# Action Recognition Through Device Sensors

Jevons Wang
New York University
&
Jia C. Shang
Temple University
&
Dr.Jie Wu
Temple University

# Sensors: Our Future

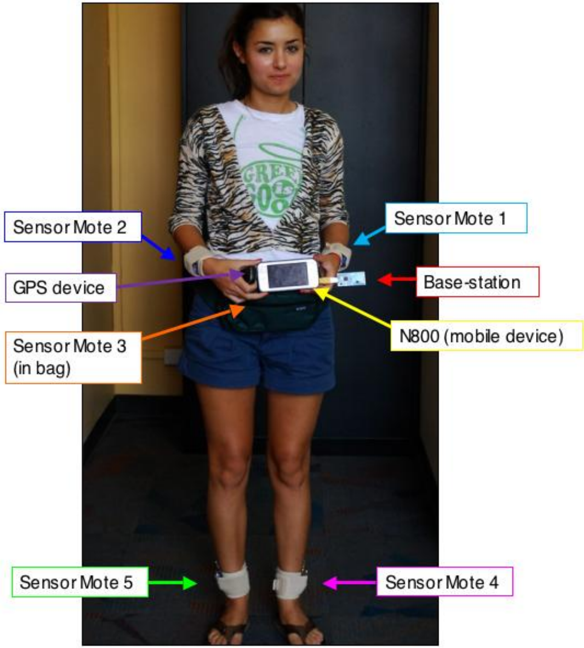
- Heavily applicable in many areas
  - Security/Health
  - Education
  - Industry
- Integrated into everyday life
  - More and more integration into technology
    - Accelerometer
    - Gyroscope
    - Finger Print
    - Compass
    - etc...

# Evolution of Sensor Use

- Increase in practicality (Miniaturization)
    - More readily available for the public
    - Big business/government → Everyone can use

# Previous Projects

- Main contributor: Allen Y. Yang
    - Data Collection Protocol for WARD (2009)



# What is WARD?

- Public human action database
- Use of body sensors to send data through a network
- Logs movements of different subjects
  - 20 human subjects (13M/ 7F)
  - 2 weeks
  - 13 recognizable actions

# Allen Y. Yang’s Project Design

- Use of DexterNet
  - 3 Layer architecture
    - BSL
    - PNL
    - GNL
- Pros
  - Removes necessity of other hardware monitors
  - Distributed Pattern Recognition
    - Reduces communication cost whilst preserving performance
- Exploits miniaturization of sensors

# Our Project: Architecture

- Implementation of new hardware
  - 2009 → 2017
  - Smart Watch and Mobile Devices
    - Samsung S6 Edge
      - OS: Android
    - Samsung Gear S3 Wearable
      - OS: Tizen
  - Use sensor logs from mobile and wearable devices
    - Create data logs and apply them to WARD

# Pros

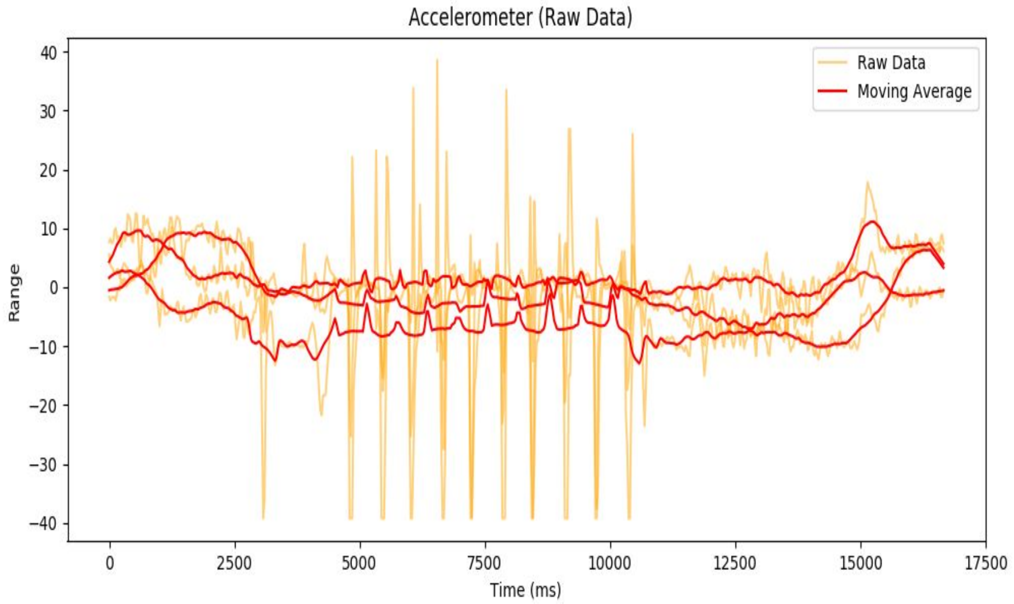
- Large array of sensors
  - Mobile Device
    - Accelerometer, Gyroscope, Compass, Magnetometer
  - Watch
    - Accelerometer, Gyroscope, Compass, Magnetometer, 4-channel sound sensor
- Recognize new actions
  - One door closes, another door opens
    - Find new recognizable actions
  - Sound sensor: possibilities are endless

# Challenges

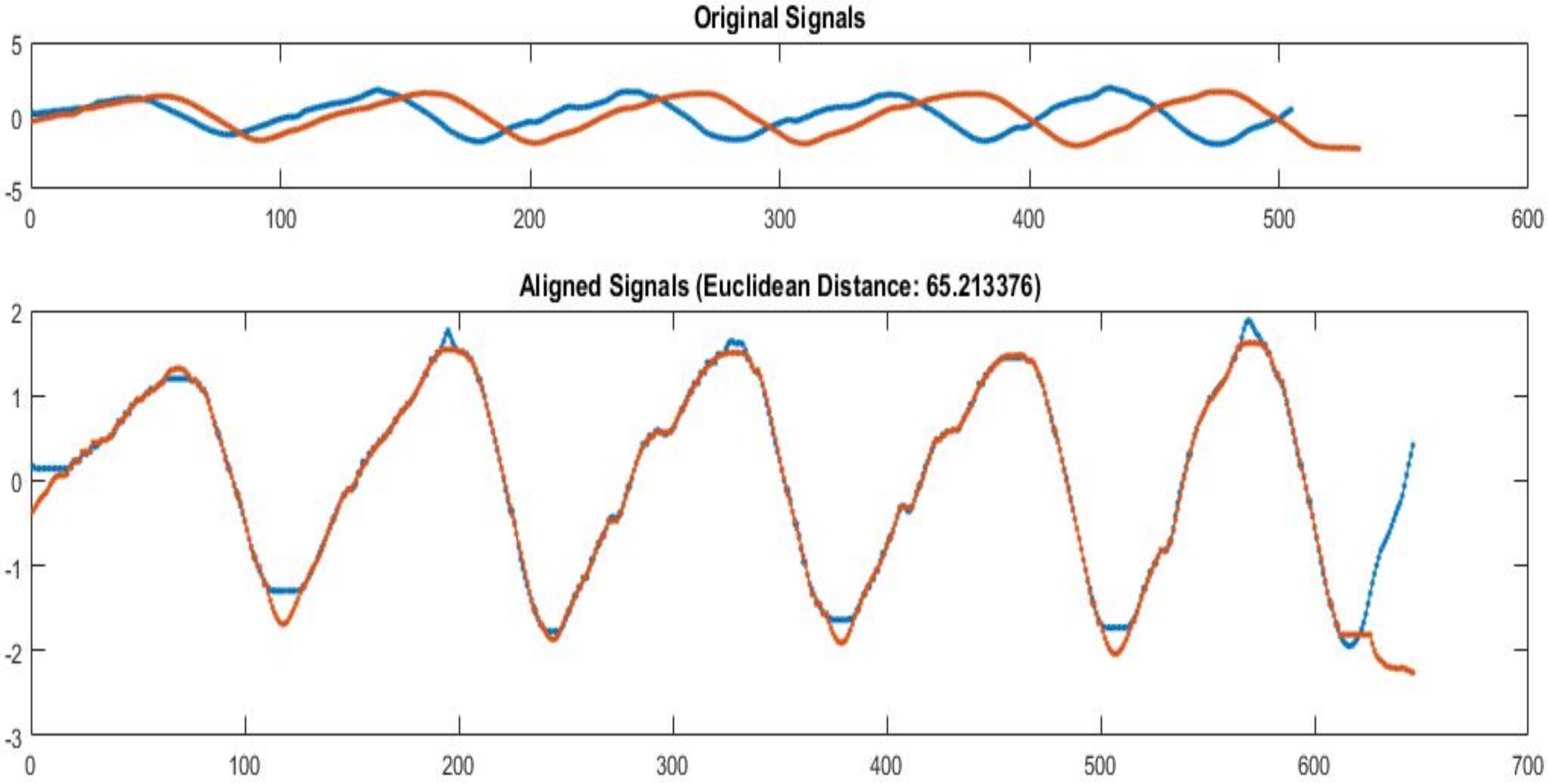
- Versatility vs. Precision
  - Sacrificing multiple sensors for practicality
    - Harder to recognize human actions with 2 pieces of hardware
      - Certain actions cannot be differentiated
- Offline data logging
  - Data is saved to internal memory
  - No real-time functionality
- Tizen - Android integration

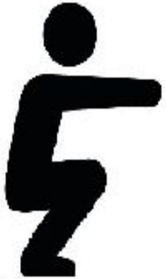
# Data Logging

- Sensor Data saved onto mobile device
  - Tab separated values
  - 4 separate files
- Three sensor axis: X, Y, Z
  - Graphed on python/MATLAB
    - Moving Average Filter
- Compare action features
  - Dynamic Time Warping
    - Time-series algorithm



# DTW: J vs. D (Squats 5x)



| ACTIONS / SUBJECTS |  |  |  |  |  |
|---|---|---|---|---|---|
| 1 VS 2 | 453.1396 | 1333.7209 | 6850.0690 | 408.5870 | 2764.1455 |
| 1 VS 3 | 2142.8952 | 3095.0594 | 10850.2859 | 8919.6368 | 7546.8719 |
| 2 VS 3 | 1576.7722 | 1955.4609 | 15347.4296 | 8721.5554 | 7688.8981 |

| (A) Vector | JJ | PU | SS | SQ | SU |
|---|---|---|---|---|---|
| JNxD | 448.2305 | 4247.0406 | 5325.2449 | 1894.4237 | 8969.9414 |
| JNxN | 1687.7892 | 3333.4114 | 16961.1449 | 8733.7938 | 15963.8875 |
| JNxJ | 38.9451 | 2848.6439 | 4652.6753 | 1610.5577 | 4029.9876 |
| (G) Pitch | JJ | PU | SS | SQ | SU |
| JNxD | 36.9305 | 101.1439 | 215.6683 | 321.4366 | 184.8711 |
| JNxN | 51.5676 | 73.0009 | 64.8086 | 61.7337 | 76.0791 |
| JNxJ | 12.6811 | 172.0071 | 217.9381 | 321.4366 | 179.4237 |
| (G) Roll | JJ | PU | SS | SQ | SU |
| JNxD | 48.2583 | 75.5987 | 218.336 | 66.8399 | 70.1634 |
| JNxN | 62.7086 | 63.7738 | 78.8307 | 73.0001 | 68.8761 |
| JNxJ | 10.8158 | 91.9781 | 135.5114 | 66.8399 | 93.9976 |
| (G) Yaw | JJ | PU | SS | SQ | SU |
| JNxD | 74.2453 | 113.7198 | 205.3022 | 87.5820 | 112.7518 |
| JNxN | 82.1154 | 74.2333 | 102.5962 | 95.7560 | 81.5021 |
| JNxJ | 35.7603 | 100.1559 | 97.4966 | 87.5820 | 92.4320 |
| (M) Vector | JJ | PU | SS | SQ | SU |
| JNxD | 5651.5856 | 34626.2761 | 43302.0076 | 11220.0451 | 65434.7465 |
| JNxN | 11290.5332 | 25854.8222 | 10724.1603 | 47154.8415 | 97068.5102 |
| JNxJ | 132.3367 | 21145.1436 | 33767.3311 | 11099.2611 | 27477.8490 |

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