Biometric Gait Identification

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Goal

- Classify individual based on their gait pattern obtained from acceleration, angular velocity, and orientation sensor data
  - Implement the classifier using existing hardware i.e. cell phone sensors
- Determine the similarity of walking patterns between an un-enrolled and enrolled user
- Use classifier for enhanced security in public and private areas

Motivations and Objectives

- Motivations
  - Recognition could be used to verify that people leave a building during emergency situations, or track an intruder in a building.
  - Gait recognition could unlock doors as a person approaches them, avoiding the need for keys.
- Objectives
  - Develop a neural network classifier that achieves an accuracy of at least 90%
  - Implement classifier with existing, "off-the-shelf" hardware in cellular phones.

Research Challenges

- Recording data for our trials was difficult because we had to find a walkway without sharp turns or corners that was long enough to collect 1600 images for each metric
- In order to obtain a high accuracy from our Neural Network, we had to obtain around 3 hours of walking time from each walker
- After deciding to use the treadmill to record data we realized that certain directions do not move much and would produce very low accuracy and validation
- Quantifying features that discriminate between users

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Methodology

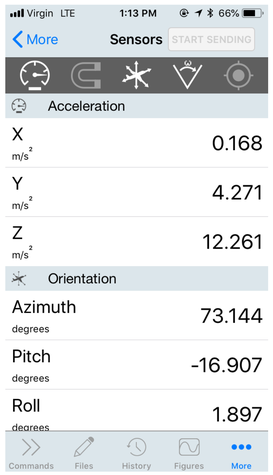

Figure 1: Screenshot of MATLAB Mobile's sensor interface, with relevant sensors activated

- Four participants (1 male, 3 female) walked on a treadmill for about 3 hours over several days
- Acceleration, angular velocity, and orientation data collected with an iOS device using MATLAB Mobile
- Two types of classifiers created using:
  - Manual feature extraction
    - Classification tree, support vector machine, k-nearest-neighbors, maximum likelihood
  - Deep learning
    - Fine tuned the ImageNet Inception V3 neural network
    - Wavelet decomposition images of 501 samples, starting from a peak in the signal
    - 1120 training, 240 validation, and 240 test images

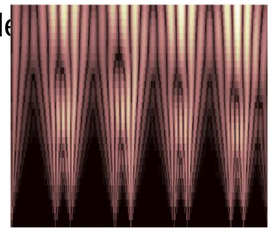

Figure 3: Wavelet decomposition for orientation in z-direction

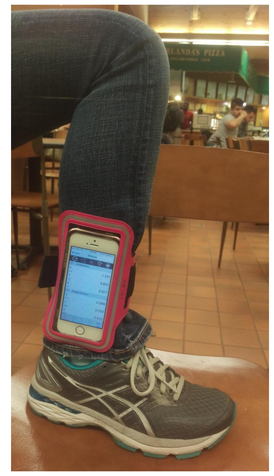

Figure 2: iOS device was strapped to the right ankle, screen facing outwards

Results

Manual Feature Extraction

- Extracted features such as *time between peaks*, *average power, max signal power,* and more
- ROC curves showed overfitting of data
- Proceeded with deep learning since feature extraction did not solve need for much more data

Deep Learning

- After adding one pooling layer and two dense layers to the network, results in the magnitude, *y-*, and *z*-directions improved greatly.
- Standard deviation among networks with accuracy greater than 50% is 1.634

	acceleration	angular velocity	orientation
x	15.3125	12.2917	25.8333
y	99.46	98.54	99.79
z	99.479	100	94.895
magnitude	99.6875	99.7917	97.8125

Table 1: Accuracy percentage of network for each dataset

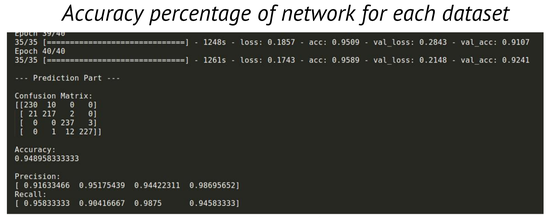

Figure 4: Results from training and testing classifier for acceleration in the z direction

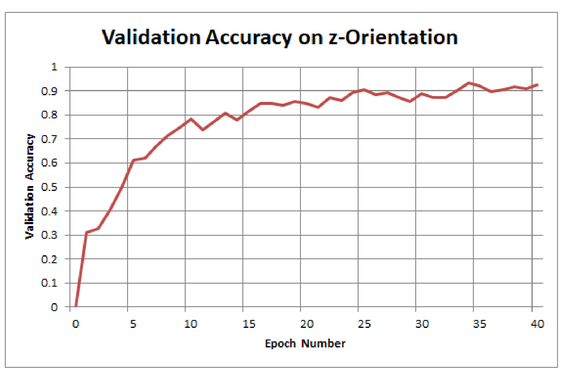

Figure 5: Validation accuracy as a function of epoch

References

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