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Baandhav: Smart Mobile Application for the Safety of Women and Elderly Population

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Abstract:
The subject of women's security is one of major concern areas in India and around the world. This is apparent from the recent incidents which have been reported in media, where a criminal attempt has been made to denigrate women's social dignity. Although there has been many suggestions to improve upon the safety of women such as enforcing stricter laws, 24x7 helpline etc. The use of technology presents a major stepping stone. In addition to women, elderly population represents another set of population segment requiring the use of technology to provide safe monitoring. Injuries due to falls are among the leading causes of hospitalization in elderly people, often resulting in a rapid decline in functionality and death. Constant monitoring of individuals at risk for falls is one of the practical way that mobile devices could be used to improve persons' health. Although there are numerous applications in the market catering to safety of either population, none of them cater to both population needs. The paper represents an alert system for fall detection as well as scream detection using common commercially available electronic devices to detect both the fall or scream and alert concerned people. The proposed system provides a reliable and cost effective solution to fall detection and scream detection. The Android platform is chosen for writing this application as it has biggest market presence in the world i.e. close to 80% of mobile world market and also its an open source, having very good developer community.

1. Introduction

A twenty first century has proved to be the trendsetter for women empowerment. Despite of this, women security is a major issue. Atrocities against women are increasing with faster pace [1]. In today's society women are becoming a soft target for molesters, eve-teasers and rapists. The chances of harassment and violence increase while travelling and going on the roads especially in the late nights. Several methods are being suggested by the police and other self-defense outfits for women. Keeping in line with current generation demands, the application is developed for security [2].

Smartphones are not only just communication devices but also might be used as an alarm in case of emergencies. The use of pervasive mobile equipment in identifying and calling resources to help out in the dangerous situation minimizes the chances of becoming a victim to the violent crimes. This is particularly helpful for women who are on the move habitually or have to travel through unsafe areas. Safety apps for women might reduce the risk of travelling alone all the way or through dangerous zones [2]. This application can help women to feel secure during emergency situation and get rapid response.

In addition to women, elderly population is another set of population who is suffering from lack of monitoring. Due to increase in life expectancy, the problems that accompanied aging have become more acute. It is widely acceptable that elder people display symptoms of lack of orientation, impaired balance and their health can be burdened by various kinds of diseases [3].

Injuries due to falls are among the leading causes to hospitalization in elderly persons. Every second is important between fall and emergency room. Constant monitoring of individuals at risk for falls is one practical way that mobile devices could be used to improve persons' health.

As for women security, modern smartphones also provide a medium that incorporates latest generation technologies, are affordable, portable and feature a variety of sensors that are not present even in modern personal computers for elderly safety.
An application developed in Symbian s60 is one of the existing applications. If there is a fall, fall indication appears and a buzzer sounds. It has two options: If feels uncomfortable, can make a call to a caregiver or to cancel within predefined time slot. But Nokia has abandoned Symbian platform [3]. NIRBHAYA is one such application that provides a single click facility to trigger emergency alert with location information. It also provides scream detection. But the limitation of this application is that it does not provide an automatic way of detecting fall and triggering emergency alert [4]. Apple has developed another such application using an accelerometer to detect falls. It provides alerts via SMS or automatic dialing .It gives geographic location. Since the percentage of IPhone users are very less in India and also the development platform is not open source and very expensive, this application would be unreliable and expensive for most of the mobile users [3].
The proposed application caters to the needs of both women and elderly. There is a provision for automatic fall detection based on posture recognition and fall detection algorithm and for emergency alert notification via messaging and social media such as Facebook. There is also a provision for creating emergency contact list, accurate location identification and scream detection.
A typical android smartphone is loaded with a variety of sensors. Accelerometer, magnetometer, proximity sensor, light sensors are some of the sensors available which can be used to detect postures and potentially detect events like fall.

2. The Proposed System

The main aim of the proposed system is to cater the needs of both population viz. women and elderly people.
The modules of the system are:

- Accelerometer Sensor: The accelerometer in Android phones measures the acceleration of the device on the x (lateral), y (longitudinal), and z (vertical) axes. It can be used to detect movement and the rate of change of the speed of movement.
- Micro Phone: Micro phone helps to detect the scream made by a person.
- Alerting: If a smartphone detects the fall, it finds the GPS location of the smartphone and sends an SMS to the people who are in emergency contact list and updates the status with emergency message in a social network such as Facebook.
- Scream detection: In scream detection, the smartphone detects the scream and compares with the normal voice which is preconfigured in the smartphone. If the scream exceeds the normal range, the phone will send SMS to preconfigured contact numbers using GPS Location Finder and updates the status in a social network.

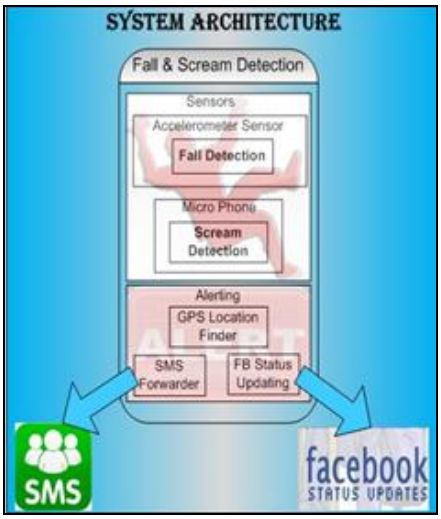

Figure 1: The Proposed Architecture

3. Workflow of Fall Detection

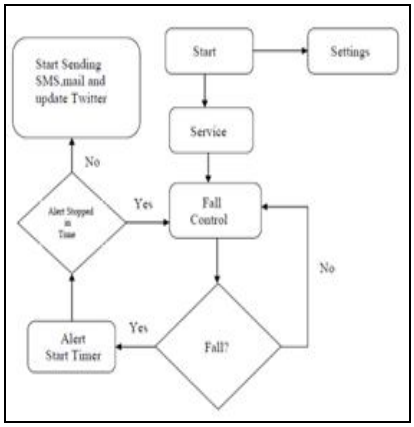

Figure 2: Workflow of fall detection

The above figure explains the work flow of fall detection. Initially the application is started and required settings are made. The application starts running as a background service or daemon service. It keeps on monitoring the fall. If fall occurs, it starts the timer. If timer is not stopped in time, it sends SMS to preconfigured numbers and also there is provision of updating in a social network. If the timer is stopped in time, the application starts running as background service [5].

4. Decision on fall

Fall detection	**Posture recognition**	**Decision on occurrence of fall**
Fall	Walking	False
Fall	Standing	False
Fall	Sitting	True
Fall	Null state	True

Table 1: Decision on fall

The table 1 explains the different conditions for the fall detection [6]. There are mainly four conditions for fall detection.

- If a person is walking and fall is detected then decision on occurrence of fall is false.
- If a person is standing and fall is detected then decision on occurrence of fall is false.
- If a person is sitting and fall is detected then decision on occurrence of fall is true.
- If a person is in undefined condition or in null state and fall is detected then decision on occurrence of fall is true.

5. Fall Detection Algorithm

The fall detection algorithm consists of two modules. They are:

- Posture recognition
- Fall detection

5.1. Posture Recognition

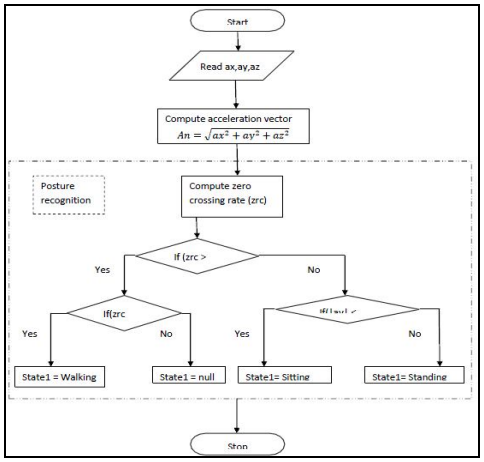

Figure 3: Flowchart of posture recognition

The figure 3 explains the flow chart of posture recognition. In the Posture recognition module, the user postures are classified into three basic postures. They are sitting, standing and walking. The value of "ay" is applied as threshold to find out the orientation.
When the application starts, the values of ax, ay and az are read from accelerometer. Acceleration vector is then computed using these three values. After acceleration vector is computed then zero crossing rate (zrc) is also computed. Different postures are recognized based on zero crossing rate value [6].

5.2. Fall Detection

The Figure 4 explains the flow chart of fall detection. The values of ax, ay and az representing acceleration in the x ,y,z axis are read from accelerometer. Acceleration vector is computed using these three values as below

$A_n = \sqrt{(ax^2 + ay^2 + az^2)}$

A_n represents the total acceleration of phone body.

The difference of present acceleration vector value and previous acceleration vector value is found out. If the difference between consecutive minima and maxima is greater the 2g, the output is decided as a fall as shown in figure 5.

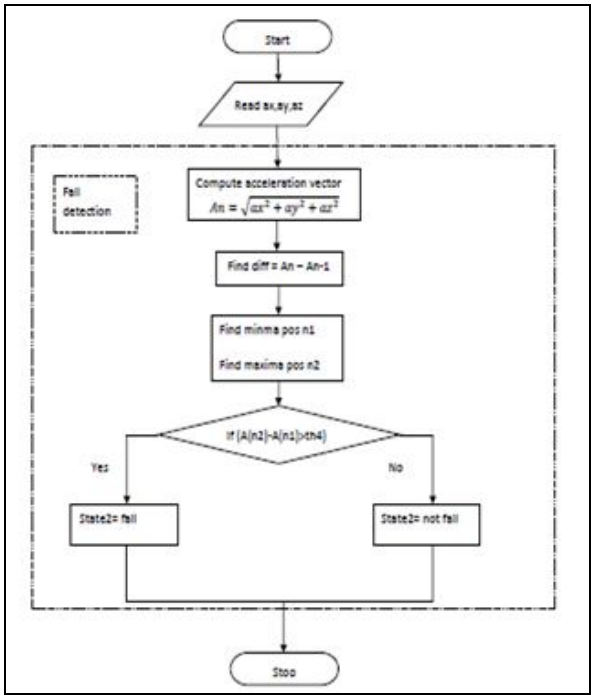

Figure 4: Flowchart of fall detection

The figure 5 shows typical pattern during fall detection.

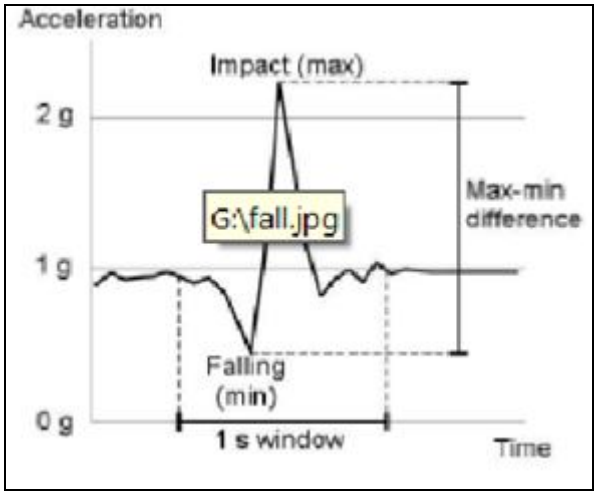

Figure 5: Fall pattern graph

6. Snapshots of the Application

Figure 6: Snapshots of the application

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The figure 6 shows various screen shots of Baandhav application. Figure 6(a) shows start up screen. Figure 6(b) shows interface for entering the contact information for emergency communications. Figure 6© shows option for starting the application in the background. Figure 6(d) shows fall detection algorithm processing the accelerometer readings.

7. Conclusion

The proposed system provides a viable solution to fall detection and scream detection for women and elderly. Using existing, mass marketed technologies will limit cost, making it available to the majority of the public. Implementing fall detection algorithm makes the system highly reliable.

Reliability and reduced number of false positives means greater adoption by emergency services. The importance of the smartphone in everyday life decreases the chances of being forgotten. Everyday interaction with the phone makes the interface more familiar to the user. A cell phone is also less intrusive than dedicated devices.

The friendly user interface, non-intrusiveness, and affordability leads to less rejection from users. By combining cheap hardware and open source software, a realistic solution to the security of women and elderly fall problems is provided.

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