ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Volume 5, Special Issue 1, March 2016*

National Conference on Recent Trends in Electronics and Instrumentation Engineering (NCRTE 2K16)

1st& 2nd March 2016

Organized by

Department of Electronics &Instrumentation Engineering, Adhiyamaan College of Engineering, Hosur, Tamilnadu, India

A Portable Fall Detection and Alerting System by k-NN Algorithm Using GSM

Jayakumar.S[1], Priyadharshini.S[2], Priya Shanmugam[2], Sharmila.A.S[2]

Assistant Professor, Department of EIE, Adhiyamaan College of Engineering, Hosur, Tamil Nadu, India[1]

UG Student, Department of EIE, Adhiyamaan College of Engineering, Hosur, Tamil Nadu, India[2]

ABSTRACT:A custom vest and a mobile smart phone is enhanced in this paper to detect the fall of an elderly and alerting the nearby healthcare. A motiondetection sensors like dual-axial accelerometer, gyroscope and GSM isbuilt into a custom vest which has been worn by the elder people. The custom vest can acquire the involuntary acceleration and angular velocity on the activities of elderly in real time. The acquired data via GSM is then sent to a mobile smart phone running a program basedon k-NN algorithm. During a fall occurs the phone can alert a family or health care via a textmessage using a Global Positioning System. This system can provide remotemonitoring and timely help for the elderly.

KEYWORDS: Fall detection; k-NN; Smart phone; GSM; GPS

I.INTRODUCTION

As today's technology has improved rapidly in medical field, the quality of health care has greatly increased owing to its requirement which credits " healthcare" shift towards "hospital/home centered healthcare" [1].Telemedicine[2] system comprising of three parts : the home terminal, the network communication and the invigilating center. In real life telemedicine is not widely used, forits client server is not well developed[3], such as the device isnot small and light enoughthat the userfeels uncomfortable while using it.Wearable telemedicine technology gives an solution to solve this problem. Watches or clothes are embedded with medical sensors to achieve a non-informative and noninvasivemonitoring[4] . In today's society the aging of population, falls are one of the main health problem than the older community due to the increase in mortality, disability, and frailty [5]. As a kind of wearable medical device fall detection system, can monitor the user's daily activities, and will send feedback to the nearby monitoring center. For example if a person is sitting in high velocity the acceleration will be calculated and displayed. The sensors which is placed in the custom vest will monitor the acceleration and inclination will be noted.

Wen J Li' steam[6] introduced the air bag system to secure the hip joining during fall, which is similar to the air bag opening during the clashing of the car. This air bag will be in link with the sensors accelerometer and gyroscope and the according to the output of sensors the air bag system works. But the timing, efficiency and accuracy are less in this method Tong et al [7] enhanced accelerometer for detecting purpose.To monitor the daily activities of an elderly, a system detection and alerting have been implemented. Most of the research has been done to detect the fall. Lindeman [8] implemented a system with sensor using the tri-axial accelerometer to check the fall. Using this accelerometer has a disadvantage of showing the false positives during the fast movement of the user.

II.SYSTEM MODEL AND ASSUMPTIONS

In this model sensors like tri-axial accelerometer and gyroscopes has been used. An accelerometer is used for the measurement of acceleration and gravity induced forces. Single- and multi-axis models are also available to detect magnitude and acceleration direction. Accelerometers can be used to detect an inclination, vibration, and shock. They are increasingly present in electronic devices. Under the influence of gravity or acceleration the evidence mass changes from its void position. This deflection is measured in an analog or digital manner. Most commonly the capacitance between a beams which is fixed and a set of beams attached to the evidence mass is measured. This method is easy and authentic; it also does not entail additional process steps making it inexpensive.

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To detect the spring deformation piezo resistors are used and thus deflection, is a good alternative, even though some process is needed. For very high sensitivities quantum tunnelling is also used; it is more expensive because of fabrication steps. Optical measurement has been demonstrated on laboratory scale.Micromachined inertial sensors, inhering of accelerometer and gyroscope, are one of the most necessary types of silicon- based sensors. Microaccelerometers are having the second largest sales volume after pressure sensors. It is suspected that gyroscopes will be mass-produced at similar volumes. Applications for gyroscopes are very wide. Some instances for these applications are; automotive; vehicle control for stability, rollover perception, navigation, load levelling/suspension control, event recording, collision avoidance; consumers, computer input devices, handheld devices, controllers of game, reality in virtual gear, sports equipment, camcorders, robots; industrial., navigation of automatic vehicles, motion control of hydraulic equipment or robots, platform stabilization of machines with heavy weight, transporters, control of yaw rate wind-power plants; aerospace/military; platform stabilization of avionics, pointing systems stabilization for antennas, unmanned air vehicles, or land vehicles, inertial measurement units for navigation of inertia. This paper presents a review of silicon MEMS gyroscopes (rate sensors), status of their production and towards fabricationchallenges of the next generation of lowcost gyroscope and the system to calculate the errors in detecting the position of the user. According to [9] both accelerometer and gyroscope should be used for the fall detection.

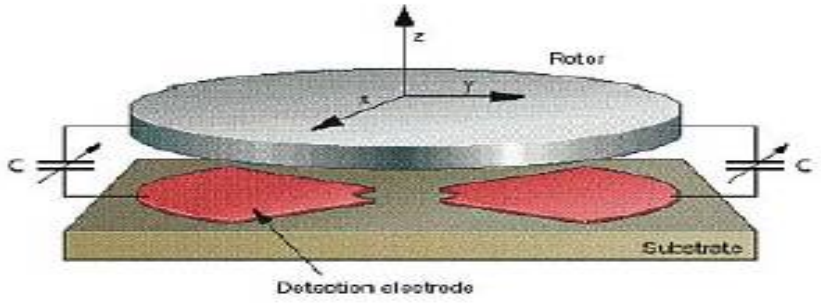

Fig. 1 Gyroscope

In the Fig 1, it shows the three dimensional axis monitoring of the gyroscope.

III. COMMUNICATION TECHNOLOGY

K-Nearest Neighbor algorithm is used in this model as it is an effective classification model. It is one of the lazy learning algorithm. Here k is an user defined constant where the speed and orientation value will be set to it as the constant value. Every new value of K will be compared with the target value and the new value will be displayed in the led and send as the text message to the smart phone. According to Erdogan S.Z, Bilgin.T.T[10] k value is user defined which can be assumed by the daily living activities of the user.

The Global System for Mobile communication(GSM) uses Time Division Multiple Access (TDMA) SYSTEM for transmitting signals. The GSM was developed using digital authorized technology. It has a facilty to carry 64 kbps to 120 Mbps of data rates. The GSM provides basic to advanced speech and data services including Roaming. Roaming is the ability to use your GSM phone number in another GSM network. Here GSM technology is used in this paper to send the text message to the health care and family members. A GSM digitizes and pinches data, then transmit it down through a channel with two other streams of user data, each in its own time slot. Global Positioning System(GPS) is a system that provides position and time information in all critical condition, anywhere around the earth where there is an unhampered line of sight to four or more GPS satellites .GPS is enhanced in this system to locate the place of the elderly to health care for timely prevention[11].

IV.SYSTEM AND SOFTWARE DESIGN PROCESS

In this fig.2 system GSM module is implemented as it is used to send the text message. For this purpose an application is created using JAVA to transmit and receive the messages. The PIC16F87X devices have a 13-bit program counter

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capable of addressing an 8K x 14 memory space. The PIC16F877/876 devices have 8K x 14 words of FLASH program memory and the PIC16F873/874 devices have 4K x 14. Access to a location above the physically implemented address will cause a wraparound. The reset vector is at 0000h and the interrupt or break vector is at 0004h. PIC16F77A is enhanced in this system because it has debug features. It is one of the most important types of silicon- based sensors which is interfaced ADC in a PIC microcontroller.The converted digital data is then processed by the microcontroller. Embedded C is used to program on the chip in microprocessor that will decodes an information regarding the fall after the detection and send the text to the health care using the GSM module. In this process the first step includes the fall detection using accelerometer and gyroscope [12]. Then the data is decoded using the ADC and an information is send to smart phone via GSM. For each time when the value is monitored it is compared with the target value using K-NN algorithm. When the target value differ from the user defined constant then value will be send to the smart phone through GSM. A smart phone with an application will transmit the text message to the family members and health care where an application is already installed. Hence the timely prevention can be given to person who is affected.

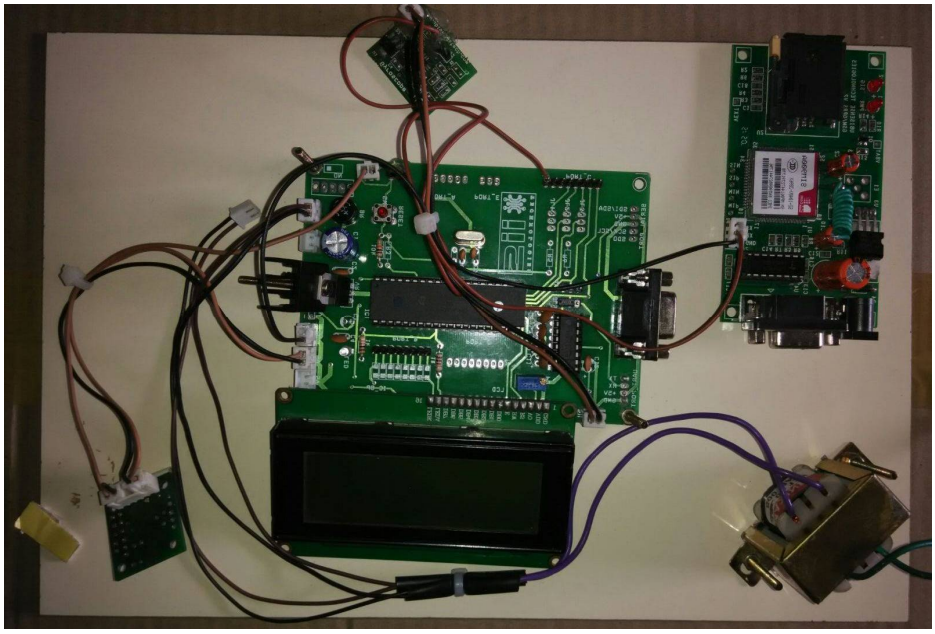

Fig.2 Sensor board, Sensor board with GSM module, gyroscope and accelerometer

V. RESULT AND DISCUSSION

In this experiment a fall is detected using the sensors like accelerometer and gyroscope. An accelerometer is a device for calculating speed and gravity induced. Single and multi-axis models are available to detect magnitude and speed of the acceleration whichis a vector quantity. Operating Principles and Specifications Almost all reported micro machined gyroscopes use oscillating mechanical parts (proof-mass) to sense rotation. They have no rotating parts that require bearings, which can be miniaturized easily and batch fabricated using micromachining techniques. All oscillatory gyroscopes are based on the energy transfer between two vibration modes of a structure caused by Coriolis acceleration which is an apparent acceleration that occurs in a rotating reference frame and is proportional to the rate of rotation.

The following processes are the results of an experiment:
1. Detection of fall.
2. Receives an information via GSM to the smart phone
3. Transmit the text message after the fall of the user to the health care and family members.
4. Locate the position of the user using Global Positioning System.
5. Timely prevention and remote medicine.

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VI. CONCLUSION

According to the result and analysis in this paper, it is been concluded that fall detection and alerting process has been implemented through the GSM technology. Hence this system provides a timely prevention of an elderly and alerting the health care.

Limitations in this system are:

1. GSM will take some time to deliver the message due to an insufficient network coverage which can be overcome by shifting an user to a network coverage area.
2. K-NN algorithm can be improved which can be replaced by ANN algorithm.

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