Wearable Fall Detector for Elderly People

1Meeradevi.T, 2Swethika Ramesh, 3Vikash Kumar V, 4Sherli Subhiksa and 5Visnu Rajhan
1,3,4,5Department of ECE
2Department of CSE
1,2,3,4,5Kongu Engineering College, India
1meeradevi.ece@kongu.edu, 2swethikaramesh2981@gmail.com

Abstract - Now a days, most of the elderly person live in home alone. In their day to day living, some activities likely to have some accidents, such as fall. If the fall is unobserved for a longer period, it may lead to severe health trauma or even leads to death. According to the insights announced in National Safety Council, they are the subsequent driving reason for unexpected passing assessing 424000 passing worldwide. The objective of this paper is to develop a device that detects the fall event of the elderly person and intimate to the family members about the event. A call will be made automatically to the contact number provided in the fall detector application installed in the smart phone. It can accompany elderly people both indoors and outdoors in contrast to ambient devices. Computation of this method is simple and it is possible to implement in small size, so it can be easily carried by the elderly people. It can be afforded by

Keywords - Elderly people, fall detection, Unintentional deaths, Living alone

1. Introduction
An implanted embedded framework is a mix of software and hardware. An embedded hardware is generally microprocessor or microcontroller. Each hardware has its own program code. The software used for embedded systems is usually called as firmware. It can be either Machine code or Programming code. Each embedded system is designed for specific purpose. The advantages of embedded systems are smaller size, faster to load, low cost and more. Embedded system finds its application in the field of military, communication, home appliances, security, instrumentation, automobiles and in different embedded systems projects.

In worldwide, the population of people aged 65 and above is growing faster than all other age groups. Today, 8.5 percent of people worldwide (617 million) are aged 65 and over. According to the data from World Population Prospects in 2019 revision, one in six people will be over age 65. In the United States, approximately 30% of the older people live in home alone. In their day to day living, some activities likely to have some accidents, such as fall. In a real world, when an elderly person experiences a fall, it is very difficult for them to recover and communicate with their cared ones. If the fall is unobserved for a longer period, it may lead to severe health trauma or even leads to death. In view of the information from the U.S Centers for Disease Control and Prevention: Every 11 seconds, a more seasoned grown-up is conceded for crisis in medical clinic because of fall. Like clockwork, a more seasoned grown-up is conceded for crisis in medical clinic of the person i.e., standing, walking, lying or in null state. Fall is detected using the third threshold. When the fall is taken. Monitoring of elderly person 24 x 7 is necessary to avoid such events. Monitoring can be done by family persons or caretakers. But it is hard for the people of bustling world to monitor an older people all the time. Therefore, monitoring can be indirectly done by using technology such as smart phone or wearable devices. Fall related researches can be classified as Fall Detection and Fall prevention. First category is further classified as wearable and non-wearable devices. The second category needs lots of computing and huge amount of money

2. Literature Survey
A fall detection system using smart phones

[1] projected a fall detection prototype with smart phones. The user has a smart phone placed on their left chest. Sensor data is sampled from a smart phone and analyzed. The first step is done by detecting the instability of the user. Next step is to compare the data with minimum and maximum values in the sample and the last with a specific threshold. To find the posture of the person, the angle value is measured. When the system detect that the person experiences the fall, then the system will activate an alarm system.

A low cost highly accurate wearable fall detection system

[2] proposed an ease exceptionally precise wearable fall recognition framework. A triaxial accelerometer is mounted to the abdomen of the older. This gadget gets the action of the old individual utilizing accelerometer , spinner and magnetometers. Accelerometer combined with indicator estimations used to gauge the vertical speeding up of the old. Gyroscope and magnetometer are utilized to distinguish fall in edge based techniques. This framework removes the highlights from the sliding time window and presents to the prepared machine to settle on a parallel choice 0 for nonattendance of fall and 1 for presence of fall.

Fall detection prototype using an accelerometer and cascade posture

[3] introduced a fall location model utilizing an accelerometer and cascade postures. This paper proposed a technique to plan and build up a low cost, programmed fall discovery framework which works proficient in both outside and inside conditions. The accelerometer is positioned in the waist of the body in such a way that the Y-axis is parallel to the earth's gravity. Based on the two thresholds, the system will determine whether the position of the person i.e., standing, walking, lying or in null state. Fall is detected using the third threshold. When the fall is

@ IJAICT India Publications 2020
M.G. Sumithra et al.(eds.). Advances in Computing, Communication, Automation and Biomedical Technology,
https://doi.org/10.46532/978-81-950008-1-4_022
detected, the system will send SMS to their family persons using GSM /GPRS.

Fall detection system based on home camera for the elderly

[4] introduced fall detection system using home camera for the elderly which depends on artificial vision techniques. This system is based on Raspberry pi 2. To identify the fall event, this system extracts data from each scene in a video. The algorithm involves following steps: taking away the person image from the background, identifying the unwanted objects and learning the person’s changing environment, following the person throughout the scene. A kalman filter is utilized to diminish noise and person’s current state is identified by machine learning algorithm. The information model depends on three parameters such as ratio, ratio derivative and angle. These parameters are used to identify the person in different postures.

Fall detection system based on deep neural network in cloud environment

[5] proposed a fall recognition framework dependent on profound neural organization in cloud climate which doesn’t depend on wearable gadgets. The camera will take high frequency images and it will be transmitted to server. The deep cut neural network will detect human keypoints. Deep neural network will take the output of keypoints as input and softmax function is used to detect fall [6].

3. Methodology

The proposed system uses threshold-based fall detection algorithm to detect fall as it will reduce system complexity [7]. Initially the average acceleration and average orientation change is calculated by using the formula as given below.

\[
\text{Average acceleration} = (A\times^2 + A\times^2 + A\times^2) ^{(1/2)}
\]

\[
\text{Average orientation change} = (G\times^2 + G\times^2 + G\times^2)^{(1/2)}
\]

MPU-6050 is used for measuring acceleration and orientation change along the three axes. The MPU-6050 has both accelerometer and gyroscope integrated on a single PCB. For reading data from MPU-6050 and as main processing unit, arduino nano board is used. I2C interface is used between MPU-6050 and Arduino nano for faster data transfer. HC-05 bluetooth module is used to establish communication between the controller and the developed android application. Figure 1 represents the block diagram of the proposed system.

The gadget is attached to the abdomen of the individual since it is the situation of focus of gravity of the body and it is less inclined to record the adjustments in pose during everyday exercises. Table 1 gives the acceleration values for everyday activities.

| Everyday activities | Acceleration (in g’s) |
|---------------------|---------------------|
| Sneeze              | 2.9                 |
| Cough               | 3.5                 |
| Crowd Jostle        | 3.6                 |
| Slap on Back        | 4.1                 |
| Hop Off Step        | 8.1                 |

When the person experience fall, the accelerometer reading decreases since the person is moving in the direction of gravity and there will be less opposing force. When the accelerometer reads value less than 2 g force, it means the fall event is triggered. Once the person impacts on the ground, there will be huge opposing force against the gravity. Once the accelerometer reads the value greater than 10 g of force, it checks for orientation change. When there is huge change in orientation, the algorithm recognize it as fall and waits for 10 seconds before sending notification to the care taker. If the orientation of the person changes within 10 seconds, it means that the person has recovered from fall and no notification will be sent to the care taker [8]. If the orientation remains unchanged even after 10 seconds, it indicates the person has experienced severe injury and call will be made to the care taker by the android application for providing immediate assistance.

4. Results and Discussion

Android Application

Figure 2 represents the user interface of the developed application. The device is connected to this application via bluetooth.

1. Install the application from the given link
2. Turn on the bluetooth on the smart phone
3. Open the application
4. Set the phone number of the care taker by pressing the Set Phone Number button
The caretaker’s number is to be saved in the application by pressing Set Phone Number button as shown in Figure 3.

5. Enter the phone number and press Set button
6. Press Scan for BT Devices button
7. Select HC-05 from the list
8. The device is now connected
9. Once fall is detected, this application will make a call to the given caretaker.

The device is to be attached to the waist. Once the person experiences fall, the device will recognize it and make a call to the caretaker. Figure 4 image has been taken from the video clippings of the real-time demo of the fall of a person.

Device

Fig. 6: Portable Fall Detector device

Experimental Result

Table 2: Fall attempts result

| Activity      | No. of Attempts | Successful Attempts | Accuracy in % |
|---------------|-----------------|---------------------|---------------|
| Walking       | 20              | 19                  | 95            |
| Sitting Down  | 20              | 17                  | 85            |
| Standing Up   | 20              | 19                  | 95            |
| Lying Down    | 20              | 18                  | 90            |
| Waking Up     | 20              | 18                  | 90            |
| Fall          | 20              | 20                  | 100           |
| OVERAL ACCURACY | 20              | 20                  | 92.5          |

Table 2 shows the results obtained during testing of the device with respect to day-to-day activities of the elderly person.
5. Conclusion

The fall detector for elderly people has been designed to provide immediate health assistance to them by making an intimation to their care taker immediately thereby preventing severe trauma. This is done by interfacing MPU-6050 accelerometer and gyroscope module and HC-05 bluetooth module to arduino nano and monitoring the acceleration and orientation of the person. If the fall is detected, the developed android application will make a call to given number. The future enhancement may be made by making the size of the device even smaller and compatible to wear.

References

[1]. K. Chaccour, R. Darazi, A. H. El Hajjam, and E. Andrès, "From fall detection to fall prevention: A generic classification of fall related systems," IEEE Sensors J., vol. 17, no. 3, pp. 812–822, (2017).

[2]. P. Pierleoni et al., “A wearable fall detector for elderly people based on ahrs and barometric sensor,” IEEE Sensors J., vol. 16, no. 17, pp. 6733–6744, (2016).

[3]. Majd Saleh and Régine Le Bouquin Jeannès, “Elderly Fall Detection Using Wearable Sensors: A Low Cost Highly Accurate Algorithm”, IEEE Sensors J., vol. 19, no. 8, (2019).

[4]. Kabalan Chaccour, Rony Darazi, Amir Hajjam El Hassani, and Emmanuel Andrès, “From Fall Detection to Fall Prevention: A Generic Classification of Fall-Related Systems”, IEEE Sensors J., vol. 17, no. 3, (2017).

[5]. M. Yu, A. Rhuma, S. M. Naqvi, L. Wang, and J. Chambers, “A posture recognition-based fall detection system for monitoring an elderly person in a smart home environment,” IEEE Trans. Inf. Technol. Biomed., vol. 16, no. 6, pp. 1274–1286, (2012).

[6]. P. Pierleoni, A. Belli, L. Palma, M. Pellegrini, L. Pernini, and S. Valenti, "A High Reliability Wearable Device for Elderly Fall Detection," IEEE Sensors J., vol. 15, pp. 4544-4553, (2015).

[7]. T. Shany, S. J. Redmond, M. R. Narayanan, and N. H. Lovell, “Sensors based wearable systems for monitoring of human movement and falls," IEEE Sensors J., vol. 12, no. 3, pp. 658–670, (2012).

[8]. C.-F. Lai, S.-Y. Chang, H.-C. Chao, and Y.-M. Huang, “Detection of cognitive injured body region using multiple triaxial accelerometers for elderly falling,” IEEE Sensors J., vol. 11, no. 3, pp. 763–770, (2011).