An Enhanced fall detection system 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 reason for death and hospitalization among elderly. Falls among older people become a major problem facing hospitals and nursing homes. 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 surveillance system for elderly people with high requirements on accuracy. 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, Pulse rate sensor, ARM.

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I. 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 triumph 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. The terms "Elderly", "Older population" and "Senior citizens" are generalized to refer to people aged 60 years or older. People aged 80 years or older is referred as the oldest of old [1].

A consumer home network usually contains various types of electronic devices like sensors, remote appliances and actuators, so that home users can control them in a smart way or intelligent and automatic way to improve their quality of life. In recent years, particularly with the proliferation in Micro-Electro-Mechanical Systems (MEMS) technology which has facilitated the development of smart sensors. These sensors are small, with limited processing and computing resources, and they are inexpensive compared to traditional sensors. These sensor nodes can sense, measure, and gather information from the environment and, based on some local decision process, they can transmit the sensed data to the user.

During the last de cades, 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 monitor the elderly people in all direction and when it detect a fall, caregivers are notified about 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. 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.

II. 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, and can have many applications on gesture-based interactions with smartphone such as automatic screen rotation. This study focus on the advanced technologies to help 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 [2]. 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 [3]. 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

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was developed and combines both impact and posture detection capability [4]. 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 [5]. 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 [6]. 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 [7]. 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 [8]. 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 [9].

III. 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. As shown in Figure 1. 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.

The designed system required +5V power supply by using a voltage regulator. In this paper system designed based on all (SMD) surface mount device. Because by using this SMD components overall PCB made by very less size as compared to other due to used by SMD component. Power is required for operating the ARM controller. Any adjustment in the axis from its typical pre-set position is distinguished by the sensor. GPS module will be constantly transmitting area of the individual wearing the sensor. The output of the three-axis accelerometer sensor that is tilt in all

three axes is compared with the given threshold value. When the tilt exceeds given threshold value, the corresponding location of the fall will be transmitted or send to the receiver's mobile phone through GSM module. The output message includes also send the information about the change in axis, latitude and longitude values with the location of the fall by using GPS.
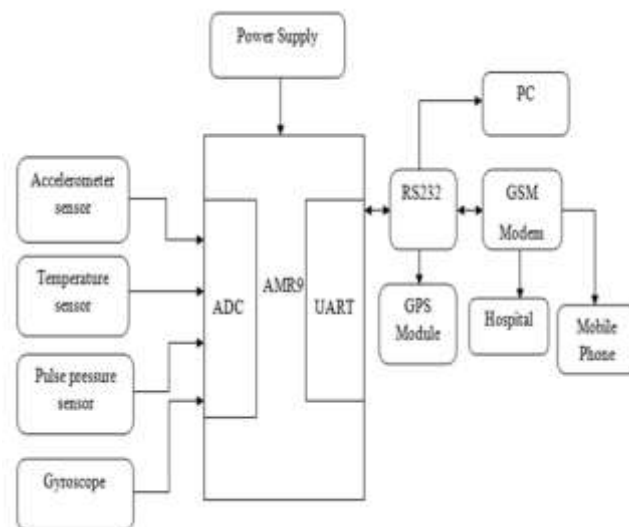

Figure 1. Block Diagram of the System

IV. HARDWARE DESCRIPTION

This paper used designed model is based on ARM 9 controller board LPC2929 all sensor interfaced to ARM9 controller by using ADC with signal conditioning circuit. 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.

A. ARM 9 controller (LPC2929)

ARM 9 controller used in this system i.e. ARM9 LPC2929, ARM is proposed to smooth the progress of developing and debugging of various designs encompassing of High-speed 32-bit Microcontrollers. ARM controller performing more millions of instruction per second, by stripping out unneeded instructions and optimizing pathways hence power is reduced. The user can easily engage in development in this platform, or use it as a reference to application development. The memory of ARM 9 controller is 768K flash program memory.

B. MEMS Accelerometer

It is a small, thin, low power complete 3-axis accelerometer with signal conditioned as shown in the Figure 2. This sensor measures acceleration with a minimum fall scale range of $\pm3g$. It can also measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion, shock or vibration. Using this sensor set specific threshold by moving or tilt sensor if sensor move

346

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and over the set threshold and then fall is detected and send the message to a caretaker.

Figure 2.   MEMS Sensor

C. 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 as shown in Figure 3. This 3 axis is raw, pitch, roll of the body. 3-axis gyroscopes are often performed with a 3-axis accelerometer to provide a full 6 degree-of-freedom (DoF) motion tracking system.
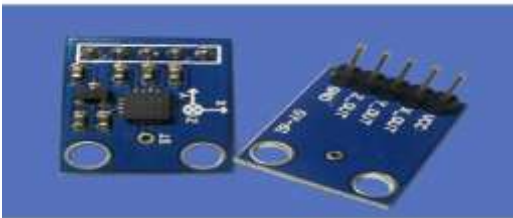

Figure 3.   Gyroscope-61 sensor

D. 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 4.   GSM module

E. 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 5.   GPS module

V.   RESULTS

The following table 1 shown results of system

TABLE I.   RESULTS OF SYSTEM

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

VI.   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

VII.   CONCLUSION

The system based on Advanced RISC Machine. Hence, concluding to this project is a wearable sensor system

347

could capture the every movement of the human body under the condition of low lost and activities daily life condition. Using of this project 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 proposed 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.

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