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# Machine Learning Technique For Women Safety Using Activity And Fear Detection Methods

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## Abstract

*The world is becoming unsafe for women in all aspects. The crimes against women are increasing at a higher rate. This paper proposes a quick responding mechanism that helps women during trouble with the use of a mobile phone . Accelerometers embedded in the mobile phone allow the assessment of physical activity for long periods of time. The features of the signal are selected based on the time and frequency domain. Then, Principal Component Analysis (PCA) is used to reduce the dimensionality of the features and extract the most significant ones that can classify human activities. Acquisition of data is then followed by activity recognition which is a process of employing a specialized machine learning algorithm - MLP NN. The audio input from the mobile phone splits into frames and find out the feature -pitch. KNN algorithm is used for recognizing the emotion. The combination of detected activity and recognized emotion determines whether she is in trouble or not. An alert message/notification is sent to designated individual along with her location using GPS.*

*Keywords: Women safety, Machine Learning, activity detection, emotion detection, MLP NN, KNN, GPS, GSM*

## Introduction

Women all over the world are facing much unethical physical harassment. It happens on streets, public transport, parks, in and around schools, workplaces, in public sanitation facilities, water and food distribution sites, or in their own neighborhoods. A report compiled by the World Health Organization in 2013 stated that 35 percent of women around the world have been victims of sexual violence. In India, every day more than 30 women were murdered and many are suffering austere mental and physical trauma. The National Crime Records Bureau of India reported that crimes against women have recorded a whopping 83% increase from 2007 to 2016. With the number of criminal acts towards women increasing at such an appalling rate, it is evident that a method is required from the technical community to ameliorate the situation.

There are variety of applications for women protection when they are in dangerous situation. The existing application has the disadvantages like manual pressing of button to trigger alarm, complex design, multiple hardware devices or it cannot be carries easily. So the aim of this project is to develope a real time mobile application that automatically detect whether a women is in danger or not from the activity and emotion and send an alert message to her guardian along with location. As we move forward into the digital age, One of the modern innovations we've seen is the creation of Machine Learning. ML has the power to solve very complex problems and comes with the ability to enable decision making. The capabilities of Machine Learning for Women's safety all around the world can be of ultimate success and importance. Here we are looking some of such Machine Learning techniques to develop a women safety application.

For activity detection it uses machine learning classifier tool, namely MLP NN. This machine learning tool is chosen as they have been proven to give better results compared to other classifiers for frequency and time domain features[1]. To select fear, emotion classification based on machine learning methods is used to extract fear from other emotions. Pitch based feature has a relatively great discrimination power between emotion states. Compared to other classifiers KNN shows best accuracy for emotion recognition[2].

In today's world, people using smart phones have increased rapidly and hence, a smart phone can be used efficiently for personal security or various other protection purposes. This application was developed for Android

devices and is planned to be extended to other platforms in the future.

This work concentrate on detection of both activity and fear. The accelerometer embedded in the mobile phone returns the value of displacement of a body along its X axis, Y axis and Z axis, that allow the assessment of physical activity for long periods of time. The features of the signal are selected based on the time and frequency domain. Then, Principal Component Analysis (PCA) is used to reduce the dimensionality of the features and extract the most significant ones that can classify human activities. The extracted features are subjected to the machine learning algorithm -MLPNN to classify the activities - Struggling or Normal. The audio input from the mobile phone splits into frames and extract pitch based features. Then the emotion is classified using KNN algorithm. The combination of detected activity and recognized emotion determines whether she is in trouble or not. If she is in trouble, an alert message is send to designated individual/ police along with her location using GPS.

The paper is organized as follows: Section 2 explains the related work on women safety applications. Section 3 discusses the methods and architecture of the proposed system. Section 4 explains the result we obtained and some screen shots. Section 5 summarize the conclusion and future work.

## 2. Related work

Women security is a topic well discussed in the current scenario. Keeping the same in mind many developers have come up with innovative applications. Each application has its own merits and demerits. The existing systems available and surveyed can be categorized as a) Systems designed as a mobile app for the android mobile b) Systems designed as a device with the help of microcontroller and c) An advanced artificial intelligence security systems.

George et al [3] proposed a women safety system based on face recognition. This system can be turned on by a woman in case she even thinks she would be in trouble. The system mainly consists of two cameras and a processor. Mainly three expressions are used in this system which includes smile, fear and anger. The expression recognition is done using correlation with an already created database The drawback in the face recognition is that the message can be sent wrongly even though we are not in trouble. Sohini R et al [4] makes use of internet of things (IOT) and ML to ensure human safety. They designed a human safety band consisting of five sensors such as breath rate sensor, heart rate sensor, glucometer, sweat sensor, and optical blood flow sensor. Move free app is responsible for taking suitable action depending upon the readings of the sensors which are being compared to the previously stored values in order to see if the new readings have crossed a certain threshold or if they are normal. However, it is mentioned that the wearable sensor band has not yet been developed as the prototype for real time monitoring health data for women.

Ravi Sekhar[5et al proposed an android app which was mainly developed for women safety that provides instant location to the registered contacts by pressing a single power button in the phone. A single click on this app identifies the location of place through GPS and sends a message comprising this location URL to the registered contacts and also call on the first registered contact to help the one in dangerous situations. Chand et al. [6] developed a simple women's safety application namely WoSApp, which allows the victim to inform the local police station by either pressing the panic button or by shaking the phone 40 times consecutively in 8 seconds.

Paradkar et al [7] proposed a new model for the women security in public places. The major disadvantage of the proposed model is cost and implementing all the ideas into one system will cut down the pocket and increase the size of the system which makes it as non-portable device. AnandJatti et al [8] developed a wearable device for the safety and protection of women and girls. The objective of this study is to analyze the physiological signals with body position. Body temperature and galvanic skin resistance are the parameters used for analyzing the physiological signals. The machine learning algorithms used make the device intelligent.

Monisha et al [9] proposed a safety device and application called FEMME using ARM controller. The application is activated by pressing the volume key and the power button together. It is linked with smart phone and it provides 2 buttons, one being the emergency button and the other to activate hidden camera detection. If the emergency button is clicked once, the GPS location is tracked and is sent to preset contacts once in every 2 minutes with updated location. If it is clicked twice, audio recorder is activated and is sent to preset contacts with an emergency help

message. If it is pressed for long (Long Press) it automatically calls the preset contact. Pallavi et al [10] proposed a system that consists of a wearable safety device which operates automatically when the pulse rate increases. The security for the women is provided by the continuous monitoring of the pulse rate. The pulse rate are detected by using pulse sensors. When the detected pulse rate increases more than that of the normal pulse rate, it automatically gets connected to the mobile app provided. In the mobile app, the emergency contact to be contacted are already saved. A message is also sent to the emergency contact provided along with the user's location. This message is also forwarded to police station/helpline number.

## 3. Methodology

In today's fast moving world, Women Security is an issue of growing concern. We have read about many unfortunate incidents happening with women and the rate is increasing. Safety of women matters a lot whether at home, outside the home or working place. We are trying to contribute little efforts towards women which will ensure the safety and respect for women. When a woman or girl is in danger situation, her sound has variations because of fear and she might be in struggling position. We propose a real time mobile application that automatically detect the danger situation and send an alert message to the guardian.

### A. System architecture

Fig 1 shows the architecture of the proposed system.

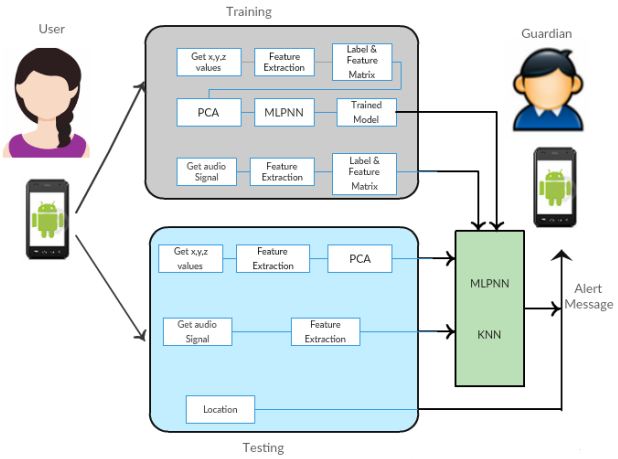


Fig 1: Proposed system architecture

The main modules are:

i. Data Acquisition Module
ii. Feature Selection Module
iii. Classification Module
iv. Alert Module

### i. Data Acquisition

In order to collect data, this system used a triaxial accelerometer in the Android phone to measure acceleration for the activity detection. Data from this accelerometer includes the acceleration along the x-axis, y-axis and z-axis. These axes capture the horizontal/sideway movement of the user (x-axis), upward/downward movement (y-axis), and forward/backward movement (z-axis). Fig 2 and fig 3 shows the raw signal of two activities: Normal and Struggling, which have been captured by accelerometer sensor. Then, the segmentation technique is used to divide sensor signals to small time window segments so that the feature can be easily extracted in each segment. In this work, a sliding window with 50% overlap is chosen as the method of segmentation. The microphone inside the mobile phone continuously collect the audio data. These audio input data is then segmented into frames.

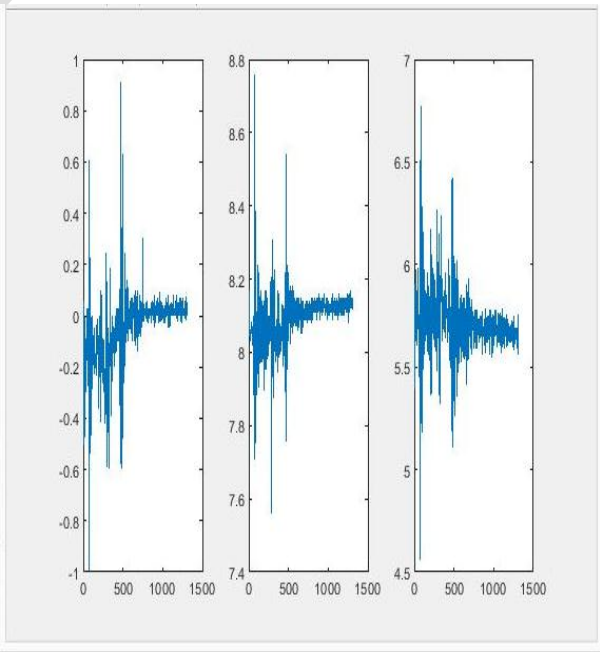

Fig 2: Raw data captured by accelerometer (normal activity-walking)

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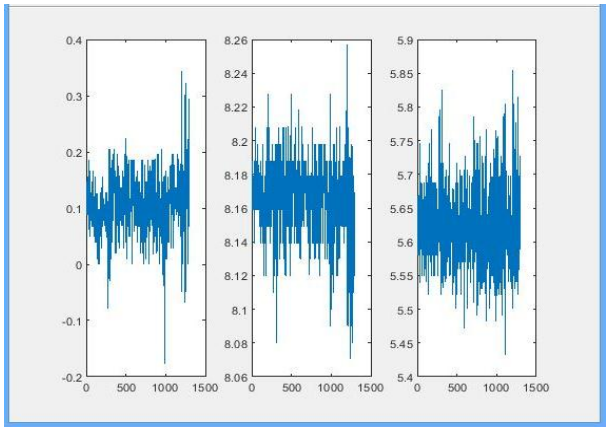

Fig 3: Raw data captured by accelerometer (struggling activity-running)

## ii. Feature Extraction

Extraction of features is a very important part in analyzing and finding relations between different things. All classification systems employ the extraction of a set of features from the input signal. Each of these features represents an element of the feature vector in the feature space. The dimension of the feature space is equal to the number of extracted features. These features are given to a classifier that employs certain rules to assign a class to the incoming vector. Time-domain and frequency-domain features are widely used for feature calculation.

For the accelerometer data, the features in time domain include min, max, mean average, standard deviation, Signal Magnitude Area (SMA) and Signal Vector Magnitude (SVM). SMA is calculated using (1), where $x_u$, $y_u$ and $z_u$ are referred as the signals from the sample of the tri-axial accelerometer. Meanwhile, SVM is calculated using (2), where $x_i$ is the $i^{th}$ sample of x-axis, $y_i$ is the $i^{th}$ sample of y-axis and $z_i$ is the $i^{th}$ sample of z-axis accelerometer signals. Additionally, tilt angle is calculated using (3). The frequency-domain features include power spectral density (PSD), signal entropy and spectral energy.

$$SMA = \frac{1}{i}(\sum_{u=1}^{i}|x_u| + \sum_{u=1}^{i}|y_u| + \sum_{u=1}^{i}|z_u| \quad (1)$$

$$SVM = \sqrt{x_i^2 + y_i^2 + z_i^2} \quad (2)$$

$$TA = \arcsin\left(\frac{y_i}{\sqrt{x_i^2+y_i^2+z_i^2}}\right) \quad (3)$$

For the audio data, the feature in frequency domain include pitch based feature- mean. Time domain feature-maximum amplitude is also taken as a feature. The amplitude and frequencies are important parameters of the sound. The features are calculated frame by frame. Pitch is the mean of the all frequencies of each frame.

Finally, PCA is applied. It is the dimensionality reduction process to transform original features in high dimensional data in to a meaningful representation data in the form of reduced dimensionality. This process facilitates classification process and visualization of high-dimensional data. PCA is considered as one of the popular approaches that can reduce the dimensionality of data by converting original features into new mutually uncorrelated features. The new features are called as principal components.

## iii. Classification

Classification is the process of predicting the class of given data points. Classes are sometimes called as targets/ labels or categories. This work makes use of machine learning techniques for classification. Classification belongs to the category of supervised learning where the targets also provided with the input data. There is a lot of classification algorithms available now but it is not possible to conclude which one is superior to other. It depends on the application and nature of available data set. It is observed that MLP-NN gives the best results compared to other classifiers for activity detection[1]. K-nearest neighbors algorithm gives highest accuracy for the fear recognition[2].

### a. Multi Layer Perceptron Neural Network

MLP-NN is a class of Artificial neural network. It is a supervised learning technique.MLP train on a set of input-output pairs and learn to model the correlation between those inputs and outputs. Training involves adjusting the parameters of the model in order to minimize error. An MLP consists at least 3 layers: Input Layer -Generates the input for the network, Hidden Layer -Maps the input to the corresponding output and Output Layer - The layer from where the resultant can be seen. MLP-NN algorithm is used in both training and testing part for the activity detection. Training involves adjusting the parameters, or the weights and biases, of the model in order to minimize error. In this work, the algorithm classifies the activity of the women with the accelerometer data -struggling or normal. Fig 4 shows the basic structure of MLP.

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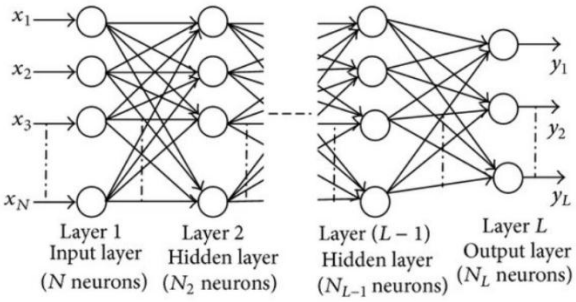


Fig 4: MLP-NN Basic structure

## b. K- Nearest Neighbors

The K-nearest neighbors (KNN) algorithm is a simple, easy-to-implement supervised machine learning algorithm that can be used to solve both classification and regression problems. It is Non-parametric, instance based and lazy learning algorithm. KNN has no model other than storing the entire dataset, so there is no learning required. Makes predictions using the training dataset directly. For classification, the output can be calculated as the class with the highest frequency from the K-most similar instances. To select the K's right value, we run the KNN algorithm several times with different values of K and choose the K that reduces the number of errors we encounter while maintaining the algorithm's ability to accurately make predictions when it's given data it hasn't seen before. Works well with a small number of input variables. This system uses KNN to classify the emotion of the victim. KNN detects whether she is in fear or not using the audio signal. Fig 5 shows KNN classification.

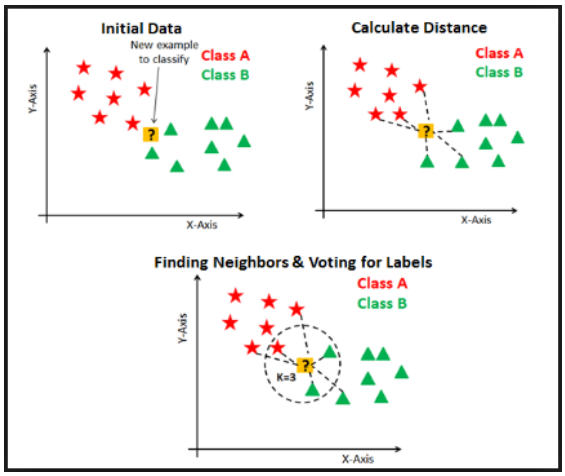


Fig 5 KNN Classification

## iv. Alert Module

Upon detection of activity and emotion, an alert message is send to saved contact. If the activity of the victim is struggling, the system checks the detected emotion and if it is fear then the message "SHE IS IN DANGER.. HELP HER" along with location send to the guardian with the use of GSM and GPS technology.

### GSM and GPS

**GSM (Global System for Mobile Communication):** GSM is a cellular technology used for voice and data transmission. A GSM modem accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

**GPS (Global Positioning System):** GPS is used to determine the location of object that has GPS receiver. GPS sensor gives two values: latitude and longitude. With the help of these parameters one can easily locate the position of any object.

## 4. Result analysis

This application was successfully implemented and got desired result. It is very simple in operation and reacts quickly. We hope this would ensure the safety of women effectively.

## i. Data Set

In the data collection phase, the real time data was collected from 12 subjects. The dataset consists of activity data and voice data. The data is collected by using accelerometer and microphone. The activity data includes struggling activity like running and normal activities like sitting, standing and walking. The voice data includes screaming or crying and normal conversation. 70% of the dataset is used in the training stage, while the remaining 30% is used in the testing stage.

## ii. Confusion Matrix

Confusion Matrix are used to measure the performance of an algorithm in Machine learning process, it is mostly used in supervised learning. It is an important tool for analyzing the performance of binary and multi-class method. Confusion matrix is a specific table which provides the means to group the classification results into a single matrix. It helps the developer to understand the types of errors that occur during the testing stage.

Fig 6 shows the confusion matrix formed when MLP-NN model was used to classify the activity from the real time data set. 100 samples are used for testing. It is observed that out of 50, 46 is classified correctly as struggling. For normal activity, 44 out of 50 is correctly classified as normal activity. The accuracy is obtained as 90%.

| Activity | Struggling | Normal |
|---|---|---|
| Struggling | 46 | 4 |
| Normal | 6 | 44 |

Fig 6 confusion matrix based on MLP-NN model for activity classification

Fig 7 shows the confusion matrix generated when KNN algorithm was implemented to predict the emotion from the voice data. Total 100 samples are used for testing. It is observed that out of 50, 42 is classified as fear and 43 out of 50 is classified correctly as neutral emotion. The accuracy obtained is 85%.

| Emotion | Fear | Neutral |
|---|---|---|
| Fear | 42 | 8 |
| Neutral | 7 | 43 |

Fig 7 confusion matrix based on KNN model for emotion classification

## iii. Screen Shots

The following figures are the screen shots of this work. Fig 8 shows the screenshot of the starting of the application. By clicking the browse button, it select the folder to which the data is collected. The application runs by clicking the start button.

Fig 9 shows the screenshot of the mobile when the application is running. The acquired data (accelerometer, audio and location) is sending to the server for training and testing.

Fig 10 shows the screenshot from the guardian's mobile phone. When the women is not safe the alert message receives the guardian.

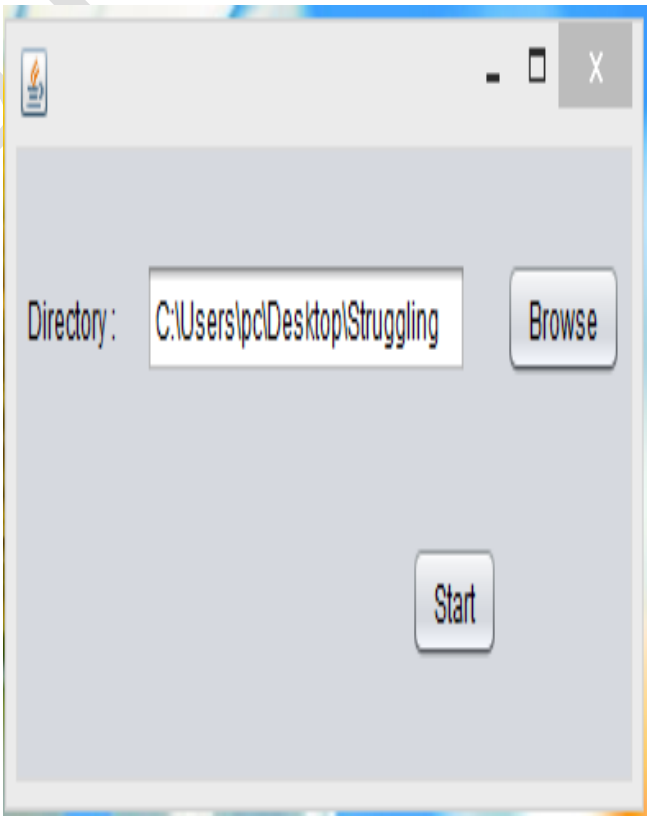


Fig 8: Screenshot of the start of application


Fig 9: Screen shot of Data acquisition

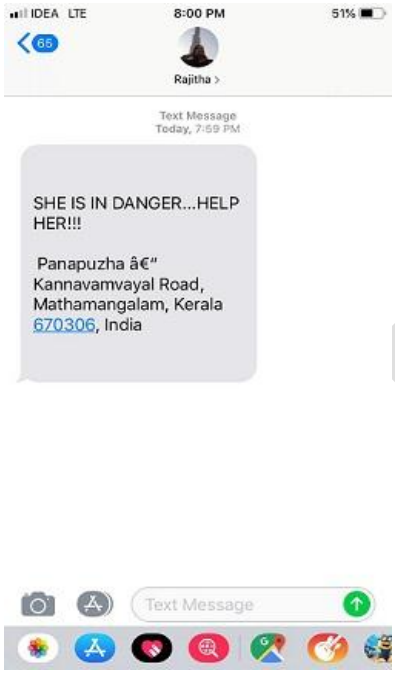


Fig 10. Screen Shot of SMS received by one of the registered contact numbers

## 5.Conclusion and Future Work

This mobile application for women aimed to ensure the safety of women in public places. This real time application makes use of Machine learning algorithms MLP-NN and KNN to detect activity and emotion recognition using MATLAB for ensuring the safety. Upon detecting danger situation the system will sent an alert message along with location to the guardian using GSM and GPS technology. The victim don't have to press any button to give an alert message, this is an automatic process. The application like this improves the level of safety of women and girls. Accurate recognition of a dangerous situation is a complex matter, however, the scope for improved accuracy is promising.

This application was developed for Android devices and is planned to be extended to other platforms like iOS, Windows and Blackberry OS in future. If we implement this work Using IoT, we can expect tremendous result for women safety.

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