

Activity classification using wearable devices

Introduction, motivation and specification of the work

This project involves the expansion of existing sensor management libraries to wearable devices. These libraries will then be used to augment sensor data collected from smartphone.

The new wearable libraries will be used to answer the question “how much better is activity classification with both wearable and smartphone data in comparison to smartphone data on its own?” The definition of ‘better’ is expanded on in the evaluation section, but essentially means increased accuracy in classification and a wider range of activities able to be classified.

Tracking the motion of a wrist enables distinguishing between various activities where smartphone sensor data is not sufficient. Examples include distinguishing typing from eating.

The recent explosion in available wearable devices (Apple Watch, Moto 360 etc.) has lead to wearable sensor data becoming hot topic in mobile systems research. While it remains to be seen whether wearables will become as ubiquitous as smartphones, the wrist-mounted, sensor-rich smartwatch creates valuable potential for insight.

Resources required

- Smartwatch running Android Wear. Group is buying Samsung Gear Live and a Samsung Gear 2.
- An Android smartphone. Group is buying Nexus 5 and Samsung Galaxy S5.

Starting point

No Android development knowledge. No sensor system knowledge.

Existing sensor management library for Android¹.

DetectedActivity exists in the Android SDK², but is quite coarse in the activities it recognises and has no support for Android Wear.

¹ "xsenselabs/SensorManager · GitHub." 2014. 23 Oct. 2014 <<https://github.com/xsenselabs/SensorManager>>

² "DetectedActivity | Android Developers." 2013. 23 Oct. 2014

<<https://developer.android.com/reference/com/google/android/gms/location/DetectedActivity.html>>

Substance and structure of the project

The project has six main parts:

1. A study of working with sensing systems.
2. A study of developing with Android and Android Wear.
3. Implement an Android Wear app to collect and export sensor data.
4. Implement a classifier external to the phone and to classify activity from the app.
5. Evaluating the Android Wear activity classification against only using smartphone classification.
6. Write the dissertation.

The software engineering complexity comes in part from writing an Android Wear app to collect the sensor data, but primarily from writing a classifier for the data once it has been collected. The classifier will require machine-learning techniques using labelled sample data.

The project will therefore contain three significant pieces of software:

1. An Android phone application that collects accelerometer data from sensors from the phone. It also serves as control for the Android Wear application. This app must also be able to export the phone and watch sensor data as a CSV.
2. An Android Wear application that collects accelerometer data from the smartwatch and copies it to the smartphone.
3. A classifier running externally to the phone which will take the CSVs of data and attempt to classify them. The classifier will be trained using machine learning techniques. The classifier comprises the bulk of the software engineering effort. The classifier will not run on the phone but instead be run offline. Running the classifier on the phone would be computationally intensive and would have very little benefit to running a classifier offline. One can think of the offline model as an approximation to having the data upload to an external server ('the cloud') for processing.

Timeline

1. 24/10/14 – Proposal final submission.
2. 31/10/14 – Research into Android app and Android Wear app construction.
3. 06/11/14 – Research into sensor systems and classifiers.
4. 20/11/14 – Build Android Wear app to collect data.
5. 19/12/14 – Build classifier to classify Wear data.
6. 09/01/15 – Write activity report.
7. 23/01/15 – Begin evaluation. Record training data.
8. 20/02/15 – Record and classify data for evaluation.
9. 06/03/15 – Produce evaluation with graphs
10. 01/05/15 – Write dissertation and hand in by beginning of May.

Success criteria

- Android Wear app that collects sensor data.
- Classifier for Wearable data.
- Extension: train classification engine to recognise new types of activity only detectable using a smartwatch.
- Another possible extension: allow users to train their classifier to their own movements for more accurate person-specific classification.

Evaluation

The evaluation will take the form of a user study. In order to have an unbiased evaluation, any user study should take place on a variety of people and ideally these people will not have had involvement with the project beforehand. Having involvement with the project may influence the user to change their movements to make them more recognisable to the classifier.

All evaluation will require the user to wear the device and carry a smartphone for a period while it gathers data. During this data gathering period, users will have to document what activities they are doing and when. The data will be run through the classifier and its classifications compared to the actual activities to get an accuracy of classification measurement.

Labelled sample data may be available from the research group by the time I perform the evaluation, but I have assumed that it won't be and I will have to gather my own labelled sample data to train the classifier.

Other opportunities for evaluation include:

- Comparing the classification from the smartphone and from the wearable separately, and compute which is more accurate for which types of activity.
- Attempt to use both sets of data in the same classifier and compare accuracy of classification compared to smartphone sensors alone.

Possible problems

- Hardware
 - Battery life
 - Solution: we have multiple devices we can swap out, and each device will last at the very least a few hours - enough time to gather some activity data.
 - Sensors not sufficient in current Wearables
 - Sensors in Galaxy Gear 2 sufficient for sensing. Galaxy Gear Live is a newer version.
- Software
 - Developer APIs do not provide sufficient access