Winter 2015 – ECE457B Computational Intelligence
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Smartwatch Gesture Recognition

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Abstract and Overview

Wearable technology, such as smartwatches, are poised to become a ubiquitous consumer product. Because of their small size, most smartwatches rely heavily on voice commands for user input, which is not practical in many situations. We created a system which allows arm gestures to be used as an alternate input method.

Problem Formulation

To make gestures an effective user input method on smartwatches, we need to define a set of gesture types that are easy to perform, create a system to collect sensor data while the user performs gestures, and create a system which can reliably and efficiently classify gestures.

Proposed Solution

We used a subset of the gesture types defined in the canonical "$1 Recognizer" paper, published by University of Washington and Microsoft researchers. We built a custom Android application and accompanying Android Wear application to collect data from users while they perform the gestures. We then used that data to train a neural network in order to make it capable of classifying the gestures.

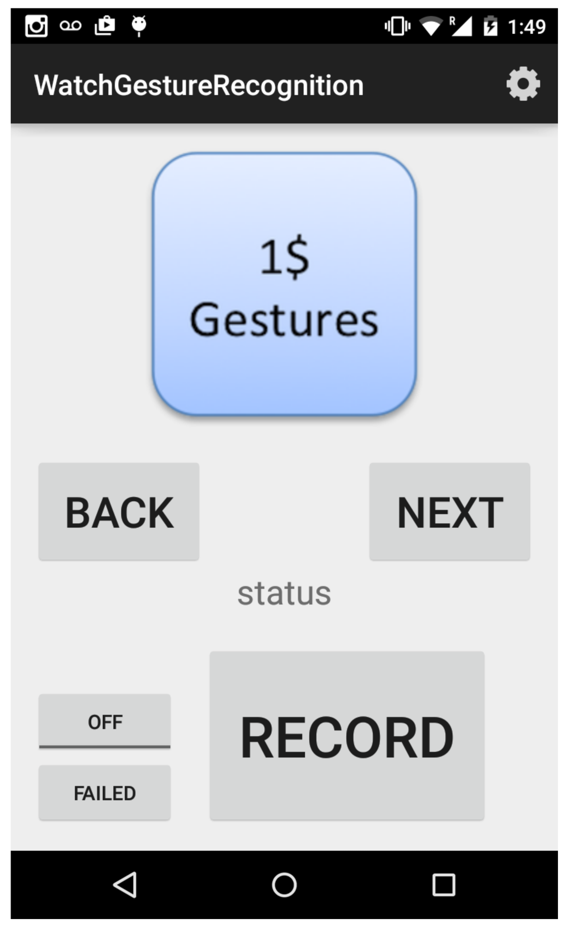
Tools, Algorithms

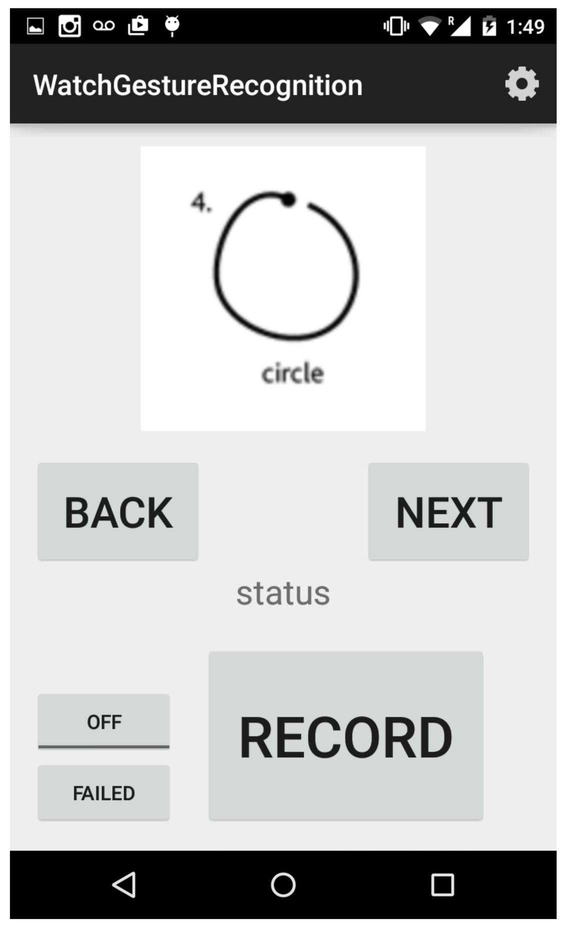
Data Collection

The data collection Android application pairs with the Android Wear smartwatch app. The user is asked to perform a gesture type and the watch vibrates indicating the beginning and end of the two-second data collection period. This data is stored for offline training and classification.

Neural Network

We created a neural network to classify the gestures. The custom Java codebase was designed for performance, accuracy, and portability to Android smartphones. The gestures are classified using a feed-forward multi-layer perceptron which is trained using the backpropogation algorithm. The input layer has a neuron for each accelerometer data point recording during the data collection period and the output layer has a neuron for each supported gesture. We tuned the structure of our neural network using genetic algorithms.





Experiments, Analysis

Using our Android app, we collected data from 336 gestures, split into pools of 216 training gestures and 120 testing gestures.

The optimal neural network has 1350 input neurons, 4 hidden layers of neurons (150 neurons, 150 neurons, 50 neurons, 50 neurons), and 6 output neurons and uses a learning rate of 0.7.

Our neural network was 95% accurate in classifying gestures and could classify a gesture in 0.26 microseconds on a 2.3 GHz Intel Core i7.

Conclusion

Neural networks are a good tool for classifying gestures performed by smartwatch users. Our neural network demonstrated sufficient accuracy and performance for a potential commercial application. Future work should be done tuning the neural network to run on smartphone hardware, improving the network's classification accuracy by collecting larger training data sets, and evaluating performance in noisy environments, such as moving vehicles.