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# Hand written Digit Recognition by Gesture Recognition and Speech Generation using Android Phone

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**Abstract -** *Hand gesture recognition system received great attention in the recent few years because of its various applications and the ability to interact with machine efficiently through human computer interaction. Also Hand gesture is one of the typical methods used in sign language for non-verbal communication. Sign gestures are a non-verbal visual language, different from the spoken language, but serving the same function. It is often very difficult for the hearing impaired community to communicate their ideas and creativity to the normal humans. The evolution of hand gesture technology from android based sensing to most recent model based sensing is explained in accordance with their advantages and limitations. Android mobile based sensing has an advantage that there is no hardware component required and it also gives a benefit of directly using natural motion of hand. In this project we describe the uses of android mobile accelerometers and computer for gestures recognition for hand written digit by human. Using Android mobile phones for human activity recognition has a wide range of applications including healthcare and anomalous situations alerting.*

***Key Words***: N**on-verbal communication, MATLAB**

## INTRODUCTION

Day by day Percentage of disabled persons in India is increasing both in rural and urban areas during the last decade. "CENSUS OF INDIA 2011 DATA ON DISABILITY" report says near about 20 million peoples are disable due to various disability. It's now one of the biggest challenges faced today is providing separate and equally non complex services to the differently disabled and handicapped peoples. As writing is a challenging task for physically disable people, old age people and paralyzed patient also communication problem in mute people, so our project works as an device which is use to recognized gesture recognition of hand written digit so that disable, old age, paralyzed people can write by only doing some gesture. Also in this project gesture is converted in to speech so mute people can communicate with normal people.

Android smart phone based gesture recognition systems can tell us different kinds of human activities in real time using machine learning techniques. In addition, using smart phones for human activity recognition has a wide range of applications including anomalous situation alerting, personal biometric signature identification, the interaction between computer and human being is easy with the help of smart phones devices. Smart phones in the market have embedded sensors, and the advanced MEMS (micro-electromechanical systems) design has enabled low-power and high-quality sensors for mobile sensing. The best-known MEMS sensors in smart phones are accelerometer and gyroscope, but there are a lot more MEMS sensors in today's mobile device like electronic compass, GPS sensors, audio sensors, image sensors, light sensors, temperature sensors, direction sensors and acceleration sensors. As the system uses the low cost and easily available sensors based smart phone the system is very much cost effective. This electronic device can translate sign language into speech and bridges the communication gap between the mute communities and the general public.

## LITERATURE REVIEW

The field of gesture recognition has been extensively studied in the past. Recently, some studies have focused on the development of accelerometer based digital pens for gesture recognition of hand written digit.

Jeen-Shing Wang Yu-Liang Hsu Cheng-Ling Chu [1] presented an accelerometer-based pen device for online handwriting recognition applications. The accelerometer-based pen device consists of a tri-axial accelerometer, a microcontroller, and an RF wireless transmission module. Users can hold the pen device to write numerals in air without space limitations. The accelerations generated by hand motions are generated by the accelerometer embedded in the pen device, and are transmitted to a personal computer for further signal preprocess via the wireless module. The accelerometer is used to detect accelerations of hand motions. The microcontroller collects the digital signals generated from the accelerometer and wirelessly transmit the data to a PC main processor for further signal processing and recognition via the RF wireless transceiver.

Jennifer R. Kwapisz, Gary M. Weiss, Samuel A. Moore [2] presented a system that uses phone-based accelerometers to perform activity recognition, a task which involves identifying the physical activity a user is performing. To implement our system we collected labeled accelerometer data from twenty-nine users as they performed daily

activities such as walking, jogging, climbing stairs, sitting, and standing, and then aggregated this time series data into examples that summarize the user activity over 10- second intervals. We then used the resulting training data to induce a predictive model for activity recognition. Standard classification algorithms cannot be directly applied to raw time-series accelerometer data. Instead, we first must transform the raw time series data into examples. To accomplish this we divided the data into 10-second segments and then generated features that were based on the 200 readings contained within each 10-second segment. Where each reading contained an x, y, and z value corresponding to the three axes/dimensions In this paper we described how a smart phone can be used to perform activity recognition, simply by keeping it in ones pocket. We further showed that activity recognition can be highly accurate, with most activities being recognized correctly over 90% of the time.

Usharani J, Dr. Usha Sakthivel [3] presented a technique in which Activity recognition system takes the raw sensor reading from mobile sensors as inputs and estimates a human motion activity using data mining and machine learning techniques. In this paper, we analyze the performance of two classification algorithms i.e. KNN and Clustered KNN in an online activity recognition system working on Android platforms and this system will supports on-line training and classification using the accelerometer data only. Usually first we use the KNN classification algorithm and next we utilize an improvement of Minimum Distance and K-Nearest Neighbor classification algorithms, i.e. Clustered KNN . For the purpose of activity recognition, clustered KNN will eliminate the computational complexities of KNN by creating clusters (creating smaller training sets for each actions and classification will be performed based on these reduced training sets). We can predict the performance of these classifiers from a series of observations on human activities like walking, running, lying down, sitting and standing in an online activity recognition system. In this paper, we are intended to analyze the performance of classifiers with limited training data and limited accessible memory on the phones compared to off-line.

Xian Wang, Paula Tarrío, Ana M. Bernardos, Eduardo Metola, José R.Casar [4] presented a technique *an* accelerometer-based gesture recognition system for mobile devices which is able to recognize a collection of 10 different hand gestures. The system was conceived to be light and to operate in a user-independent manner in real time. The recognition system was implemented in a smart phone and evaluated through a collection of user tests, which showed recognition accuracy similar to other state-of-the art techniques and a lower computational complexity. The system was also used to build a human-robot interface that enables controlling a wheeled robot with the gestures made with the mobile phone.

Ravindra J. Mandale, Sagar Pawar Vikram Chavan [5] Motion Gesture based mobile (GESMO) app in Android which allows user to draw gestures in the air resulting opening of a desired app assigned to corresponding gesture. In order to start the motion, user must press and hold any point on the screen until the motion is completed. Once motion completes, it is released. For sensing the motion, we used two built-in sensors from mobile devices: accelerometer and gyroscope. The paper proposes a two-stage approach for spotting and recognition of generated stroke gesture. The spotting stage uses a Support Vector Machine (SVM) to identify data fragments containing one stroke gesture. The recognition stage uses Hidden Markov Models (HMM) to generate the text representation from the motion sensor data. With this technique, you can successfully receive 70-80% accuracy in detecting an air gesture for mobile devices.

**PROPOSED WORK**

Most smart phones are embedded with tri-axial accelerometers and gyroscopes as well as other motion and environment sensors. Using smart phones for human activity recognition has more flexibility than wearable devices, along with a wider range of applications including healthcare, daily fitness recording, and anomalous situations alerting. In this paper, a smart phone based human activity recognition system is proposed to detect human activities. Figure 1 shows a basic process of smart phone based human activity recognition system based on supervised learning. The data collection and feature extraction are performed using a smart phone while the model generation is performed in a computer. It consists of an accelerometer based android mobile phone. The accelerometer measures the acceleration signals generated by a user's hand motions. The acceleration signals are transmitted wirelessly to a personal computer (PC).

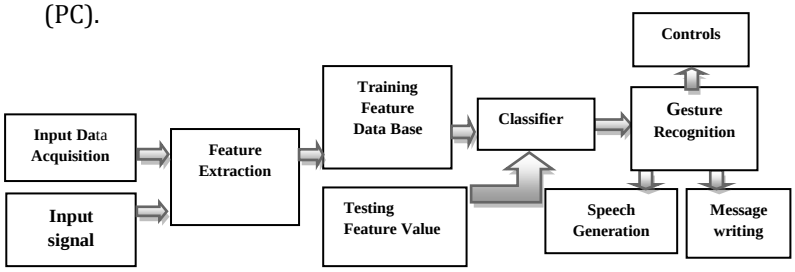


Figure 1: Block diagram of proposed system

Our technology enables devices to interpret human gestures using smart phone sensors, whose data is then processed using algorithms. The system is built to identify specific human gestures, and then use them to convey information by converting in to voice signal. The gestures used have to be intuitive, simple and universally acceptable to ensure they are easily adopted by users. Gesture recognition makes computers more accessible for the physically-challenged and also makes interaction more natural in the 3D virtual world or in gaming. In today's world, gesture recognition is an evolving technology that can

be seen all around us. The proposed system as shown in figure consists of android mobile and PC section where the smart phone device consists of different sensors like tri-axial accelerometer, gyroscope, GPS, etc. The acceleration signals measured from the tri-axial accelerometer are transmitted to a computer via the wireless module. Users can utilize this smart phone to write digits and numbers with make hand gestures at normal speed in air. The measured acceleration signals of these motions can be recognized by the trajectory recognition algorithm. In this task, we can recognize alphanumeric word. Acceleration signals are transmitted to personal computer where trajectory reorganization algorithm is used for gesture recognition in which the features are extracted from the accelerometer data to represent the characteristics of different motion signals, and make data base according gesture. According to training and testing data set a KNN classifier is used to recognize the gesture to which the feature vector belongs.

The block diagram of the proposed trajectory recognition algorithm consisting of acceleration acquisition, feature extraction, classification, speech signal generation and message generation according to gestures.

**Data Collection:**

In our data collection, a user chooses what kind of activities he/she is performing, which means each data point was labeled with the corresponding activity. The accelerometer data of a smart phone according to different gestures performed by the subject is acquired by the personal computer. Acquire data from built-in sensors on your device, and send this data to a MATLAB session running on your computer for further analysis and visualization. This action starts the transmitting of data from all selected sensors. For data collection accelerometer of different gesture subject puts a smart phone in his/her hand with a fixed position and performs gestures according to alphanumeric in air.

We get the accelerometer signal graph of gesture for each handwritten digit. Following are sensors registration data figures.

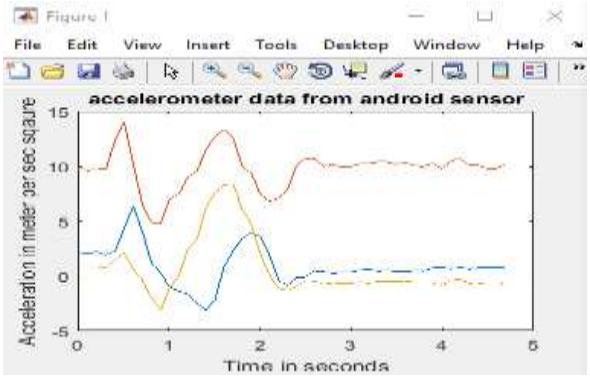


Figure 2: Accelerations signals for digit 0

**Feature Extraction**

Feature Extraction was the process used to extract the key elements from a processed signal which made the signal distinct. The characteristics of different hand movement signals can be obtained by extracting features from the preprocessed *x*-, *y*-, and *z*-axis signals, and we extract features from the tri-axial acceleration signals. For activity recognition, we can extract features in both time and frequency domains.

**Time-domain features:**

1. Mean:

The mean value of each segment in each dimension.

2. Max, Min:

The maximum and minimum values of each segment in each dimension.

3. Variance /(STD) Standard deviation:

It measures how far a data set is spread out.

4. Correlation:

Correlation is calculated between each pair of axes of the acceleration data.

5. Relative power:

**Frequency-domain features:**

Frequency-domain features describe the periodicity of the signal, which are typically calculated based on the FFT.

1. Entropy:
   The entropy feature is calculated as the normalized information entropy of the discrete FFT components, and it helps in discriminating the activities with the similar energy features.

**CLASSIFICATION**

In classification phase mean, minimum, maximum, entropy, variance cross correlation, power spectral density values of the data of gesture is calculated and these values are compared one by one with the values in the training sets which were created during the pre-processing step. *K* nearest sample to test data is selected from training sets and voting is done by looking at the final list of activities. We use KNN Classifier. KNN is an instance-based classifier based on the majority voting of its neighbors. In general, KNN is one of the most popular algorithms for pattern recognition and is par with Decision Tree in terms of performance and the computational complexity. According to their test, KNN is identified as the classifier classifies the testing signals feature values and feature data base values and give the output.

## RESULT

### Algorithm for recognition

The acceleration data corresponding to the different gestures is collected using an Android phone, which has a built-in 3-axis accelerometer. A dictionary of 62 gestures is created .The defined gestures are not limited to one plane only as is the case in other studies, but span the X Y Z planes. The dictionary contains a variety of gestures ranging from the A-Z, a-z, letters gestures and 0-9 numbers. This definition of gestures is to increase the robustness of the gesture recognition system. The database consists of 310 traces. For system evaluation, the database is split into two datasets: a training set and a testing set. The training dataset is generated by choosing traces from three gesture samples out of the five gestures of each numbers and digits. First 3 traces are chosen from each of the digits and numbers gesture trace resulting in a total of 186 gestures are for training and last 2 trace are chosen from total gestures i.e. 124 gesture for testing. Feature vector length of single axis is 8 so as the total feature vector length for three axes is 24.Training data base vector (186×24) and class label vector (186×1).

In a system consists of 62 hand gestures and for each gesture 3 traces are stored in a database. The gesture database is produced in an off-line procedure and stored for later use, which constitutes the training stage. In a test stage, a user moves his/her accelerometer equipped device, such as a smart phone, to signal a particular gesture from the above database. The objective of a gesture recognition system is to find out which gesture is intended by the user.

### Experimental results

The effectiveness of this project and its associated trajectory reconstruction algorithm is validated by the following experiments: 1) handwritten digit recognition 2) speech generation according to gesture. In the handwritten digit recognition, two experiments were designed to demonstrate the effectiveness of this project and its associated trajectory reconstruction algorithm. Experiment allowed users to write digits for particular duration. The acceleration and angular velocity data utilized in our experiments were collected using the tri-axial accelerometer sensor based smart phone. The output signals of the accelerometer are sending to personal computer where on a PC running with an MATLAB. The handwriting recognizer of the PC was employed as the recognizer for the handwriting trajectories. An online GUI written in MATLAB was developed to perform the following tasks: 1) signal collection, 2) trajectory reconstruction, 3) transformation of trajectories into images, and 4) gesture recognition 5) speech generation Fig. (3) Shows the GUI and the experimental setups for the handwritten digit recognition experiments.

### Recognized Gesture:

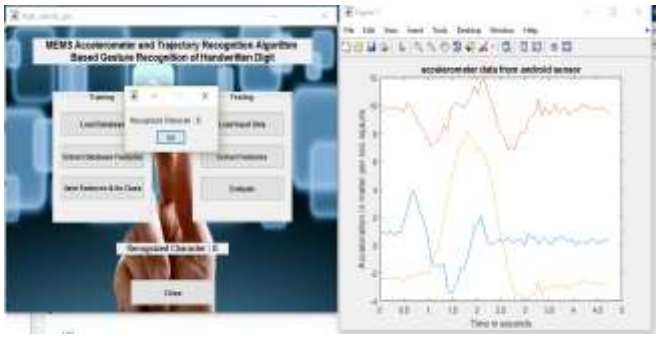


Figure 3: Gesture recognition of digit 'D'

### Speech signal Generation

The Receiver section consists of PC with MATLAB where Text to Speech converter is used for speech signal generation for different digits and numbers with specific message for different digits like medicine for digit "M", lunch for "L", water for "W" Once the sensor data is matched with the database then the speech of text will be played out through the speaker. Each hand gesture represents a message and taken in a way such that user can modify it as per their requirement.

## CONCLUSION

In this paper, we proposed an activity recognition system working on Android platforms by developing an application that supports on-line training and classification while using only the accelerometer data for classification. Also this system prototype was designed to automatically recognize sign language to help normal people to communicate more effectively with speech impaired people. This system recognizes the hand signs using sensor based smart phone and these recognized hand gestures are converted into speech so that normal people can easily understand. The project aims to lower the communication gap between normal world and the mute community.

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**BIOGRAPHIES**

**Dr.D.T.Ingole** had completed engineering graduation B.E. in electrical engineering from the Govt. College of Engineering, Karad, India, in 1983; M.E.in Electrical Power System from the Govt. College of Engineering, Amravati, India and Ph.D. degrees in electronics engineering from the Visvesvaraya National Institute of Technology (VNIT), Nagpur, India..

In 1986, he joined the Department of Electronics & Telecomm Engineering, Prof Ram Meghe Institute of Technology & Research, Badnera, Amravati, as a Lecturer, and subsequently became a Professor. He was the Principal of the same institute from 2012-2014. His current research interests include biomedical signal processing, image processing, electrical machine and drives. D.T.Ingole is a Fellow of the Institution of Engineers (India); Fellow of the Institution of Electronics and Telecommunication Engineers (IETE), member of IEEE, life member of The *Biomedical Engineering Society* of India (BMESI). He is a Life Member of the Indian Society for Technical Education (ISTE).

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