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Android Based Elderly Assistance System for Fall Detection and Rescue

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Abstract - *We propose in this paper a system of assistance for the elderly – detecting whether an accident has occurred by sensing whether the said person has fallen. Also incorporated, is a corresponding wide area rescue system based on a smart phone and the mobile networks. The system is made in such a way that it can run on any wearable technology that runs on the android platform (i.e., any Android Wear). To detect a fall or any other related emergency conditions the waveform sequence of the triaxial accelerometer on the smart phone is used as the system inputs. The acquired signals are then used to generate an ordered feature sequence and then examined in a sequential manner by the proposed cascade classifier and with the help of machine learning technology (support vector machine) for recognition purpose. Once the corresponding feature is verified by the classifier at current state, it can proceed to next state; otherwise, the system will reset to the initial state and wait for the appearance of another feature sequence. Once a fall accident event is detected, the user's position can be acquired by the global positioning system (GPS) or the assisted GPS (A-GPS), and sent to the rescue centre via mobile network so that the user can get medical help immediately. With a cascaded classification architecture, the computational burden and power consumption issue on the smart phone system can be alleviated*

Key Words: Android, Elderly Assistance, Fall Detection, *Wearable Technology, Rescue System, Support Vector Machine*

1.INTRODUCTION

In today's world with advanced healthcare, the percentage of elderly population is on a rise. In this scenario, elderly assistance systems are gaining importance and attention. Current fall detection algorithms are of two types, environmental monitoring-based, and wearable sensor-based systems. In this paper we are proposing a cheaper Smartphone-based fall detection algorithm which provide more accurate result compared to existing systems. the necessity of wearing an additional sensor module can cause the elderly feel uncomfortable and lead to certain degree of inconvenience, so Smartphone-based fall detection algorithms are getting more attention.

2. EXISTING SYSTEMS

There are environmental monitoring-based, and wearable sensor-based systems are available today.

2.1 Environmental monitoring-based systems

In environmental monitoring-based systems, typically used sensors such as cameras, acoustic sensors, radar and infrared sensors, pressure sensors, or Wi-Fi routers are placed in an open space or environment to monitor the activities of the elderly as well as the occurrence of a fall accident event. Environmental monitoring-based fall detection system is more comfortable to the elderly since there is no need of wearing any module. However, the environmental monitoring-based system can only function in a open environment where it is installed. Moreover, the protection of the private matters for the elderly is another problem since it is based on camera and similar devices.

2.2 Wearable sensor-based systems

With the advances of integrated circuit technologies sensors like triaxial accelerometer and gyroscope, can be made very compact in its dimension and easy to be embedded in portable devices. Based on this technology many all purpose smart watches and smart bands are available today, and fall detection based on these technologies are getting more accurate results preserving privacy of users. Most algorithms based on wearable technology make use of multiple triaxial accelerometers or a tri-axial accelerometer in conjunction with a gyroscope is usually applied. In certain multiple sensor-based systems, even the atmospheric air pressure sensor or a surface electromyography sensor are used to assist the tri-axial accelerometer in discriminating the posture as well as the motion of the elderly.

3. SYSTEM DESIGN

The proposed system is a 5-stage system which consist of data processing and 1 cascading classifier build using support vector machine. The basic working of the system is as shown in the DFD shown below, if the event passes all stages in this model and if there is an internet connection, it is then send to the classifier build on SVM, and more accurate result is generated. Working of each stage is explained below.

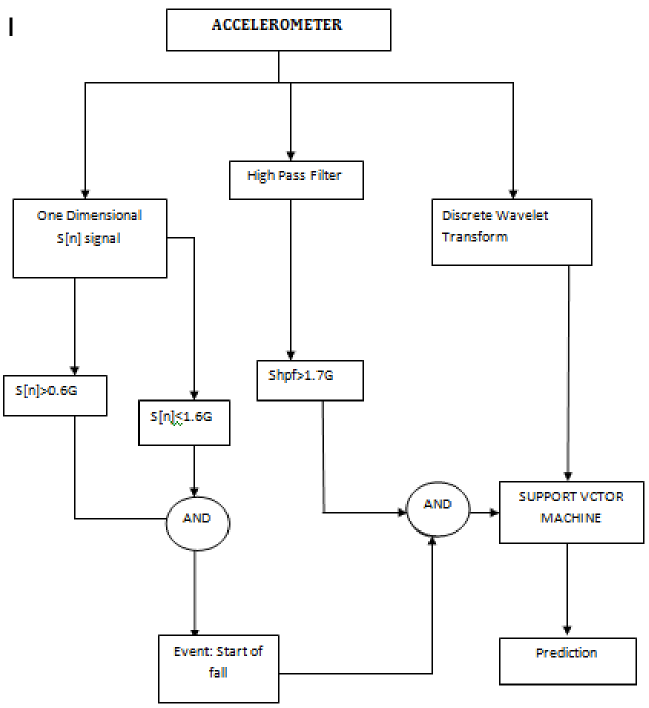

Fig -1: DFD of proposed system

3.1 Tri – Axial Accelerometer

In this system, the outputs of the tri axial accelerometer are sampled with a frequency of 50Hz. The sampled signal is a three-dimensional data sequence, i.e., [ax[n], ay[n], az[n]]. To simplify the dimension of the sampled signal, we make use of the one-dimensional signal magnitude vector (SMV) S[n] as below.

$$\sigma = \sqrt{\frac{1}{50}\sum_{n=251}^{300}(S[n]-\bar{S}_{50})^2},$$

The system passes the first phase if we get a Smin<.6G and Smax>1.6G.

3.2 High Pass Filters

A high-pass filter (HPF) is an electronic filter that passes signals with a frequency higher than a certain cut-off frequency and attenuates signals with frequencies lower than the cut-off frequency. The amount of attenuation for each frequency depends on the filter design. To extract the high frequency characteristic of the S[n] sequence, a high-pass filter with finite impulse response (FIR filter) is designed in this paper. The speciation of the designed high-pass filter is listed below.

1. Stop-band gain (Astop): 80dB
2. Pass-band gain (Apass): 1dB
3. Stop-band cut off frequency (Fstop): 40Hz
4. Pass-band frequency (Fpass): 50Hz

We make use of the one-dimensional signal magnitude vector (SMV) here also and proceed to next stage if and only if the new S value is greater than 1.7G.

3.3 Discrete Wavelet Transform

The discrete wavelet transform (DWT) is an implementation of the wavelet transform using a discrete set of the wavelet scales and translations obeying some defined rules. In other words, this transform decomposes the signal into mutually orthogonal set of wavelets, which is the main difference from the continuous wavelet transform (CWT), or its implementation for the discrete time series sometimes called discrete-time continuous wavelet transform (DT-CWT). In addition to the use of a high-pass filter, we also apply the use of discrete wavelet transformation (DWT) so that the high frequency details of a fall accident event can be easily observed. As we are paying attention to the high frequency characteristic of a fall event we apply the Harr wavelet analysis filter bank to the ax[n], ay[n] and az[n] (i.e., sequences generated by the triaxial accelerometer), and get the part of detail coefficients, i.e., the adx[n], ady[n] and adz[n]. We take max of these variables as one of the input to the SVM.

3.4 Support Vector Machine

In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall. In this system we provided average of the S[] sequence and maximum of adx[n], ady[n] and adz[n] as input to the SVM. SVM is build on python using scikit learn library. We trained the system with about 500 real fall events and 500 fake falls, and the classifier is now able to get 90% accurate predictions.

4. RESULT

We built our system as an android app which runs always in background. The pre-processing system is coded on java, and it sends the message to a python server running on Google app engine. Python server will send back the result to user within 15 seconds. During that interval we monitored the motion of mobile and If we detect it as stable, we reconfirm it as fall event and send information to emergency contacts, and if there is consistent motion we report self-recovery and won't send notifications to emergency contacts.

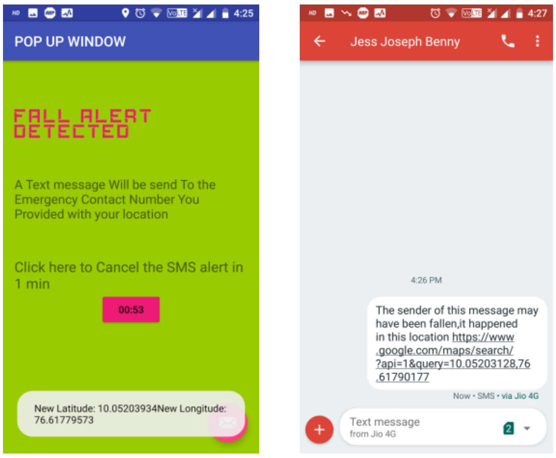

Fig -2: Screenshots of android app designed with proposed system

5. CONCLUSION

We propose through this paper an Android Based Elderly Assistance System for Fall Detection and Rescue. The fall detection algorithm is realized with the proposed state machine which investigates the features in a sequential manner. Once the corresponding feature is verified by the current state, it can proceed to next state; otherwise, the system resets to the initial state and waiting for the appearance of another feature sequence. The four states of the state machine run in the android phone and the final state is a prediction state, which uses an online sever with a trained SVM model and is used to increase the overall efficiency of the system.

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