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Design and Implementation an Enhanced Fall Detection System for Elderly Person with GSM and GPS Technology

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Abstract:
Fall-related accident and injury are a standout among the most widely recognized motivations to a reason for death and hospitalization between elderly. Falls among older people become a major problem facing hospitals and nursing homes. The eldercare problem becomes important due to the population aging. An enhanced fall detection system is proposed for elderly person monitoring that is based on-body sensor. Various fall-detection solutions have been previously proposed to create a reliable monitoring system for elderly people with high requirements on precision. In this paper, an enhanced fall detection system is proposed for elderly person monitoring that is based on smart sensors worn on the body and operating through long distance as well as consumer home networks. The principle behind this work is the detection of changes in the motion and position using the sensor which tracks the acceleration changes in three orthogonal directions. By using MEM's accelerometer sensor is used for determining exact angle of an elderly person with the help of signal magnitude vector (SMV). When the fall is detected the GPS locates the exact fall location and GSM modem is used to transmit the message to the mobile phone of caretakers/relatives of the fallen subjects at that time also send their latitude and longitude value by using GPS. This alert message helps to provide immediate assistance and treatment.

Keywords: *Fall Detection System, Elderly Monitoring, GPS, GSM, Accelerometer, Gyroscope, heart beat sensor, ARM.*

1. Introduction

Now a day's population ageing is unprecedented in the history of humanity and started in the western world during the 20th century. It is considered as a human success story, through the success of public medical and health advancements. But this ageing process also puts a lot of challenges regarding national development, issues concerning heath of the elderly individual, the sustainability of families, and the ability of health care system to provide for ageing populations. In recent years, there are many types of consumer electronic devices such as sensors and actuators have been developed for home network applications. A consumer home system usually contains various types of electronic gadgets like sensors, remote appliances, and actuators, so that home users can control in a smart way or intelligent and automatic way to improve their quality of life.

In recent years, particularly with the generation in Micro-Electro-Mechanical Systems (MEMS) technology which has facilitated the development of smart sensors. These sensors are tiny, with limited processing and computing support, and they are inexpensive compared to traditional sensors. These sensor nodes can sense, measure, and collect information from the conditions and, based on some local decision process, they can transmit the sensed data to the user. In a few years ago some representative technologies to perform a home Network include IEEE 802.11, Bluetooth, Ultra-Wide Band (UWB), and Zigbee, GSM etc. Zigbee is suitable for consumer home networks because various sensors can be expanded to collect home data information in a distributed, self-organizing manner with relatively low power. In this paper used a GSM module which is suitable for long distance communication it transmits the message to a mobile phone of caretaker or relatives of the fallen subjects.

During the last decades, many solutions have been proposed for elderly fall detection. Such solution can be categorized into three types. One of the earliest solutions 3- axis Micro-Electro-Mechanical Systems accelerometer, such system continuously monitors the elderly people in all direction and when it detects a fall, caregivers are notified of the occurrence of such event. In last decade many studies pointed or proposed out that the elderly often delay treatments after falls occur because of the disorder. They cannot use phones to inform the medical treatment about the exact fall location or emergency help, most of the fall simply lying on the ground and missing the best rescue timing, which may even lead to incurable consequences. Many old people with fall experiences are not willing to conduct the rehabilitation work in the future because they are worried to fall again. They often limit the range of actions by themselves, which not only affects their life quality seriously but also results in their muscle atrophy; some of them even require long-term care in their daily life.

In this paper fall detection system application for detecting falls and distinguishing them from ADLs has been developed. This fall detection application has been designed for a specifically elderly person because if fall happens at that time cannot help to this person quickly, so for this reason system is designed to help quickly. When a fall is detected, with the purpose of drawing attention to the faller in need for help, is automatically triggered. Additionally, the system will also send SMS and GPS location to a previously configured set of contacts. These messages include the sensor value like a heartbeat, temperature of the fall and the user's current location, with the Global Positioning System (GPS) coordinates and latitude-longitude value. The location information is computed using the integrated GPS module. The described workflow is illustrated in Figure 1.

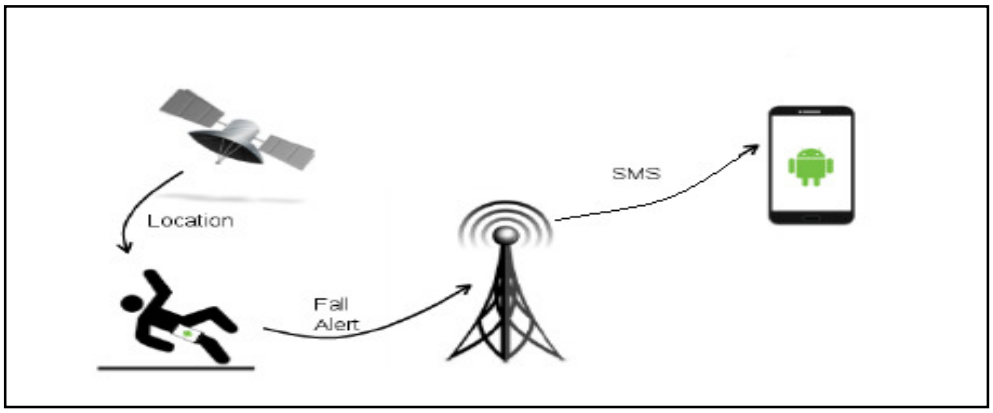

Figure 1: Application flow of events when a fall is detected

This paper proposes the new model by using advanced modern technology to detect the fall and also continuously monitoring the elderly person in various levels. And also when the fall is detected GPS is used to track the exact location of elderly person.

2. Related Work

Modern technologies are equipped with different sensing devices such as accelerometers, gyroscopes, and magnetometers. The accelerometer (also called inertial sensor or G-sensor) can measure the proper acceleration felt by the sensors. In previous and current research projects use medical sensor networks to identify and track human activities in daily life. With the purpose to successfully detect falls. This study focuses on the advanced technologies to help the elderly person and detect the fall by various ways. Jin Wang et al. has presented to create a reliable surveillance system is design for elderly people with high requirements on accuracy, sensitivity and specificity. An enhanced fall detection system is proposed for elderly person monitoring. It is based on smart sensors worn on the body and operating through consumer home networks [ii]. Paola Pierleoni et al. has exhibited fall detection system comprising of an inertial unit that incorporates triaxial accelerometer, gyroscope and magnetometer with proficient information combination and fall identification calculations. Beginning from the crude information, the executed introduction channel gives the right introduction of the subject regarding Yaw, Pitch and Roll angles [iii]. Alan K Bourke et al. The author has presented developed fall detection system consists of a tri-axial accelerometer, microcontroller, battery and Bluetooth module. This sensor is attached on designed vest, designed to be worn by the elderly person under clothing. The fall detection algorithm was developed and combines both impact and posture detection capability [iv].

M. R. Sie et al. proposed a string matching based algorithm is applied to recognize all possible fall events from the acceleration values sensed by the smartphone. This paper is based on application is also implemented on this system android-based platform [v]. Mihail Dumitrache et al. This article presents a fall detection a system based on a tri-axial accelerometer, which also provides GPS (Global Positioning System) localization and GSM (Global A system for Mobile Communications) wireless communication. This way, in case a fall is detected, family, social care assistants and/or medical personnel are quickly alerted and can easily occur, acknowledging the patient's exact location. Also, this paper presents an algorithm which is used in this paper for fall detection, which can be easily implemented in a microcontroller [vi]. Amrit k. et al the author has proposed an improved fall detection system is proposed for elderly person monitoring that is based on smart sensors worn on the body and running through consumer home networks. With treble thresholds, accidental falls can be detected in the home healthcare conditions [vii]. S. Abbate et al. has presented a smart phone based fall detection system with consideration of the acceleration signal this signal are produced by fall-like activities of daily lives in human life.

The authors have presented a novel approach for improving the fall detection accuracy which is based on the idea of identifying specific movement patterns into the acceleration data [viii]. Woon-Sung Baek et al. proposed a new fall detection system using one sensor node which can be worn as a necklace to provide both the agreeable wearing and low computation overhead. The proposed necklace-shaped sensor node includes a tri-axial accelerometer and gyroscope sensors to classify the behavior and posture of the detection subject [ix].Bruno Aguiaret al. presents a modest smartphone based falla detection system that uses a combination of information obtained from machine learning classification applied in a state machine algorithm. The data from the smartphone built-in accelerometer is continuously screened when the phone is on the user’s beltor pocket [x].

3. System Design

The system design based on ARM9 controller is used fall detection system for an elderly person, a various sensor used in this system such as accelerometer sensor, temperature sensor, pulse rate sensor, and gyroscope this all the sensor analog output is an interface to controller by using analog to digital converter and signal conditioning circuit, the block diagram of system as shown in Figure2. By gathering all the information from sensors the fall detected at various levels such as caregiver level, relative level, and ambulance level. And all the output of this sensor showed in PC through RS232 serial communication in visual basic software. The GSM modem is interfaced to a controller by using RS232 interface. GSM is used for transmitting and receive the message as per level by setting a specific threshold. In advanced, this system is used GPS which is interfaced by using RS232. This GPS module is used for track the exact location of fallen subject.

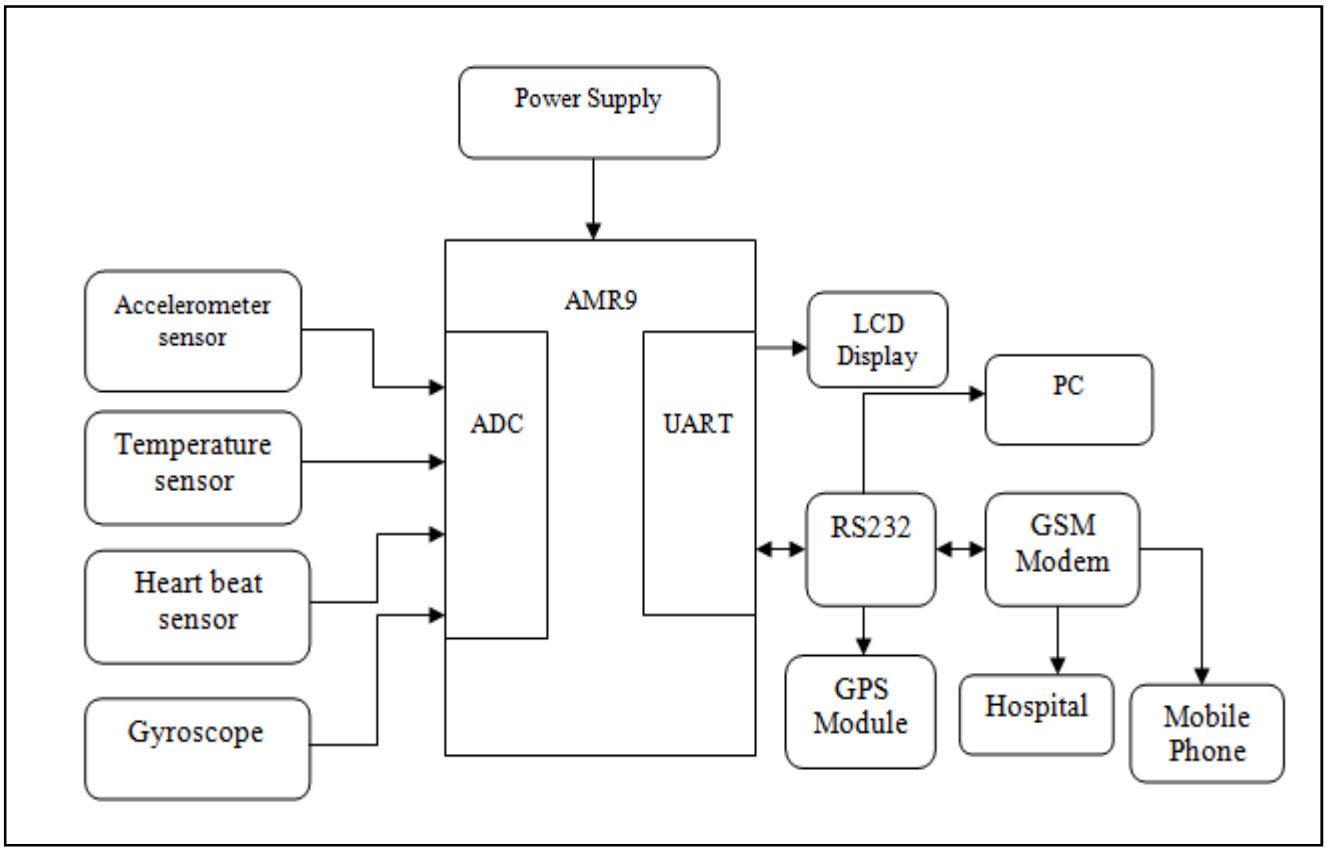

Figure 2: Block Diagram of the System

3.1. LPC2929 controller

This paper used designed model is based on ARM 9 controller board used device is LPC2929 all sensor interfaced to ARM9 controller by using ADC with signal conditioning circuit for. The unexpected human person fall is detected by the 3-axis MEMS accelerometer. The variation in the acceleration in any of the three axes is examined and sent to microcontroller which examines and the same digital data is sent to the mobile phones of the care taker/ relatives of the fallen person using GSM. The location of the human fall is determined using GPS. Through LED one can examine the fall.

3.2. MEMS Accelerometer

It is a small, thin, low power complete 3-axis accelerometer with signal conditioned voltage outputs as shown in the Figure 3. This sensor measures acceleration with a minimum fall scale range of ±3g. This technology converted more advanced the idea of integrating multi-chips was applied on to produce a unique chip MEMS with high performance and accuracy.

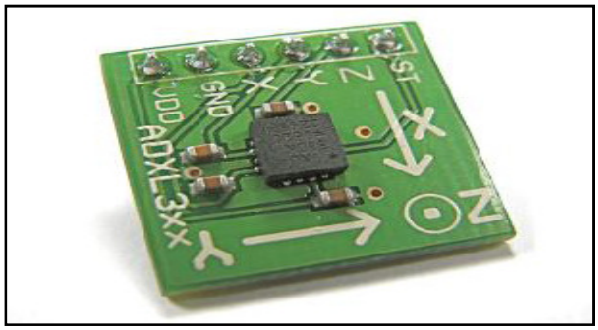

Figure 3: MEMS Sensor

3.3. Gyroscope-61 sensor

A gyroscope is a device used primarily for travel and measurement of angular velocity Gyroscopes are available that can measure rotational velocity in 1, 2, or 3 directions. This 3 axis is raw, pitch, roll of the body.

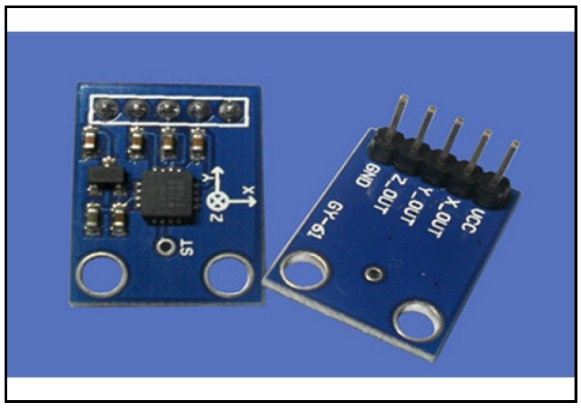

Figure 4: Gyroscope-61 sensor

3.4. GSM Wireless Modem

A GSM modem used in this system is a wireless modem that works with a GSM wireless network. GSM modem is used in this system for sending a message to the particular mobile number. A wireless modem functions like a dial-up modem. GSM modem requires a SIM card from a wireless express in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems continue a common set of standard AT commands.

Figure 5: GSM module

3.5. GPS Module L10-M29

This system used GPS module L10 brings the high performance of the MTK positioning engine to the industrial model. The L10 supports 210 PRN channels. With 66 search channels and 22 concurrent tracking channels, it acquires and tracks satellites in the smallest time even at indoor signal level. This ready, stand-alone receiver combines an expanded array of features with adjustable connectivity options. Their ease of integration results in fast time-to-market in a wide range of automotive, consumer and industrial applications.

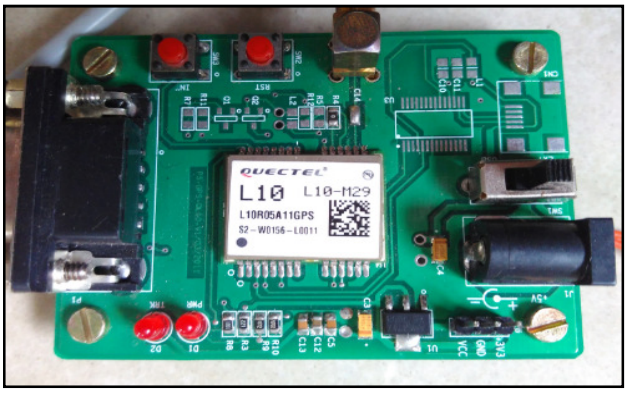

Figure 6: GPS module

4. Results

The prototype of fall detection system with GSM and GPS technology there are various sensor used in this system like accelerometer, Gyroscope, Temperature, Heart beat sensor. This all sensor interfaced with ARM9 LPC2929 controller and collect the value of all sensors and display on LCD as well as in PC via USB to serial cable. The complete hardware and their connection as shown in Figure 7.

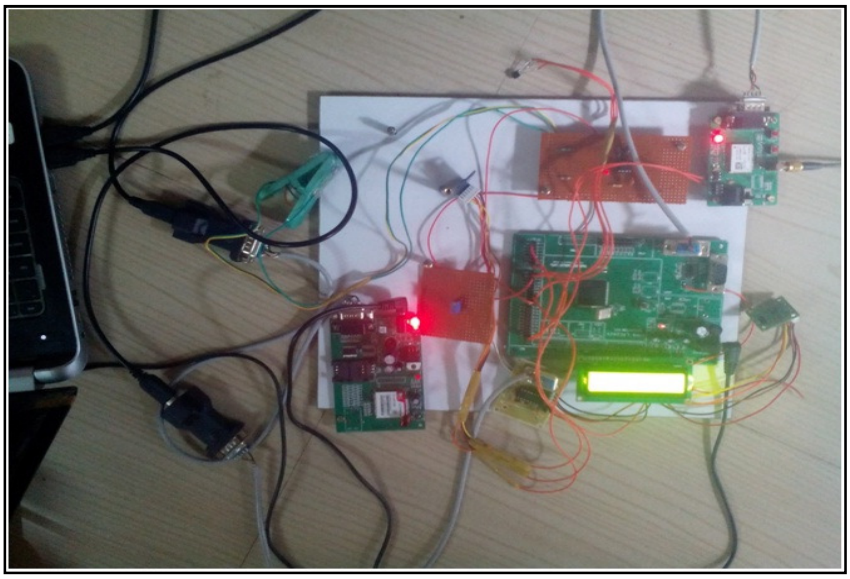

Figure 7: Complete hardware of fall detection system

The below table shown the all parameter that are used in this paper and set their initial threshold value if the sensor value crosses the threshold at that time action will be taken shown in below table I.

Sr. No.	Parameter	Threshold	Action
1.	MEMS Accelerometer	M > 90	Send SMS to caretaker with GPS location
2.	Gyroscope	G > 200	Send SMS to caretaker with GPS location
3.	Temperature sensor	T >= 40	Send SMS to caretaker with GPS location
4.	Heart Beat	H >=72	Send SMS to caretaker and Hospital with GPS location

Table 1: Parameters value and their action

When sensor threshold is over at that time fall is detected and send SMS to concern relative and also location of elderly person GPS latitude and longitude value. When heart rates over fall detected or happen at that system launch message launch relative as well hospital. The following screen shot shown other SMS send to hospital.

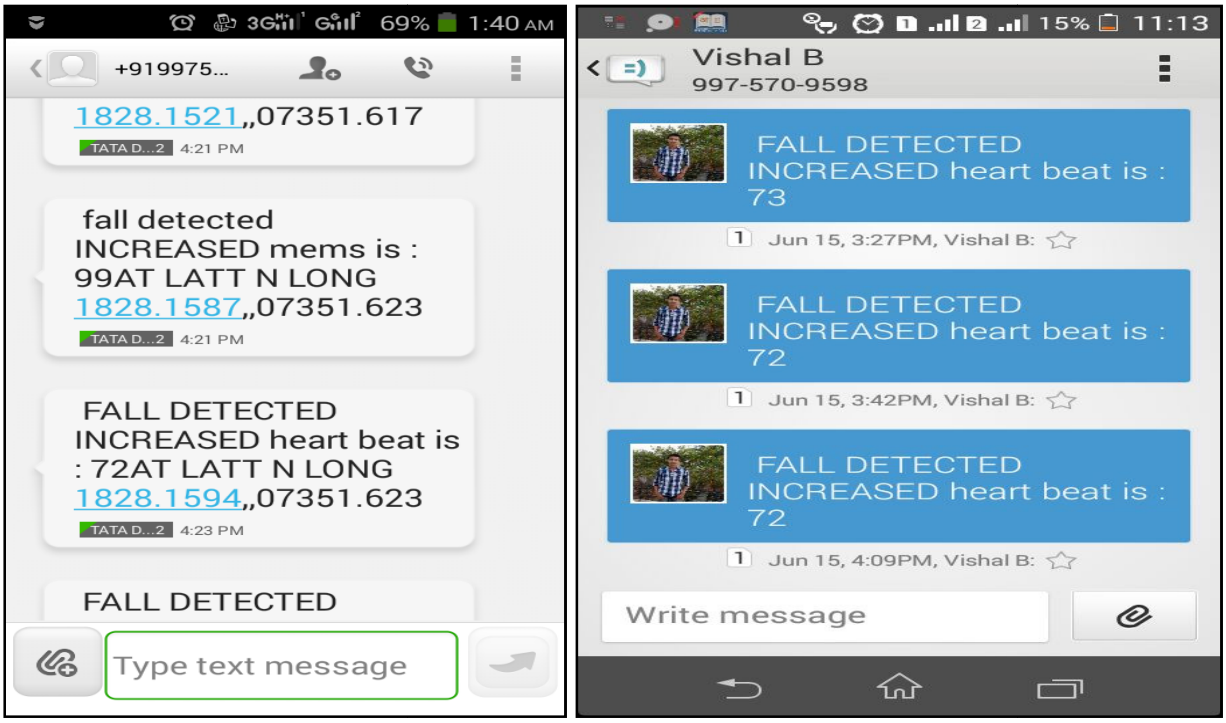

Figure 8: Displaying received SMS to relative after fall detected as well as hospital

In software design used Keil software for coding in embedded C languages and all sensor data display on LCD as well as in PC by using Microsoft visual basic software and connected through USB to serial cable. The software result as shown in flowing Figure 10.

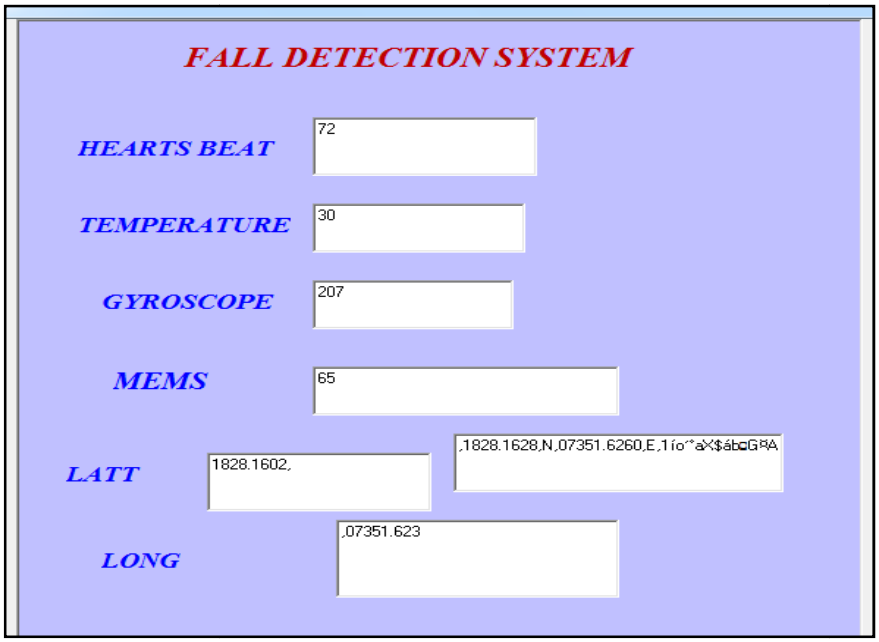

Figure 9: Displaying all sensor reading on software

5. Advantages

1. It gives immediate information to the belonging one.
2. Easy to monitor in the case of emergency.
3. Reduce the energy consumption to prolong the network, speed up and extend the communication coverage to increase the freedom for enhance patient quality of life.
4. It reduced the death percentages in accidents.
5. GSM used to communicate the nearest hospital and relatives.
6. Message to the hospital means immediate aid can be provided without any human intimation.

6. Conclusion and Future Work

Now a day's increasing awareness of the occurrence of falls among the elderly prevent an events are highly needed in order to enhance the quality of life for elderly people and provide them with convenient fall detection techniques. The system based on Advanced RISC Machine. Hence, concluding to this project is a wearable sensor system could capture every movement of the human body under the condition of low lost and activities daily life condition.

Using of this system user can live independent no need to depend on another person always with the user. Finally, we can identify the person or user by this paper using GPS Technology. The system confirmed that body worn accelerometer used for fall detection. By combine GPS and GSM with this body smart sensor can help to communicate the outputs and track a location of impact elderly people, and hence improve the quality of life for elderly person.

The system can be improved further development will include a more accurate fall-detection algorithm, more suitable attachment method, lighter and smaller sensor as well as, mobility monitoring and energy expenditure measurements.

7. References

i. U. N. D. of Economic, World population ageing 2009. New York, NY: United Nations Publications, 2010.

ii. Jin Wang, Zhongqi Zhang, Bin Li, Sungyoung Lee, and R. Simon Sherratt, "An Enhanced Fall Detection System for Elderly Person Monitoring using Consumer Home Networks" IEEE Transactions on Consumer Electronics, Vol. 60, No. 1, February 2014.

iii. Paola Pierleoni, Alberto Belli, Lorenzo Palma, Marco Pellegrini, Member, IEEE, Luca Pernini and Simone Valenti "A High Reliability Wearable Device for Elderly Fall Detection" 10.1109/JSEN.2015.2423562, IEEE Sensors Journal,2015.

iv. Alan K Bourke, Pepijn WJ van de Ven, Amy Chaya, Gearóid ÓLaighin, John Nelson, "DESIGN AND TEST OF A LONG-TERM FALL DETECTION SYSTEM INCORPORATED INTO A CUSTOM VEST FOR THE ELDERLY" ISSC 2008, Galway, June 18-19.

v. M. R. Sie and S. C. Lo, "The design of a smartphone-based fall detection system," Networking, Sensing and Control (ICNSC), 2015 IEEE 12th International Conference on, Taipei, 2015, pp. 456-461.

vi. Mihail Dumitrache1, Sever Paşca "Fall Detection System for Elderly with GSM Communication and GPS Localization" THE 8th INTERNATIONAL SYMPOSIUM ON ADVANCED TOPICS IN ELECTRICAL ENGINEERING May 23-25, 2013.

vii. Amrit kumar, Dr. M.N. Shanmukha Swamy, "An Enhanced Fall Detection System using Sensor, GPS, GSM Technology" International Advanced Research Journal in Science, Engineering and Technology Vol. 2, Issue 5, May 2015.

viii. S. Abbate, M. Avvenuti, F. Bonatesta, G. Cola, P. Corsini, and A.Vecchio, "A smartphone-based fall detection system," Pervasive and Mobile Computing, vol. 8, no. 6, pp. 883-899, Dec. 2012.

ix. Woon-Sung Baek, Dong-Min Kim, F. Bashir and Jae-Young Pyun, "Real life applicable fall detection system based on wireless body area network," 2013 IEEE 10th Consumer Communications and Networking Conference (CCNC), Las Vegas, NV, 2013, pp. 62-67.

x. Bruno Aguiar, Tiago Rocha, Joana Silva and Rua Alfredo Allen, "Accelerometer-Based Fall Detection for Smartphones" IEEE 978-1-4799-2921-4/14/2014.