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Research Article

Framework for Human Activity Recognition

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Abstract

Human Activity Recognition (HAR) is a critical component in many applications, including health tracking and human survey systems. It is also a hot research subject in health care and smart homes. Also, Smartphones became an integral part in everyone's life. The majority of people use it to search for information, watch movies, play games, and connect with their social networks, but there have been many useful studies on smartphones. Smart phones come with a range of sensors built in, including an accelerometer, gyroscope, GPS, compass sensor, and barometer. Using these sensors, a HAR device can be built to capture the user's condition. We can reliably detect the user's behaviour by implementing machine learning techniques into the system. The proposed work uses the LSTM algorithm to estimate human motion movement using raw sensor readings from mobile sensors in our smartphone as inputs. With minimal training data and usable memory in smart phones, the proposed work recognises the user's behaviour. The user's behaviours, such as walking, running, lying down, sitting, and standing, can all be observed.

Keywords – Human Activity Recognition, LSTM, Accelerometer, Smartphone.

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I. INTRODUCTION

In recent years smartphones became common in everyone's daily activities. The majority of people used it to search for information, watch movies, play games, and connect with their social networks, but there have been many useful studies on smartphones.

HAR is one of the most important technologies behind many mobile applications, including health tracking, fall detection, smart cellular apps, human survey systems, and automated homes, amongst others. Smartphone-based activity recognition systems are a hot topic of research because they could lead to new smartphone models.

The integration of these smart devices into our daily lives is rapidly evolving. Such devices are expected to keep track of our locations, research them, and ultimately assist us in making better decisions about our future behavior.

OBJECTIVE

- Designing a simple and accurate model which distinguishes and track activities like walking, running, moving upstairs , downstairs and basic movements done by person , using data from internal sensors like Accelerometer ,Gyroscope that are present in our android phones.
- The whole work of distinguishing different activities is done by a well trained model.

SCOPE

- The system is limited to study user's behaviours, such as walking, running, lying down, sitting, and standing.
- The system is only developed for android platform only.

II. RELATED WORK

[1] Istvan Pintye, et al. proposed Machine Learning Models in Smart Phone Based Activity. The proposed a application for Human Activity Recognition with the help of sensors present in the smart phone. This proposed system uses sensors such as Accelerometer, Gyroscope which are by default in smart phone. The University of California, Irvine (UCI) data is used for training the machine learning algorithms. They have prepared different models using different methods such as Support Decision Trees, K-Nearest Neighbour(KNN) .The accuracies of the different models prepared were respectively 92%,80%.The highest accuracy was obtained by Multi Layer Perception Classifier with

92.5%. The accuracy of the prediction has improved because they used deep learning algorithms. Advantage is easy device portability without the need for additional fixed equipment. They observed the relation among ordinary lifestyle and sure7 diagnosis. This study can be taken as basis for future research in medical field.

[2] Shikha, et al. proposed Human Activity Recognition the field of computer vision and image processing area. They Implemented this model which involves two major processes that are training and recognition. To proceed with the training process, they had picked a temporal spot in a film to generate training samples using sampling. A sixteen frame film is produced about the selected temporal position. They loop around the video until necessary if the video clip selected is smaller than sixteen frames. Next, they had choosen a spatial position and spatial scale accordingly as per necessary. The samples are also spatially resized to 112 X 112 pixels. While training the model that is Resnet-34 from scratch the learning rate at the beginning was set to 0.1 and later reduced by a factor of 0.1 after the saturation of validation loss. From they had populated the batch of frames from the stream of video and resize them to a width of 400 pixels and maintain the aspect ratios. The explanation here is that they're building a group of various pictures to go through the human activity recognition network, enabling it to exploit spatiotemporal data. Dataset used to train the model is the Kinetics human action video dataset. This dataset has 400 classes of human activities, with 400 and more films for each and every action. Each film lasts around tenth of a second and is extracted from a different YouTube clip. The activities are human centric and cover a wide scope of classes including human-object associations such as riding skateboard, cooking ,smoking ,reading book ,reading newspaper and also human collaborations like hand shaking, hugging etc.

[3] Vu Ngoc Thanh Sang, et al. Real Time Human Activity Recognition Using Smart Phones. In this they designed a mobile architecture for HAR based on inertial accelerometer. When the user performs any of his daily wase exercises, the smartphone gathers the sensory data sequence, extricates the high-proficiency features from the original information. Then the system extract the user's physical activity data through the sensors which are in built in smart phones. The extracted data is preprocessed by normalization and segmentation techniques to get valuable vectors. In addition, a real-time human activity recognition ,classification method based on a convolutional neural network (CNN) is proposed, which uses a CNN for local feature extraction. Some of the models they have are MLP

,SVM,LSTM etc. on the datasets. They explored how to train deep learning algorithms and demonstrated how the proposed system has marginal advantages over other systems that used two large known datasets: UCI and Pamap2.

[4] Itishree Mandal, et al. proposed a different models for Real Time Human Activity Recognition Using Smart Phones. The proposed framework uses the acceleration detecting information from built-in accelerometer regularly instrumented n cell phones such as cell phones or electronic watches. In this paper the activity recognition technique involves four processes: data processing, segmentation, feature extraction, and classification. Especially, the different arrangement of features derived from acceleration sensors that has information invariant to device rotations. There are two different approaches for activity recognition, they are computer vision based and sensors based. The real-time activity recognition system functions in four stages: Signal processing is defined as sensing data is filtered for eliminating the noise or resampling the lost information. Segmentation is characterized as a sliding window/frame is employed to segment the signal into frames. Feature extraction is defined as extracting different features from every frame to make a feature vector. Classification is defined as the system uses the features extracted from before stage as input for classification algorithms. It is seen that sensor information from the telephones is frequently unstructured and significantly noise.

[5], Amari Vaughn, et al. proposed Activity Detection and Analysis Using Smart Phones Sensors. In this paper Human Activity Recognition system they used naive Bayes algorithm to train the data collected by sensors which are in-built in the phone(accelerometer, gyroscope). Human activity detection is used as indicator for recognizing at least one human exercises utilizing data from sensor information. When considering motion catch, the essential sensors we have used are accelerometer and the gyro meter. Normally, the accelerometer and gyro meter help in finding the cell phone’s direction, permitting the devices UI to change properly. The accelerometer estimates the power of speed increase towards a path. The sensor gives a three-dimensional vector to the speed increase in m/s2 in every axis of the device. Frequently it is utilized for deciding the phone direction, but can also be used to show huge physical movements of the user. The machine learning algorithm naive Bayes classifier is used for training the model. In this they utilized sensor information to make ML models to recognize human movements like walking, running, and sitting.

[6] Ehran, et al. proposed Human Activity Recognition Based on Accelerometer Data. In this paper they discovered a algorithm for monitoring human activities .They have done this using a mobile platform that depends on movement sequences. They picked Android based mobile phone containing triaxial accelerometer to record crude acceleration information. It is a epic system for detecting

human fall, walk, run, climbing steps and plunging steps. They utilized both threshold method and SVM procedure to have enhanced recognition accuracy. They have used sliding window framework for feature extraction. A window size having data of five seconds is used with an overlapping of 50%.In this project they have used 60% of data for training and 40% of data for testing. Features were extracted from information of every activity by this window and feeded into SVM training procedure. They have used binned distribution feature of accelerometer information for classification.

[7] Yangda Zhu, et al. proposed Human Activity Recognition Based on Similarity. In this paper, Dataset containing signals from a cellphone carried by nine individuals doing six unique exercises. Information is stored with a sampling pace of 50Hz and put away as timeseries for each measurement so six unique time stamps are acquired (three from accelerometer and other three from gyroscope). Supervised machine learning is utilized to acknowledge action from dataset records. Planned models are trained using training data that has complete dataset .And then they are tested using the remaining data. Classification precision of models are tested and noticed utilizing 5-fold cross validation. Techniques used for classification are as like: Decision Trees, Support Vector Machines etc,.

III. PROPOSED SYSTEM

The proposed system takes accelerometer data as input and detects the activity being performed by the user. First it collects the data and then it performs preprocessing to remove missing values. Then a machine learning model using LSTM [8] is developed .The model has two LSTM layers. The data collected is split into train and test. The model is trained using train data and then test data is given to the developed model to detect the activity of user.

There are 5 steps to perform Human activity recognition on a given set of data.

1) Data Collection

Data is collected from an online website of University of California Irvine. The dataset is called WISDM(Wireless Sensor Data Mining) dataset.

2) Importing packages

The second step is to import the package numpy , matlplotlib.pyplot and seaborn. The class sklearn.model_selection.train_test_split is used to divide data into train and test randomly. The pandas package contains all the resources required to create and manipulate data. The data given in any format i.e. in .xlsx, .csv is difficult to perform operations directly in python, so pandas converts it into a structure called data frames. Data frames are easy to manipulate and simple in accessing.

3) Data Pre-processing

Before providing the data to the model for prediction,it needs to be in right format. Most of the times the data contains some missing values. These values are removed and replaced with appropriate values.The dataset contains accelerometer and gyroscope data at particular time.

4) Dataset Splitting

Once the information is grouped into attributes and labels, the final step is to divide information into training and test sets. The train_test_split method is used to divide data into training and test sets. The reviews dataset is split into train dataset and test dataset in the ratio of 80:20.

5) Model Fitting

All supervised estimators in scikit-learn implement a fit(x,y) method to fit the model and predict(x) method to the given unlabeled observations x, returns predicted labels y.

history = model.fit(X_train, y_train, epochs=12, batch_size=32, validation_split=0.2)

Epoch: An epoch is a term used in machine learning that shows the quantity of passes of the whole training dataset the machine learning algorithm has finished. Datasets are generally grouped into bunches (particularly when the measure of information is very huge).

Validation_split: Its value is 0.2 means that 80% of the data is used to train the model and the rest 20% will be used to test the model. So the loss and accuracy is calculated using 20% of the dataset.

6) Predictions

Once the model is trained it can be used to forecast or predict the outcome in the future, the graph showing the prediction vs actual and future predictions is obtained. The output of the model is the confusion matrix that tells the information about the actual activity and predicted activity of the user.

7) Android Application

Finally the finished model is integrated with an android application which is used to predict the activity while we are using that application.The android application is designed in such a way that there are two buttons start recording and stop recording which are used for their respective purposes as mentioned.The interface of the application is shown below Fig 1.

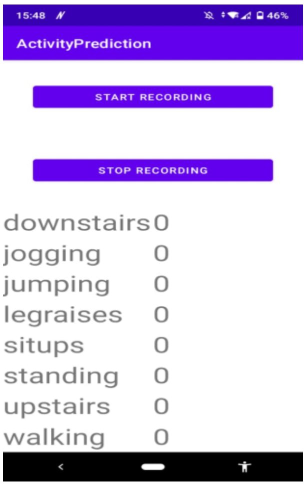

Fig 1. Android Application

8) Sequential Diagram

The Sequential diagram represents the pictorial operation of our model which is shown below in Fig 2. This can be the approach we tend to thought to be enforced through our model.

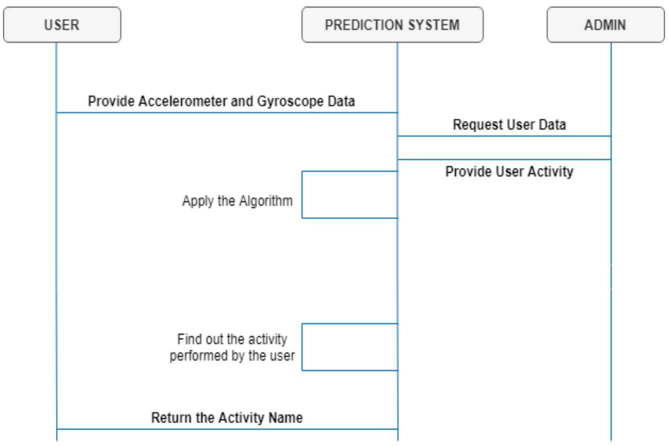

Fig 2. Sequential Diagram

IV. METHODOLOGY

1) Load accelerometer data from WISDM data set.

2) Visualize the accelerometer data.

3) Reshape the multi-dimensional tabular data so that it is accepted by ML model.

- Here we are splitting our data into small chunks whose size is 200.
- Performing One Hot Encoding of labels

4) Split up the data set into training and test set

5) Define a neural network model using LSTM.

- Here we are having 2 fully connected LSTM layers.
- Each layer is having 64 units each.
- The activation function used for LSTM layers is rectified linear activation function or ReLU [9] and activation function used for output layer is softmax [10] also known as softargmax.

6) Train the deep neural network for human activity recognition data.

7) Validate the performance of the trained RNN against the test data using confusion matrix.

5. RESULTS AND ANALYSIS

The Following figure Fig 3 shows output screenshot of the model that shows the activity performed by the user as a Confusion Matrix.

The obtained confusion matrix shows the predicted activity of the user that is being performed.

In the Confusion Matrix, we can see how the model has performed for various activities such as Downstairs, Jumping, situps etc., It shows all the activities accurately except for the standing activity. Some of the standing samples data is predicted as sit up activity.

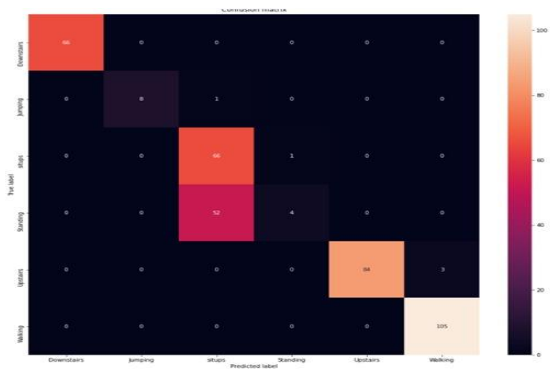

Fig 3. Confusion Matrix

After integrating the model with the android application we get the following data as output after performing some activity shown in Fig 4.

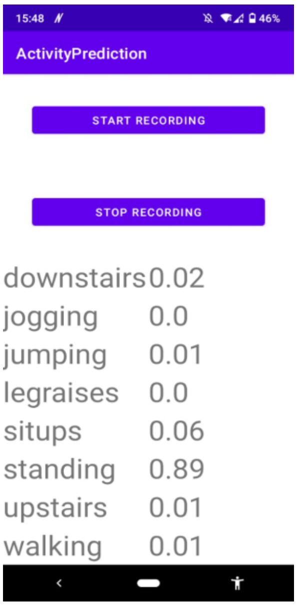

Fig 4. Predicted values of activity

6. CONCLUSION AND FUTURE WORK

The model has focused on the activity recognition by analyzing the information of accelerometer and gyroscope sensors of a mobile phone. The outcomes showed that by using only a smartphone, we could recognize different basic exercises like driving motorbike, going stairs, sitting with a smartphone in pocket and putting the smartphone on a table. The developed model can be integrated with android application so that it gives a audio output that tells the activity performed by the user at the moment.

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