An Electric Eye for Human Activity Recognition: A Hybrid Neural Network

K. N. Apinaya Prethi, M. Sangeetha, S. Nithya, G. Priyadharshini, N. Anithadevi

Abstract: ***A real time detection of human movements is a practical solution to monitor aged people or mentally challenged people with the permission of their family. Household person is needed to monitor the elder and differently abled people. Instead of monitoring their activities with the help of other people, smart phones are used as a remote to monitor their activities and simultaneously send the message to their family members. The accelerometer sensor placed in the mobile phones. It is used to identify the activities of the person who holds the mobile phones. The most commonly used classifier technique is Naive Bayes classifier which has a limitation of handle with the large set of data. To overcome this defect, the proposed system classifies the data using k-nearest neighbor (K-NN) technique and Neuroevolution. This system recognize some representative human movements such as walking, climbing upstairs, climbing downstairs, standing, sitting and running ,using a conventional mobile equipped with a single tri-axial accelerometer sensor.***

Keywords: K-NN, Naive Bayes classifier, Neuroevolution, tri-axial accelerometer sensor

I. INTRODUCTION

Smart phone highly influences the human life from day to night. Many applications smarten the exertion of human like photo shoot, mailing etc. with the help of advanced technologies. A human activity determines the fineness of human which can be detected by vision based and sensor based method. Vision based process have many complications when applied practically. On the other hand sensor based methods are easy to implement and robust by using IoT devices [1, 2]. Human activities detected using sensor incorporates many activities (sitting, standing, walking, running, walking upstairs, walking downstairs). This activity detecting sensors embedded even in smart phones. HAR is a scorching topic in ubiquitous computing, context awareness, healthcare and human computer interaction [3]. Neuroevolution is an artificial neural network which makes use of evolutionary algorithms like reproduction, mutation, recombination and selection [4]. Sensor Technology allows patient to consult based on the history of their sensor data. Data collected from sensors are huge in amount; it's very difficult to send. Hence abnormal activities alone detected and send to the doctor. This will be much useful to the caretaker of aged persons, physically challenged and cognitive disorders.

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From the dataset, some features will be chosen for further process of classification using Principal Component Analysis (PCA). Selected features are independent to each other so that classification process can result with high accuracy [5]. Xin Yao proved a better intelligent system can be developed with a combination of k-NN and Neuroevolution [6]. Clustering algorithms like K-means have the problem in selecting cluster center and suffer from noisy data [7]. k-NN is one of the best discriminative model and instance based classifier. After predicting the test data class, if any abnormal human activity is detected then message will be sent to the responsible person.

Rest of the paper is organized as follows: Section II provides details about literature review of K-NN and EANN, Section III system architecture is discussed in detail; Section IV provides detail about system implementation Section V result is discussed Section VI conclusion and discussion are included.

II. LITERATURE REVIEW

Activity recognition is done by utilizing accelerometer sensor which is embedded in smart phones to recognize the basic user activity through client/server architecture. Without server intervention, recognition process is done by exhausting available phone resources. But the mobile phone is not having enough capability to deal with large set of data [8].

Smart phone is used widely to recognize the human activity. However, the part of a gyroscope and a magnetometer is yet to be discovered along with the accelerometer and without combining accelerometer. These three sensors are used to detect the human activity and analyzed. As a result, magnetometer is not encouraging because of its dependency nature [9].

Low level sensor and high level applications combined together to recognize the activity of human. In order to obtain good accuracy, more number of sensors produced in which sensors embedded with smart phones is widely used due to its opportune ness, low cost, and intrusiveness [10].

Technology brings multitask in and also provides the ability to detect human activity. Different human activities would make different posture and motion change of smart phone with motion sensors. An Android application was used to monitor and collect the data of motion sensors. Data from motion sensors were analyzed to extract time, frequency, and wavelet-domain features to find the activity of human [11].

III. SYSTEM ARCHITECTURE

Accelerometer, a sensor embedded in smart phone plays a major role in detecting the position of human. The sensor data were collected and preprocessed in MATLAB. The focus of this system is to determine the activity aspect of context awareness, and accelerometer, a sensor device used in measuring proper acceleration.

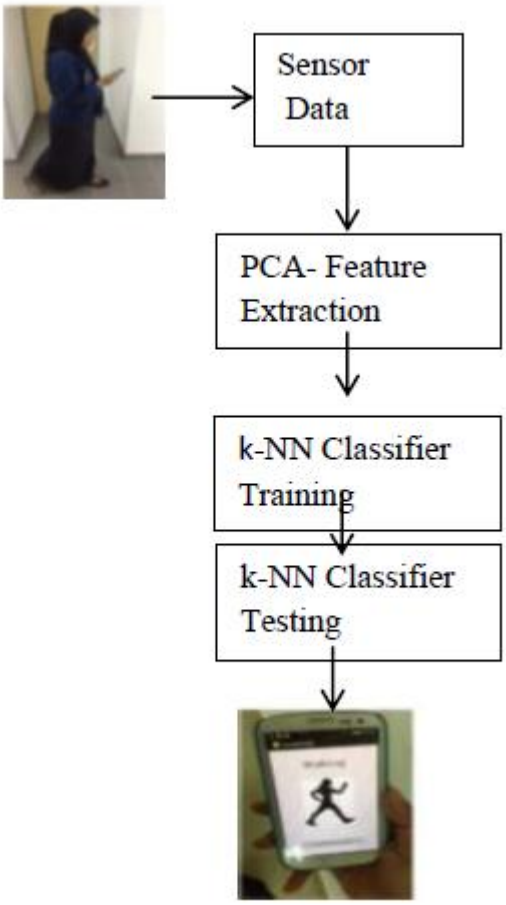


Fig. 1. Activity Recognition

Initially the tri-axial accelerometer sensor data are collected from the mobile phone. Fig .1. shows the architecture of proposed system.The collected raw data are then preprocessed in order to remove noise from those data. The preprocessed data are then classified and stored in ActiWare prototype. Dynamically the sensor data are collected and compared with the data in ActiWare. The activity is then recognized and forwarded as a message.

IV. SYSTEM IMPLEMENTATION

A. Data Collection

Data collection is an important step for the detection of activity. The tri axial sensor data corresponding to the basic activities (sitting, standing, walking, running, walking upstairs, walking downstairs) are collected by the following steps.

STEP 1: Connect MATLAB MOBILE (An Android Application) with MATLAB R2017b through IP address.
STEP 2: Enable the accelerometer sensor in the mobile application.
STEP 3: Collect the data in MATLAB.
STEP 4: Convert the received data into xlsx format and save it.
STEP 5: Open the file and save it as csv (comma separated form) format which can be then used for preprocessing and classification.

B. Preprocessing

Data preprocessing is used in machine learning and data mining to make input data easier to work with. Data preprocessing is preparing the raw data for another processing procedure. It also called as a preliminary data mining practice, which cleans and completes the raw data that makes the process to complete easily and effectively. PCA, a dimension reduction technique is used for feature reduction.

C. Classification

K-nearest neighbor's algorithm (k-NN) method and a Neural Network using GA were proposed for classification. In k-NN, similar characteristic data will be nearer to each other. A new data gets classified depending on the majority vote of its neighbors. In this proposed system k=3 (k is a positive integer), then it enclose only three neighbor data points which is on the plane. If an enclosed three data point belongs to a single class then the new data point also belongs to the same class. Enclosed two data points belongs to one class whereas third data point in another class then the new data point clustered into class with majority vote. In Neural Network, 80% of dataset used for training the system and remaining as test data. k-NN stores trained data and when a new test data given, depends on k nearest data points and majority vote the new data gets labeled.

STEP 1: Preprocessed training data are clustered.
STEP 2: Set k=3.
STEP 3: Use Hamming distance, to calculate the distance of test data with all training data i.e. iterate i=1 to n number of training data.
STEP 4: Sort the distance values in ascending order.
STEP 5: Get top k values.
STEP 6: Check the votes from the closest neighbor and neural network built.
STEP 7: Return the predicted class

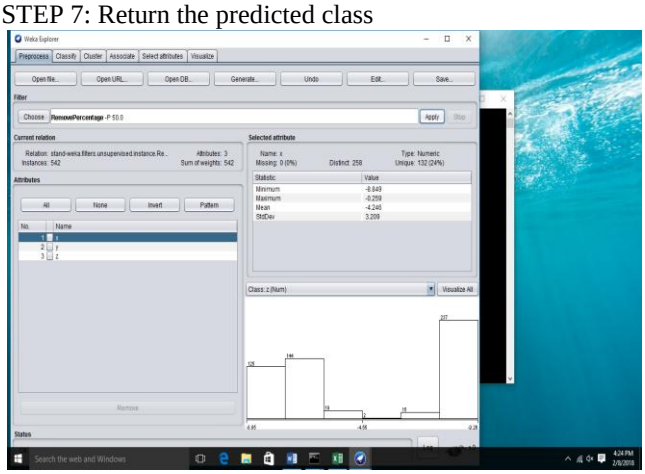


Fig. 2. Preprocessing the data

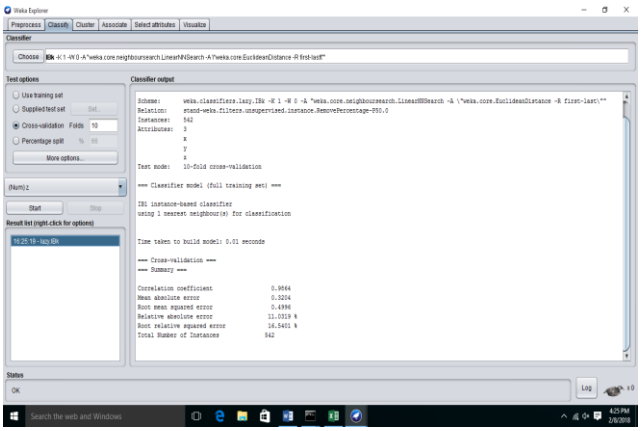
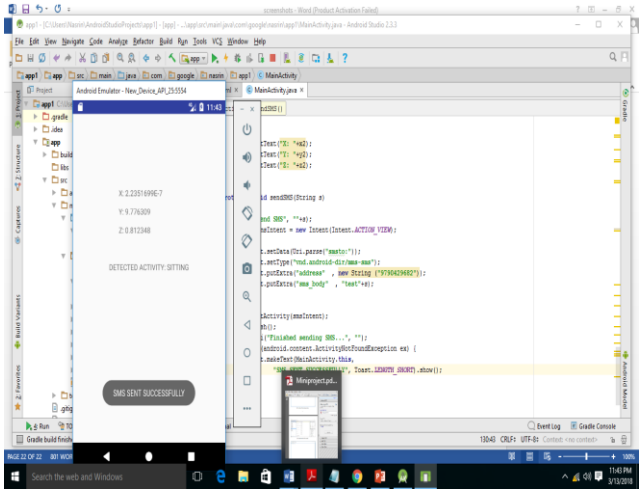


Fig. 3. k-NN Classifier with trained data



Fig, 4. Human Activity Detected for test data

D. Activity Detection

After preprocessing and classification, an Android based application is developed for detecting the current activity depending upon the sensor data. The basic human activities are recognized by following steps.

STEP 1: Start a new project in ANDROID STUDIO.
STEP 2: Design the model application with three text views.
STEP 3: Write the java code to get and display the values of three axis of accelerometer sensor in these text views.
STEP 4: From the classified data set the range of three axes and compare it with the received sensor data for each ten instances.
STEP 5: Activity will be detected based on the comparison made.
STEP 6: Create a new text view in the model application.
STEP 7: Detected activity will be displayed in the new text view.

E. Message Sending

The next step is to send message of the detected activity. In the application already developed which detects the activity, modify the java code by which the detected activity is sent as a message to a particular number. By doing so, the message will be sent as soon as the activity is detected.

V. RESULT AND DISCUSSION

In this paper, HAR is done based on accelerometer sensor. The proposed uses Principal Component Analysis (PCA) for dimension reduction, instance based classifier and an artificial neural network used to predict the human activity. To build the intellectual system, 10 fold cross validation is used. The previous studies use different classifier which reached with limited results. Table I shows the sample of outcomes after applying proposed algorithm. In this paper, best discriminative and a neural network is proposed which results in high accuracy.

TABLE I: Accuracy of k-NN and Neuroevolution

Human activity	Accuracy
Walking	94.51%
Running	83.67%
Jogging	87.73%
Stepping-up	91.29%
Stepping-down	89.24%
Dancing	93.04%
Standing	92.66%

VI. CONCLUSION

Human activity recognition has broad applications in medical research and human survey system. Here we designed a smart phone-based recognition system that recognizes six human activities: walking, sitting, standing, running, going upstairs and going downstairs and sends an instant message about the detected activity. The system collected time series signals using a built-in accelerometer. The activity data were trained and tested using k-nearest neighbor algorithm. Classification performance is robust to the orientation and the position of smartphones. Experiment results demonstrated the effectiveness of active learning in saving labeling labor while achieving comparable performance with passive learning. We achieved maximum above 94.51% accuracy on human activities. Future work may consider more activities and implement a real-time system on smartphone. It is possible to merge activity information with Smartphone connectivity status such as incoming calls/messages, in order to control the Smartphone behavior when some specific activities are occurring like calling to a person who is running or sleeping.

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