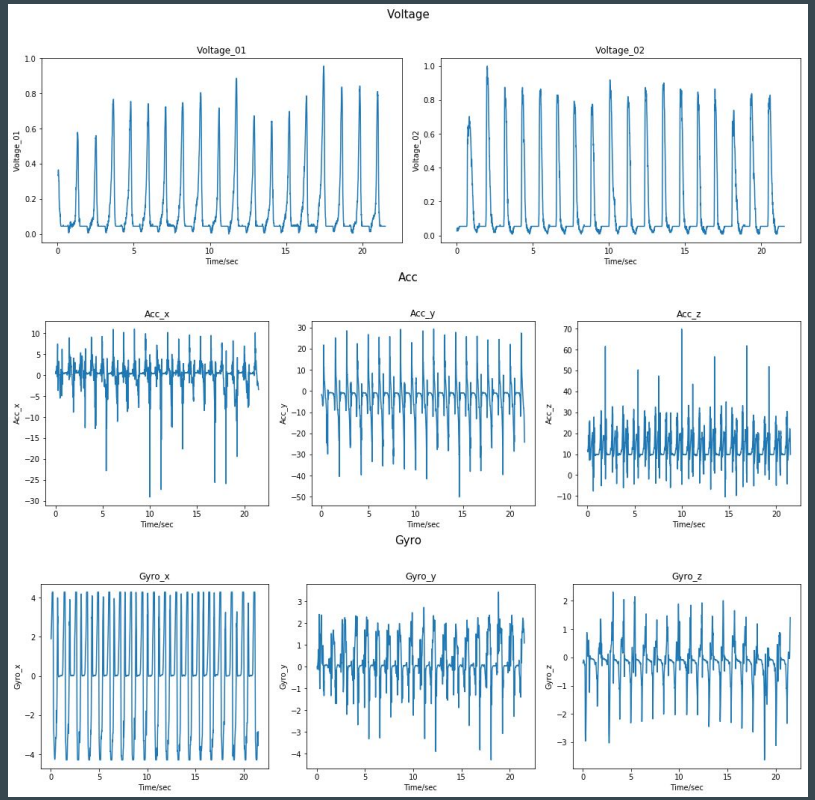
Hardware

- 9 DOF IMU and Force Sensor on Shoe insole
  - Acceleration on x,y,z axes
  - Angular acceleration around x,y,z axes
  - Voltage to represent force





Hardware


Voltage
Voltage_01
Voltage_02
Voltage_01
Voltage_02
Time/sec
Acc
Acc_x
Acc_y
Acc_z
Time/sec
Gyro
Gyro_x
Gyro_y
Gyro_z
Time/sec

Data Collection

- Four Categories
  - Tendem Gait
  - Inward
  - Outward
  - Normal

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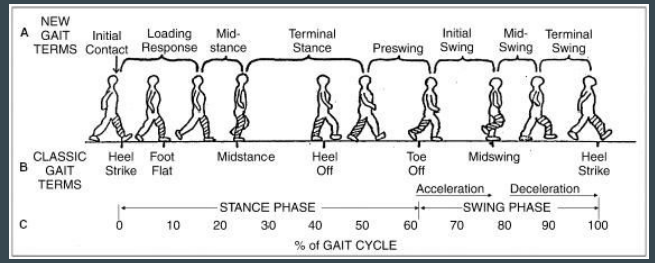
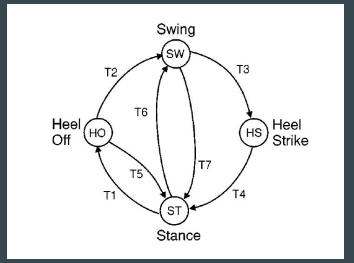
Algorithm

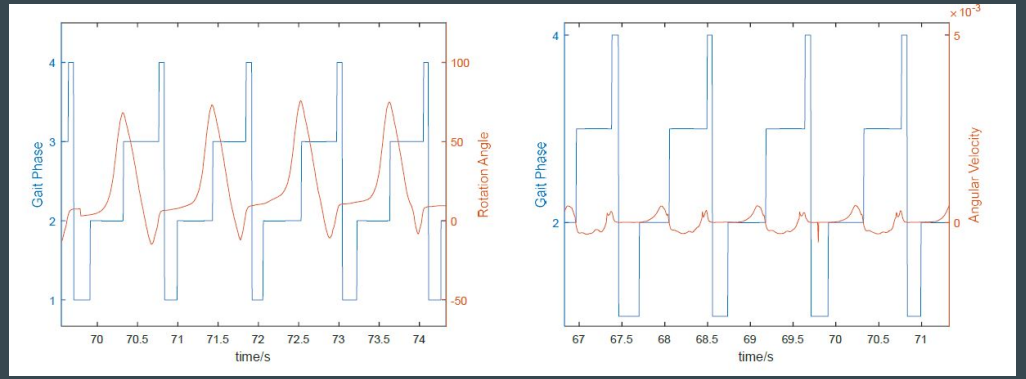
- Gait Phase State Machine
- Feature Engineering and classification algorithm
- Long Short - Term Memory Recurrent Neural Network for classification

Algorithm

- State Machine Approach:
  - Four Gait Phases
    - Stance
    - Heel Off
    - Swing
    - Heel Strike
  - Normal Gait Transition:
    - T1: ST to HO
    - T2: HO to SW
    - T3: SW to HS
    - T4: HS to ST
  - Non-walking Transition:
    - T5: HO to ST
  - Abnormal Gait Transition:
    - T6: ST to SW
    - T7: SW to ST

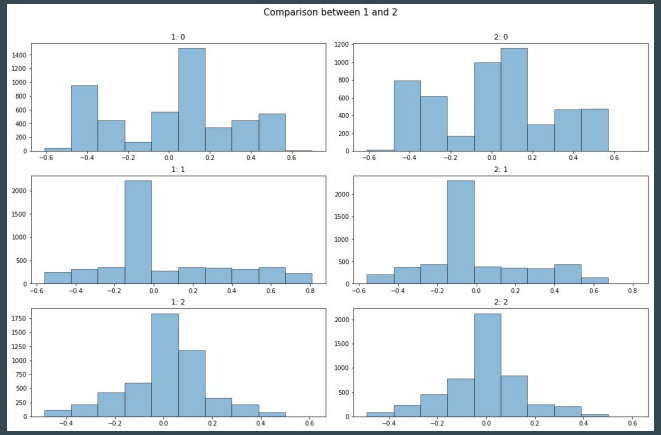


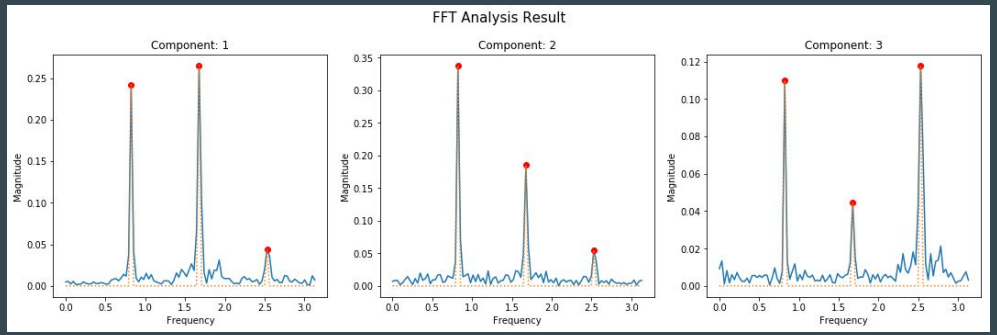




Algorithm

- Feature Engineering
  - Dimension Reduction: Principal Component Analysis (PCA)
  - Distribution Feature: Histogram
  - Frequency Feature: FFT





Algorithm

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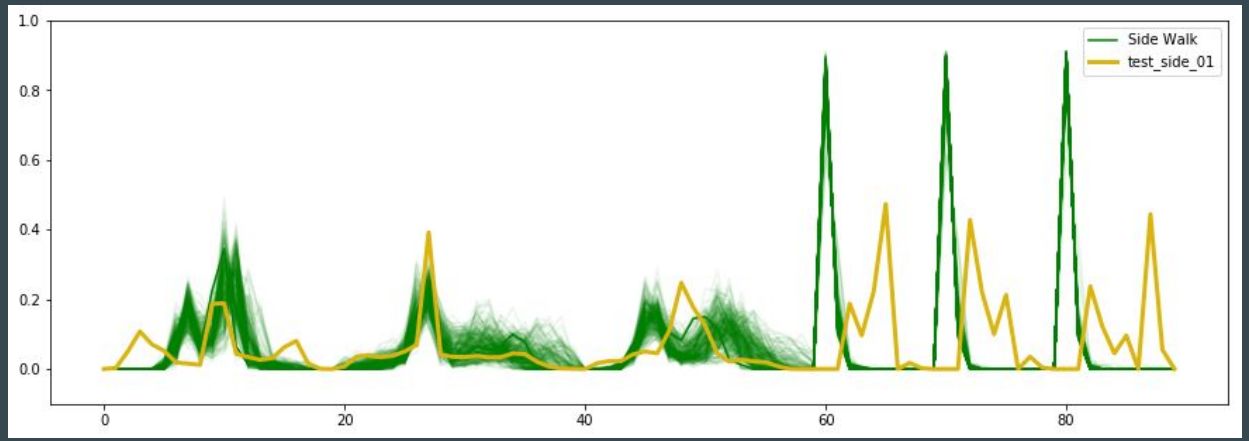
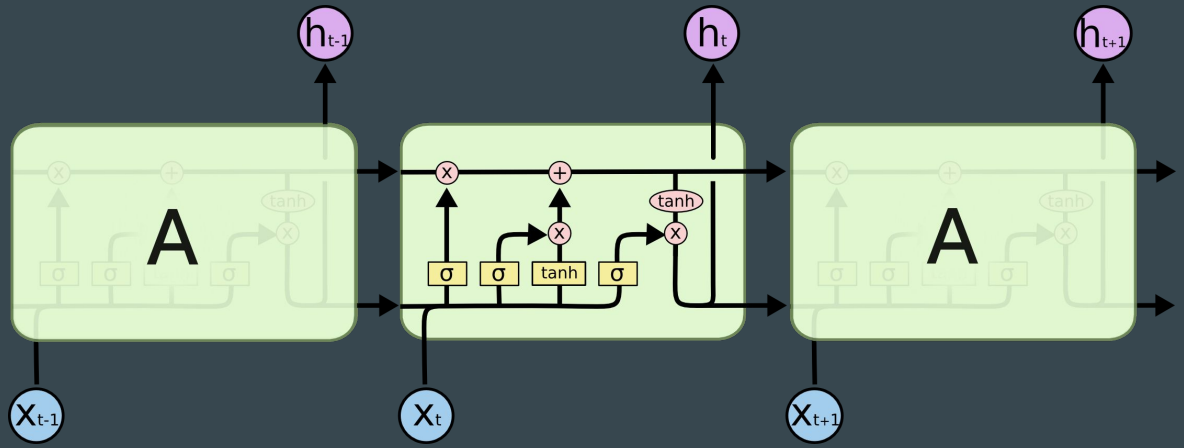


Algorithm

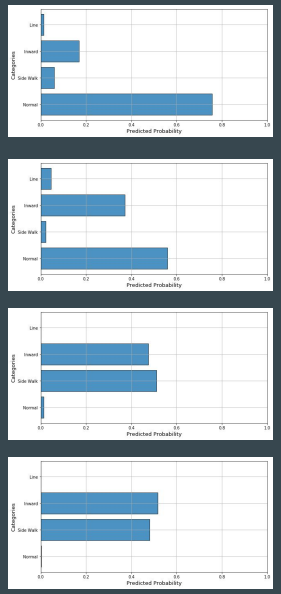
- Long Short-Term Memory RNN



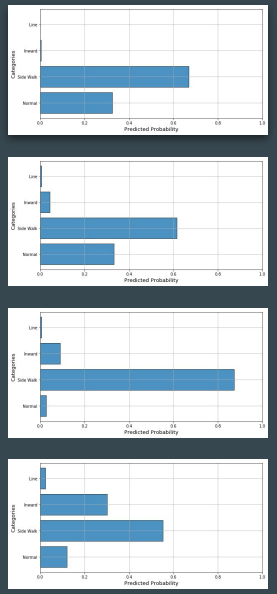
Algorithm

Outward

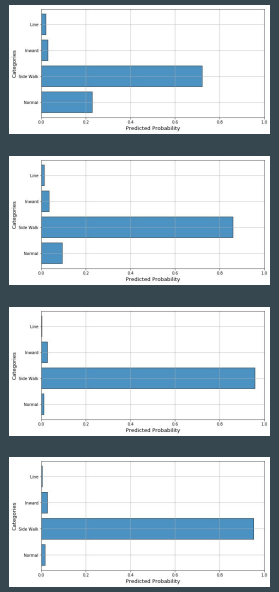
- Feature Engineering
+ Logistic Regression



- Feature Engineering
+ SVM Platt Scaling



- LSTM RNN



Interface

- Use instructions with caveats
- Interpretable diagnosis result
  - diagnosis results
  - Example videos of certain abnormality to help understanding
  - Potential solution
  - Caveats

Summary

- Importance of gait abnormality
- Hardware and experiement
- Algorithm and experiment
- Futhure work: interface

Collaboration

- The gait phase state machine approach is implemented collaboratively with YuanKai Zhu.

Reference

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Github: https://github.com/vacous/GaitDiagnosisML

Thank You