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ADVANCED FALL IDENTIFICATION SYSTEM

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Abstract: ***The population of 65-and over aged people in the developed countries will approach 20% of total population in the next 20 years and will obviously become a serious healthcare issue in the near future. In China alone, the population over the age of 60 years old is 133.9 Million. Among the elderly, the fall events can be an unpredictable and dangerous event. Statistics show that one among three 65-and-over aged person falls every year. Among these fall events, 55% occur at home and 23% occur near the home. Thus, reliable consumer based fall detection systems need to be designed, tested and commercially deployed to countries all around the world. Furthermore, the cost of healthcare is highly related to the response and rescue time, and can be greatly reduced by fast detection and delivering signals to the specified operator for immediate consideration***

Various fall-detection solutions have been previously proposed to create a reliable surveillance system for elderly people with high requirements on accuracy, sensitivity and specificity. In this paper, an enhanced fall detection system is proposed for elderly person monitoring that is based on sensors worn on the body and operating through consumer home networks. With treble thresholds, accidental falls can be detected in the home healthcare environment. By utilizing information gathered from an accelerometer, Pulse sensor and other sensors, the impacts of falls can be logged and distinguished from normal daily activities. The proposed system has been deployed in a prototype system as detailed in this paper.

***Index Terms*— Pulse sensor, GSM, Sensors.**

I. INTRODUCTION

In recent years, many types of consumer electronics devices have been developed for home network applications. A consumer home network usually contains various types of electronic devices, e.g. sensors and actuators, so that home users can control them in an intelligent and automatic way to improve their quality of life. Some representative technologies to implement a home network include: IEEE 802.11, Ultra Wide Band (UWB), Bluetooth and ZigBee, GSM/GPRS etc. GSM/GPRS 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. GSM/GPRS sends sms to person who is not connected to internet and also connect to person through GPRS which uploads data to website. Some typical applications include home automation, home activity detection (like fall detection) and home healthcare, etc., Kinsella and Phillips found that the population of 65-andover aged people in the developed countries will approach 20% of total population in the next 20 years and will obviously become a serious healthcare issue in the near future. In China alone, the population over the age of 60 years old is 133.9 Million. Among the elderly, the fall events can be an unpredictable and dangerous event. Statistics show that one among three 65-and-over aged person falls every year. Among these fall events, 55% occur at home and 23% occur near the home. In 2003, the global number of deaths caused by fall events was approximately 391,000 and specifically 40% of the falls were from people over 70 years of age. Thus, reliable consumer based fall detection systems need to be designed, tested and commercially deployed to countries all around the world. Furthermore, the cost of healthcare is highly related to the response and rescue time, and can be greatly reduced by fast detection and delivering signals to the specified operator for immediate consideration. Thanks to the development of wireless sensors and low-power sensor nodes, many novel approaches have been proposed to solve the problem. In this paper, an enhanced fall detection system for elderly person monitoring through a consumer home network environment is proposed that based on smart sensors which are worn on the body.

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II. HARDWARE SYSTEM

Micro controller: This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

ARM7TDMI: ARM is the abbreviation of Advanced RISC Machines, it is the name of a class of processors, and is the name of a kind technology too. The RISC instruction set, and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs.

Liquid-crystal display (LCD) is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as

preset words, digits, and 7-segment displays as in a digital clock

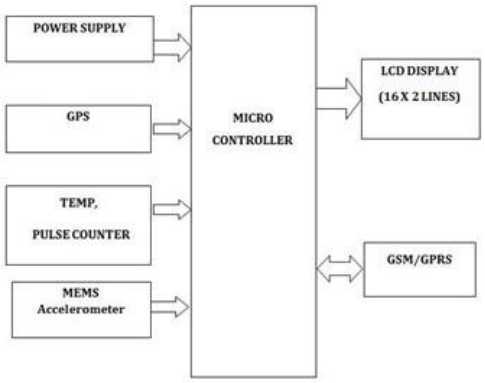


Fig.1: Sensor Section

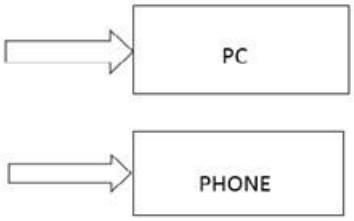


Fig.2: Data Storage Section

III. BOARD HARDWARE SYSTEM FEATURES:

Temperature Sensor (LM35):

Temperature sensors are used in many diverse applications, one of them being for the use in medical devices. The main purpose is to measure temperature change with the range that is limited within a minimum temperature of about - 25°c to a maximum of about 200°c. LM35 temperature sensor converts temperature to electricity by using substances of various physical properties with temperature variation of the sensor. The output voltage of LM35 temperature sensor has a linear relationship with the Celsius temperature. The voltage output is:

Vout_LM35=10mV/°c x T °c

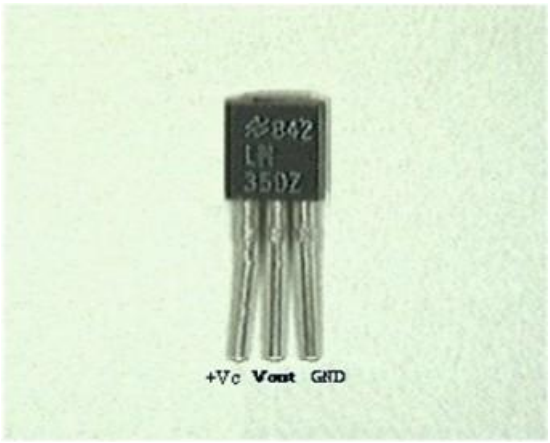


Fig.3: LM 35

The LM35 sensor used in this project came in TO-220 packaging. This sensor is sensitive to a small change in temperature, which gives accurate measurements

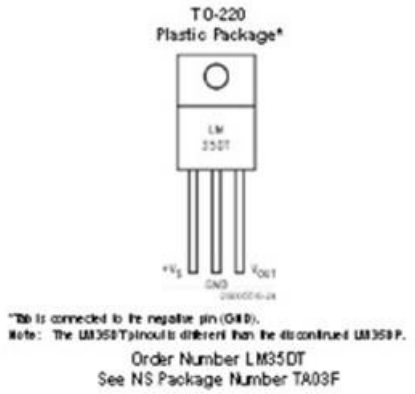


Fig.4: LM 35 Package

GSM: GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM supports voice calls and data transfer speeds of up to 9.6 Kbit/s, together with the transmission of SMS(Short Message Service). GSM operates in the 900MHz and 1.8GHz bands in Europe and the 1.9GHz and 850MHz bands in the US. The 850MHz band is also used for GSM and 3G in Australia, Canada and many South American countries. By having harmonized spectrum across most of the globe, GSM's international roaming capability allows users to access the same services when travelling abroad as at home. This gives consumers seamless and same number connectivity in more than 218 countries. Terrestrial GSM networks now cover more than 80% of the world's population. GSM satellite roaming has also extended service access to areas where terrestrial coverage is not available.

Architecture and Building Blocks: GSM is mainly built on 3 building blocks.

- GSM Radio Network – This is concerned with the signaling of the system. Hand-overs occur in the radio network. Each BTS is allocated a set of frequency channels.
- GSM Mobile switching Network – This network is concerned with the storage of data required for routing and service provision.
- GSM Operation and Maintenance – The task carried out by it include Administration and commercial operation , Security management, Network configuration, operation, performance management and maintenance tasks.

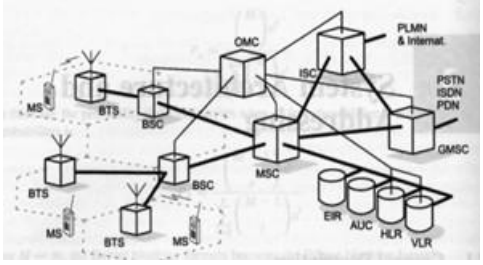


Fig.5: GSM architecture

GPS:

Global Positioning System (GPS) technology is changing the way we work and play. You can use GPS technology when you are driving, flying, fishing, sailing, hiking,

running, biking, working, or exploring. With a GPS receiver, you have an amazing amount of information at your fingertips. Here are just a few examples of how you can use GPS technology.

GPS technology requires the following three segments.

- Space segment.
- Control segment.
- User segment

Space Segment

At least 24 GPS satellites orbit the earth twice a day in a specific pattern. They travel at approximately 7,000 miles per hour about 12,000 miles above the earth's surface. These satellites are spaced so that a GPS receiver anywhere in the world can receive signals from at least four of them.

Control Segment

The control segment is responsible for constantly monitoring satellite health, signal integrity, and orbital configuration from the ground control segment includes the following sections: Master control station, Monitor stations, and Ground antennas.

User Segment

The GPS user segment consists of your GPS receiver. Your receiver collects and processes signals from the GPS satellites that are in view and then uses that information to determine and display your location, speed, time, and so forth. Your GPS receiver does not transmit any information back to the satellites.

The following points provide a summary of the technology at work:

- The control segment constantly monitors the GPS constellation and uploads information to satellites to provide maximum user accuracy
- Your GPS receiver collects information from the GPS satellites that are in view.
- Your GPS receiver accounts for errors. For more information, refer to the Sources of Errors.
- Your GPS receiver determines your current location, velocity, and time.
- Your GPS receiver can calculate other information, such as bearing, track, trip distance, and distance to destination, sunrise and sunset time so forth.
- Your GPS receiver displays the applicable information on the screen.

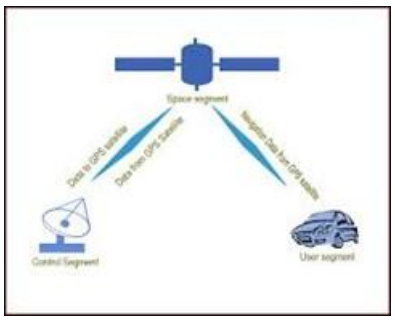


Fig.6: GPS Working

Mems accelerometer:

The ADXL330 is a small, thin, low power, complete three axis accelerometer with signal conditioned voltage outputs, all on a single monolithic IC. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1,600 Hz for X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL330 is available in a small, low-profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

THEORY OF OPERATION

The ADXL330 is a complete 3-axis acceleration measurement system on a single monolithic IC. The ADXL330 has a measurement range of ±3 g minimum. It contains a polysilicon surface micro machined sensor and signal conditioning circuitry to implement an open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The accelerometer can measure the static acceleration of gravity in tilt sensing applications as well as dynamic acceleration resulting from motion, shock, or vibration.

Features

- 3 axis sensing
- Small and low profile Package
- 4x4x1.45 mm LFCSP
- Low power 180 μA at 1.8V(typical)
- Single supply operation 1.8 to 3.6 V
- 10,000 g shock survival
- Excellent temperature stability
- BW adjustment with a single capacitor per axis
- RoHS/WEEE lead free complaint

Principle: The Free scale Accelerometer consists of a MEMS capacitive sensing g-cell and a signal conditioning ASIC contained in a single package. The sensing element is sealed hermetically at the wafer level using a bulk micro machined cap wafer. The g-cell is a mechanical structure formed from semiconductor materials (polysilicon) using masking and etching processes. The sensor can be modeled as a movable beam that moves between two mechanically fixed beams. Two gaps are formed; one being between the movable beam and the first stationary beam and the second between the movable beam and the second stationary beam. The ASIC uses switched capacitor techniques to measure the g-cell capacitors and extract the acceleration data from the difference between the two capacitors. The ASIC also signal conditions and filters (switched capacitor) the signal, providing a digital output that is proportional to acceleration.

Pulse sensor:

Blood Pressure & Pulse reading are shown on display with serial out for external projects of embedded circuit processing and display. Shows Systolic, Diastolic and Pulse Readings. Compact design fits over your wrist like a watch. Easy to use

wrist style eliminates pumping.

The number of heart beats per second can be termed as pulse rate and measured as beats per minute. For adults during resting condition, a normal pulse rate is about 60 to 100 beats per minute. Resting pulse rate is one of the physiological parameter which directly relates to the fitness and health of a person. It can be measured where the pulse is felt with fingers. Neck and wrist are the common places for pulse rate measurement. Because of this, heart rate in bpm can be easily evaluated.

Features

- Intelligent automatic compression and decompression
- Easy to operate, switching button to start measuring
- 60 store groups memory measurements
- Can read single or all measures
- 3 minutes automatic power saving device
- Intelligent device debugging, automatic power to detect
- Local tests for : wrist circumference as 135-195mm
- Large-scale digital liquid crystal display screen, Easy to Read Display
- Fully Automatic, Clinical Accuracy, High-accuracy
- Power by External +5V DC
- Serial output data for external circuit processing or display

IV. PROPOSED METHOD

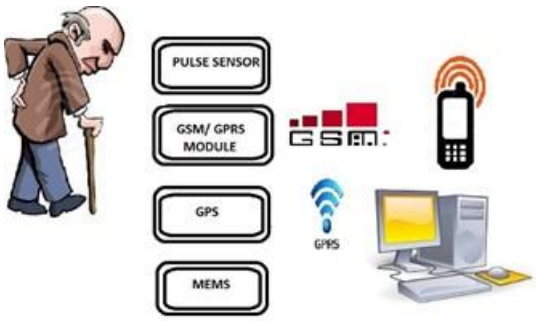


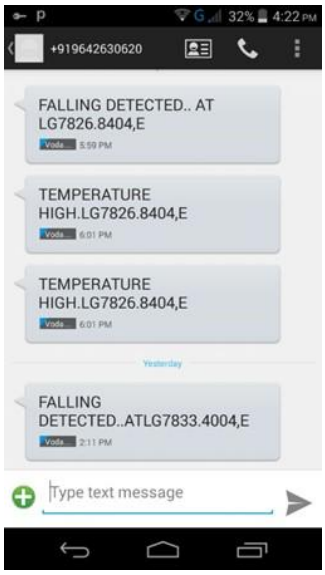
Fig.7: Proposed Arrangement

The arrangement is done by connecting as in figure. GPS provides location of the person. The person is fallen or not is determined from the values of accelerometer. The accelerometer provides the angle. The angular value tells whether a person is fallen or not. After having fall whether the person is physically or mentally fit or not can be checked by heartbeat. The heart beat values are determined by pulse sensor. This pulse sensor calculates pulse value or heart beat value in terms of beats per minute (BPM). The pulse sensor calculates the value of pulse for one minute. The temperature is calculated by temperature sensor. These values are sent to gsm/gprs module which sends the value to receiver section. The receiver section consists of gsm phone and PC. The values are sent to gsm phone through sms through gsm module. This gsm/gprs module uses gprs to upload the values to website. The values are sent through sms and uploaded to website.

V. RESULTS

Fig.8: Sensor section of the Project

The connections are made as such in figure. The noted values and fallen occurrence are sent through sms with the help of gsm/gprs module.



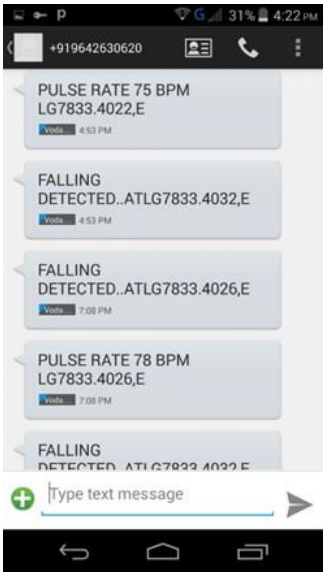


Fig.9: SMS output

The values are uploaded to website using GPRS by using the same gsm/gprs module.

Fig.10: Data stored in the PC

VI. CONCLUSION

In this paper, an advanced fall detection system based on on-body sensors was proposed, implemented, and deployed that successfully detected accidental falls in a consumer home application. By using information from an accelerometer, temperature sensor and pulse sensor, the impacts of falls can successfully be distinguished from activities of daily lives reducing the false detection of falls. Location based output is noted and sent using GSM/GPRS. The proposed system is ready to be implemented in a consumer device.

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