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REVIEW ARTICLE

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An Enhanced Fall Detection System for Elderly Person and Monitoring using GSM and GPS

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Abstract: From last few years, various fall detection solutions have been previously proposed to create a reliable surveillance system for elderly people. The eldercare problem becomes important due to the population aging. A fall accident may cause serious injury to the elderly person. How to automatically detect a fall and quickly launch a help message becomes crucial, particularly for those elderly living alone. In this paper, an enhanced fall detection system proposed for elderly person monitoring that is based on smart sensor worn on body. The principle behind this work is detection of changes in the motion and position using sensor which track the acceleration changes in three orthogonal directions. The data from sensors is continuously analyzed algorithmically to determine the accuracy of fall. When the fall is detected the GPS is locates the exact fall location and GSM modem is used to transmit the message to the mobile phone of care takers/relatives of the fallen subjects. This alert message helps to provide immediate assistance and treatment.

Keywords: Wireless Sensor Networks, Fall Detection System, Elderly Monitoring, GPS, GSM, Accelerometer, Gyroscope, ARM.

I. INTRODUCTION

Population ageing is unprecedented in the history of humanity and started in the western world during the 20th century. At the word level, the number of older persons is expected to exceed the number of children. 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 network usually contains various types of electronic devices like sensors, remote appliances and actuators, so that home users can control them in an smart way or intelligent and automatic way to improve their quality of life.

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 involved ultrasonic sensor network system, such system continuously monitor the elderly people in a nursing room and when it detect a fall, caregivers are notified about the occurrence of such event.

In last few years some representative technologies to implement 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 deployed 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 is transmit the message to a mobile phone of caretaker or relatives of the fallen subjects. Some typical applications include home automation, home activity detection (like fall detection) and home healthcare, etc.

Kinsella and Phillips [1] found that the number of population of 65-and over aged people in the created nations will approach 20% of total populace in the following 20 years and will clearly turn into a serious medicinal services issue in the future. In China alone, the population beyond 60 years old is 133.9 million [2]. Among the elderly, the fall occasions can be an unusual and unsafe occasion. Statistics demonstrate that one among three 65-and-over matured individual falls each year [3]. Among these fall occasions, 55% happen at home and 23% happen close to the home. In 2003, the worldwide number of deaths caused by fall events was around 391,000 and particularly 40% of the falls were from individuals more than 70 years old [4]. In this way, reliable consumer based fall detection systems need to be designed, tested and tried and monetarily sent to nations all around the globe. Moreover, the expense of human services is profoundly identified with the reaction and rescue time, and can be greatly reduced by fast detection and delivering signals to the specified operator for immediate consideration.

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

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 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 [5]. 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 [6]. Meng-Ruei Sie et al. has described the eldercare problem becomes important due to population ageing. A fall accident may bring about genuine harm to the elderly.

The author has presented step by step instructions to naturally identify a fall [7].

Stefan Madansingh et al. has designed of a smartphone based fall detection system and characterizes the preliminary efficacy of the proposed system in activities of daily living means that (ADLs)[8]. Bruno Aguiar et al. have proposed an unpretentious Smartphone based fall identification system that uses a blend of data got from machine learning characterization connected in a state machine algorithm. The information from the Smartphone worked in accelerometer is continuously screened when the telephone is in the client's belt or pocket [9]. Q. Zhang, L. et al. has presented (Home healthcare sentinel system), a three-stage identification plan which comprised of an accelerometer, sound, picture and video clips. Its advancement was to distinguish falls by utilizing a tri axial accelerometer [10].

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 [11]. Y.W Bai has proposed system examines the change of increasing speed as well as investigate the four normal activities of people. These are going upstairs, going ground floor, standing up, taking a seat, running and jumping. At that point contrast the four activities and the attributes of a fall. These are weightlessness, effect, stationary nature and toppling of the body [12]. M. Yu et al. has presented a vision based fall identification strategy by applying foundation subtraction to extricate the closer view human body and post preparing to enhance the outcome. To identify a fall, information was fed into a coordinated non-cyclic chart bolster vector machine for stance acknowledgment [13]. J. Winkley et al. has exhibited verity a 2-segment framework which had a based station and an immediate observing gadget. This specific system, encompassing/skin temperatures were measured for constant checking. The system uses a best in class SoC (System on Chip), utilizing a ultra-low power sensor interface and RF communication [14].

Y. Li et al. has proposed an acoustic fall identification system (FADE) that would automatically signal to this system was designed by caregiver. A roundabout receiver cluster was connected to catch and improve sounds in a space for the grouping of "fall" or "non-fall," [15]. C. Rougier et al. has proposed a human shape miss sharpening during a video arrangement which is utilized to track the individual. Surrounding construct strategies as a rule depend in light of weight sensors, acoustic sensors or even latent infrared movement sensors, which are normally actualized around guardian houses confronted with the growing population of seniors [16]. M. Belshaw et al. proposed three pattern recognition methods were compared [logistic regression, neural network, and support vector machine (SVM)] and the neural network achieved the best performance with a fall detection rate of 92% and a false detection rate of 5% [17].

Yan et al. proposed the apparent obtrusive nature of these wearable gadgets by building up a system that did not as a matter of course require the client to be wearing a sensor, yet could distinguish the client's area in view of interaction of communication with the home-installed sensor system [18]. Zigel et al. has described a fall detection system based on floor vibration and sound sensing. Temporal and spectral features were extracted from signals and a Bayes' classifier was applied to classify fall and non fall activities [19]. Kangas et al. has proposed an improved scheme, they used a single three axis acceleration sensor to attach to the subject's body in different positions and the dynamic and static acceleration components measured from these acceleration sensors were compared with appropriate thresholds to determine a fall [20]. Popescu et al. has presented an acoustic-based fall detection system which utilized a variety of acoustic sensors. The fall identification sensors are straight varieties of electrets condensers set on a pre-amplifier board [21].

Thome et al. has proposed a strategy taking into account short video arrangement action characterization. They author has give some idea thought a novel strategy was proposed to separate a man's 3-D introduction data from various aligned cameras [22]. T. Hori et al. proposed for elderly fall detection. The author has described such solution in this paper can be classified into three parts. One of the earliest solution included ultrasonic sensor network system; such a system persistently screens the elderly individuals in a nursing room and, when it distinguishes a fall, guardians are informed about the event of such an occurs [23].

III. SYSTEM DESIGN

The below system design based on ARM9 controller is used fall detection system for elderly person, various sensor used in this system such as accelerometer sensor, temperature sensor, pulse rate sensor, and gyroscope this all the sensor analog output is interface to controller by using analog to digital convertor and signal conditioning circuit. By gathering all the information from sensors the fall detected in various level 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 controller by using RS232 interface. GSM is used for transmit and receive message as per level by set 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.

Designed system required +5V power supply by using voltage regulator LM7805 is converted to +5V is regulated voltage. +3.3V 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 axis is compared with the given threshold value. When the tilt exceeds given threshold value, corresponding location of the fall will be transmitted or send to the receivers mobile phone through GSM module. The output message includes also send the information about the change in axis, latitude and longitude values with location of the fall by using GPS.

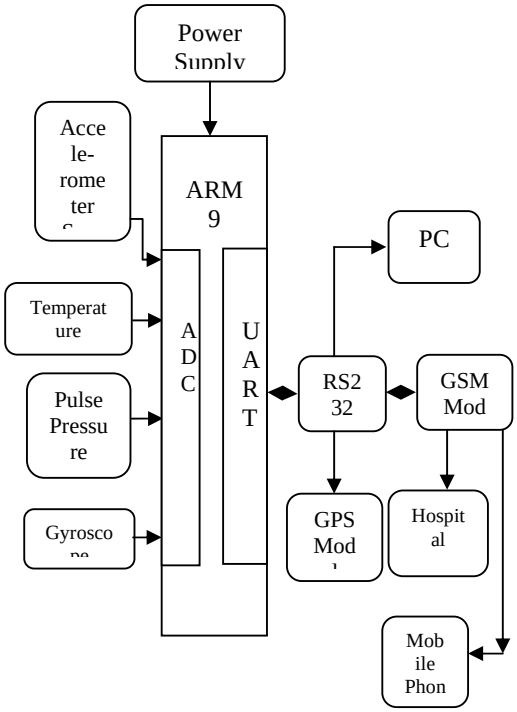

Figure 1. Block Diagram of the System

IV. METHODOLOGY

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. User can easily engage in development in this platform, or use it as reference to application development. The memory of ARM 9 controller is 768K flash program memory 56K+2*32K SRAM is data memory.

The all used sensor is interface with ARM controller through ADC and signal conditioning circuit. The accelerometer and Gyroscope sensor is used to detect the physical activity of elderly person. The 3- axis accelerometer sensor outputs change dramatically when the fall event occurs. Temperature sensor is used to continuously checked the body temperature of elderly person and pulse rate sensor is used to check the heart beat if the heart beat is above the threshold message is sent as per the level to set in this system.

UART is use to connect RS 232 serial communication and ARM controller unit. The ARM controller unit required to operate 3.3V. The GSM MODEM is interfaced to the ARM controller unit by using RS232 interface. The sensor may be a load cell. This is used to detect the level of the impact and the signal to the MCU. If the controller predicted that the sprain gauge value is more than the critical limit then the information is sent to registered number in the microcontroller through SMS to Hospital or their relation to rescue. GPS module is interface by using RS232 serial communication and PC means personal computer is used for to show the output of all peripheral sensors those are interface to ARM controller unit. The PC is interface to ARM controller unit by using RS232 serial communication. In this system use Keil software for write a code of this system. The code is written in embedded c programming and this code is burn to controller unit by using flash magic software.

Flash Magic is an application created by Embedded Systems Academy to permit you to easily get to the components of a microcontroller gadget. With this system you can delete singular squares or the whole Flash memory of the microcontroller. Utilizing Flash Magic, you can perform different operations to a microcontroller device, operations like erasing, programming and reading the flash memory, adjusting the Boot Vector, performing an unlimited free pass on an area of the Flash memory and numerous others. Microsoft visual basic is used to show the output of this system. This software is interface by USB to serial communication cable and output is show directly to the PC.

V. ALGORITHM FOR PROGRAMMING

- Declare variables.
- Initialize ADC pins using PINSEL1 register.
- Set the clock to 30 MHz using VPBDIV.
- ADC initialization ADC configuration bits CLK = 9clks/8Bit , BURST=1 , CLKDIV = 0x06.
- Initialize UART0 and UART1 to 9600 Baud Rate @ 30MHz.
- Set UART0 as irq.
- VIC slot enabled, pass address of UART0 to address register, Enable UART0 Interrupt.
- Read A/D Data Register, Wait for the conversion to complete and assign result to X, Y, Z variables.
- Sense all sensors data to pc.
- Stop.

VI. ADVANTAGES

- 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.
- It gives immediate information to the belonging one.
- Easy to monitor in the case of emergency.
- It reduced the death percentages in accidents.
- GSM used to communicate the nearest hospital and relatives.
- Message to the hospital means immediate aid can be provided without any human intimation.

VII. CONCLUSION

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. All sensors interface design based on Advanced RISC Machine. An enhanced fall detection system based on body smart sensor was proposed. The proposed system confirmed that body worn accelerometer used for fall detection. By combing GPS and GSM with this body smart sensor can help to communicate the outputs and track location of impact elderly people.

The work can be improved by designing the system to detect the different stages of fall.

VIII. ACKNOWLEDGMENT

This study is useful for the fall detection system for elderly persons. And understanding the enhanced fall detection system for elderly by using ARM controller and it is used to reduce the fall for elderly person and then improves their life.

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