Activity Recognition using Mobile Phone Accelerometer Sensor

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Abstract

The present day technology trends have led to remake mobile phone gadgets as a technical advancement which eases the life of a person. The mobile phones have grown more sophisticated as they are embedded with numerous sensors like GPS sensor, direction sensor i.e., the magnetic compasses, audio sensor i.e., the microphone, light sensor, vision sensor i.e., the camera, temperature sensor, and the acceleration sensors i.e., accelerometer. In this paper, we have built a system to recognise/describe the physical activity of a person using the accelerometer sensor of the mobile phone. We have trained the system using the data collected from multiple human subjects in the real-world scenario while they performed activities like walking, standing, sitting, walking-upstairs, walking-downstairs. Several classifiers were tested using various statistical features. We have selected six classifiers based on the above listed activities each offering a decent performance for recognizing our set of activities and studied how to combine all into an optimal set of classifiers. We found that using the random forest classification model we reach an overall accuracy rate of 70%.

Keywords

Activity recognition, mobile phone, accelerometer sensor.

I. Introduction

THE activity recognition of a human is an important research area in the field of pervasive and ubiquitous computing as it can be applied to mant real-life problems with applications in eldercare, healthcare, smart environments, and homeland security. An accelerometer is a sensor which returns a value of acceleration of mobile phone along the x, y and z axes in the units of gravitational force from which displacement and velocity can also be estimated. Activity recognition is formulated using a supervised classification problem, where the training data is obtained by an experiment having human subjects perform each of the activities in a real-world scenario.

The system has been tested in an experiment where the user performs one of the following five physical activities: walking, running, sitting, standing, walking-upstairs, walking-downstairs. We use the resulting training data to induce the model for activity recognition. This system is significantly important because the activity recognition system helps us to gain knowledge about the habits/doings of the users passively by making them carry mobile phones in their pockets. Our work has many applications, including automatic customization of the mobile phones behavior based upon a users activity like sending calls directly to voicemail if a user is running and also framing a daily/weekly activity profile to monitor if the user who is obese is performing a healthy exercise.

II. Activity Recogniton

In this section we describe the activity recognition and the model formulation and processing for performing this task. In Section 2.1 we describe the protocol for collecting the raw accelerometer data and in Section 2.2 we described how we preprocess and transform the raw data.

A. Data Collection

In this experiment first we have collected data for various activities from various people via an android application(Fig.1) to address the heterogeneity. And the data is forwarded to the local server. When you directly feed the raw data to machine learning algorithm it will not give you a better accuracy. So before we train the model we have preprocessed the data for every task. While we are collecting the data, few outliers appear so as to remove them we have taken the plot of each co-ordinate axes. After observing the plots we identified some outliers and also we made threshold that are moving farthest than the expected values.

After removing the outliers. With the help of sklearn preprocessing we converted the data between -1 to 1 for each axes data. we have used the 5-fold cross-validation. Usually, cross-validation is used for the tuning the hyperparameter into a number

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of hidden layers to be present in a neural network and also to adjust the weights. Later we divide the entire dataset into five segments. Train the model with remaining four segments and then test it with fifth segment. This is repeated five more times. In this way, all the parameters will be tuned. Fig.2, Fig.3 and Fig.4 shows the range of plots for the all the classifiers, where blue is x-coordinate, green is y-coordinate and red is z-coordinate.

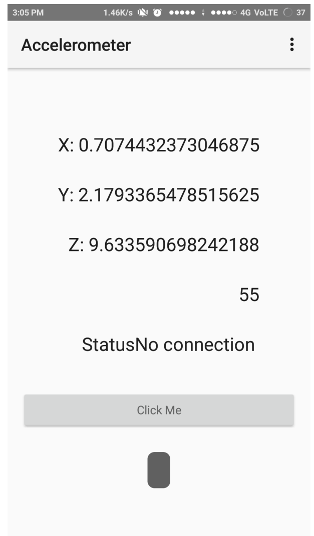

Fig. 1. The android application

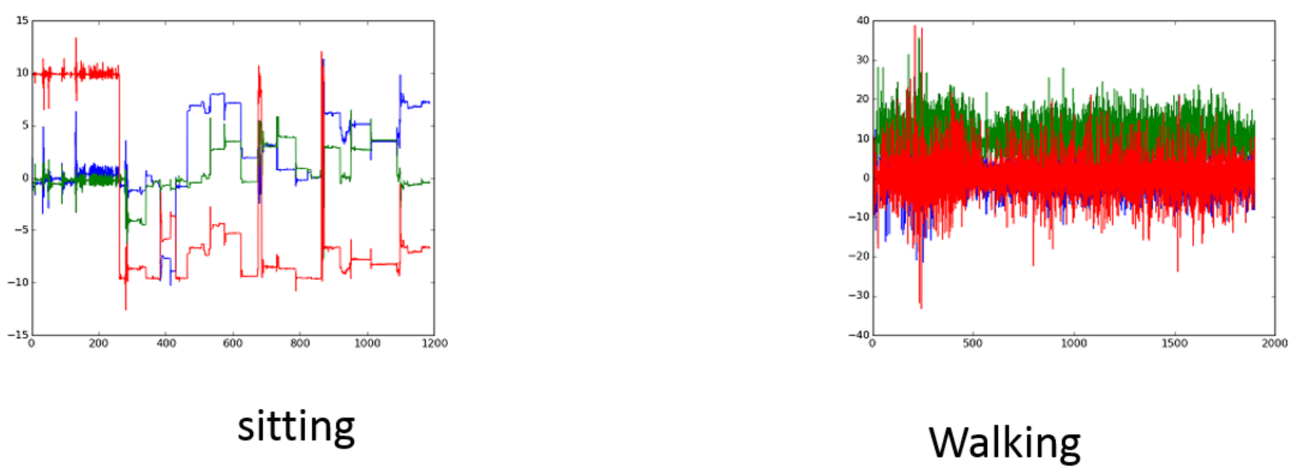

Fig. 2. (a) Graph plot for sitting (b) Graph plot for walking

B. Feature Generation and Data Transformation

Random forest algorithm is a supervised classification algorithm. As the name suggests, this algorithm creates the forest with a number of trees. Tree contains the leaf nodes as the class labels and internal nodes are the features. Using the features it will split into different parts. Random forests or random decision forests are an ensemble learning method for classification, regression and other tasks, that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees.To perform the prediction using the trained random forest algorithm we need to pass the test features through the rules of each randomly created trees.

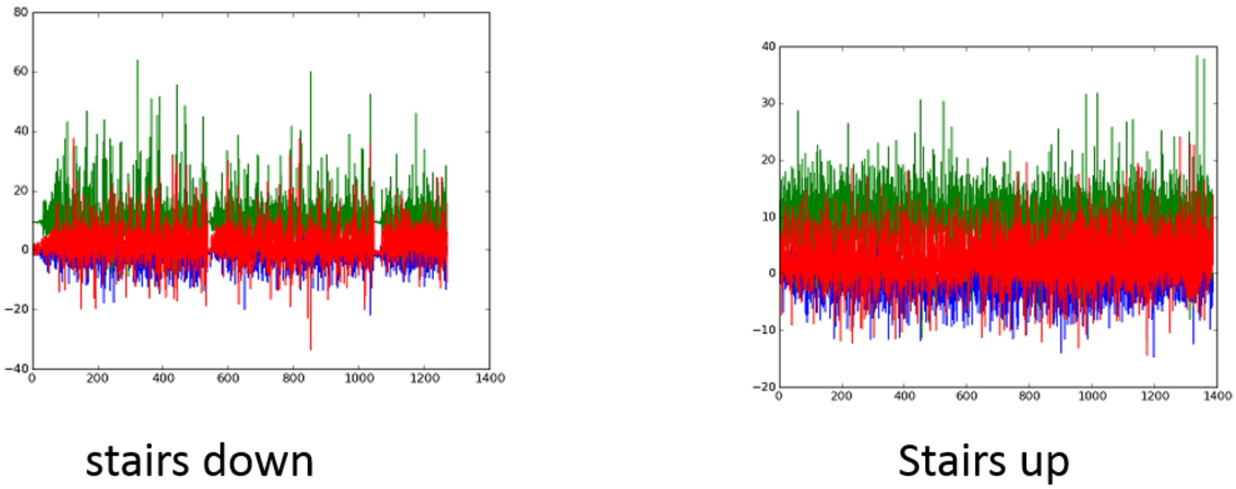

Fig. 3. (a) Graph plot for walking-downstairs (b) Graph plot for walking-upstairs

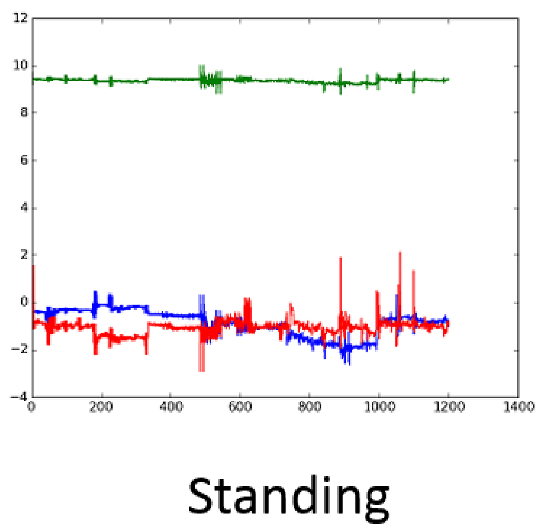

Fig. 4. Graph plot for standing

In random forest, given test data we start from the root of the tree. We compare them with the root attribute. on the basis of that it will follow the corresponding branch. We continue comparing our records attribute values with other internal nodes of the tree until we reach a leaf node with predicted class value.

III. Results

As mentioned above we have used a Random forest classsifier for training the data. We have also used different classifier models like Mluti layer perceptron, K- nearest neighbours. The problem with the random forest classifer is, it usually overfits the data. After training we have tested with the remaining 25% of the data. After comapring using all the classifier models we are able to acheive a better accuracy with the help of random forest classifier. Table.1 shows the results over different classification models.

TABLE I. RESULTS USING DIFFERENT CLASSIFICATION MODELS

Classification model	% of accuracy achieved
Random Forest	70%
Multi Layer Perseption	69%
K-Nearest Neighbour	55%

IV. CONCLUSION

In this paper, recognition accuracy of up to 70% on various everyday activities using a single triaxial accelerometer was obtained. The data were acquired from multiple human subjects in a real-world scenario where the mobile phone is placed inside the pocket. A new set of features was taken into account and different classifiers were used for evaluating recognition performance. We are achieving a better accuracy using random forest classification model.

V. FUTURE WORK

Our future work will focus on refining the approach and on verifying its accuracy in practice. We also plan to incorporate changes needed to limit unnecessary noise and reducing the redundancy of the data.

VI. REFERENCES

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