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Fall Detection System Using Tri-Accelerometer for Wireless Body Area Network

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Abstract: *In this paper, we observe the physical condition of elderly people or patients in personal environments such as home, office, and restroom. The elderly peoples mostly have limited physical abilities and are affected with serious physical damages even with small injuries like fall. The falls are not predictable also not avoidable. In case of a fall, its early detection with notification to emergency services is essential for quick recovery. The existing fall detection devices are more bulky and uncomfortable to wear. In this paper, a new fall detection system is used which includes tri-axial accelerometer sensors to classify the behavior and posture of the detection subject. Body motion can be classified into different patterns, i.e. vertical position, lying position, sitting position, horizontal position and fall. If a fall is suspected, an automatic message can be sent (GSM) with fall location (GPS). The major advantage of the proposed system is the use of mobile phone which is readily available to most people[1][2].*

Keywords: *MEMS, GPS, GSM, ARM*

I. Introduction

Falls are the major issues of accidental or unintentional injury deaths. An unintentional falls are a common occurrence among older adults, In case of older people the risk of death or serious injury arises due to fall and this risk increases with age. As a result, many complications are faced by older people such as fracture, physical harm, and functional disorder. Measures can be taken to reduce the number of falls by adopting certain safety procedures within the living environment. However, risk of fall can neither be predictable nor removable. If the fall occurs, the most important process is taking emergency measures. Therefore, there is a need for constant monitoring of fall and taking the emergency action as soon as it is detected. Fall detection systems can be classified into computer vision and worn devices according to methods. In the method of computer vision, the one can be monitored by using cameras in home or other places. When the subject are inactive for a long time, he or she may be fall condition. To monitor such objects some techniques are used like camera. But there are some restrictions for cameras in outdoor environments. The solution for this is worn devices like accelerometer. Fall detection using a mobile phone is a feasible and highly attractive technology to monitor elder adults, especially those living alone. A newly developed sensor technology called the MEMS Accelerometer is used in this project to detect an fall. Accelerometer is a device which can detect a tilt or a sudden jerk in any of the 3 axis(x,y,z). It can be used to detect any unusual acceleration and tilting of body which indicates that the body is out of control and could have suffered an fall. The accelerometers output can be analyzed by the microcontroller to find if it has crossed the threshold. GPS system is deployed to locate the place of the fall and GSM technology is used to send messages to emergency services and family. If the medical services get an alert through GSM message about an fall and its location through GPS coordinates they can reach there immediately. If the person who has suffered the fall receives medical help in time he can survive the accident and many important lives can be saved. The system is easy to build and compact in size so that it can be easily installed.

II. Liturature Survey

A. Classification Of The Approaches And Principles Of Existing Fall Detection Methods

Author Yu focused on a classification of the approaches and principles of existing fall detection methods. He also provided a classification of falls and a general framework of fall detection, alert device and system schema[1].

B. Sequence Of Falling

The authors of noury et al. Described the in-depth sequence of falling. They stated that it was difficult to compare academic studies because the conditions of assessment are not always reported. This led to the evaluation of not only the above described parameters and scenarios, but also of other objective criteria such as detection method, usability and lifespan of a device[3].

C. Algorithms And Sensors Used In The Detection Of A Fall In Elderly People.

Author Noury et al. describes the systems, algorithms and sensors used in the detection of a fall in elderly people. After an overview of the state-of the-art techniques, they discovered the lack of a common framework and hence proposed some performance evaluation parameters in order to compare the different systems. These parameters had to be evaluated for a set of falling scenarios that included real falls and actions related to falls[3].

D. Using Accelerometers-Based Parameters

Author Kangas et al.used accelerometers-based parameters to determine thresholds for fall detection. The posture information was used to distinguish between falls and activities of daily living. Their experiments showed the most suitable placement for the sensor to be waist and the head, whereas placing the sensor on the wrist gave rise to additional problems[4].

III. Existing System

Fall detection system comprises of a sensing device and an algorithm which detects the fall based on observed sensor readings. The sensing devices can be categorized as ones attached to body such as accelerometer and gyroscope and the others not attached to the body such as cameras and infrared devices[5][6]. In the former case, the wearable wireless sensors are attached to the body and they transmit body movement data to sink node. Since these devices are attached on the body, people can be uncomfortable for the person depending upon their size and position on the body. In the latter case, video camera and infrared based solutions detect the fall by using motion information obtained from a distance. Since devices are installed on fixed locations within the room, they do not interfere with the normal movement of the person[5]. However, the disadvantage is that fall detection can only be done within the scope of installed device, e.g. in a specific room. Therefore, it is of fundamental importance to provide quick support to the injured people as soon as a fall happened. The simplest solution to the fall detection problem consists of providing people with a Personal Emergency Response System (PERS), a small, light-weight and battery-powered device with a "help" button that can be carried on a belt, in a pocket, on a necklace or on a wrist band[6][7]. This kind of device also embeds a radio transmitter which is able to connect to the user's home telephone and to dial preselected numbers in case of emergency. Many of these systems have been successfully deployed in several countries and require almost no configuration . However, they sure from a major issue: the need for the user to press a button. Unfortunately, it is common that after a fall a person is unable to perform even this simple action[9]. Thus, in the last few years, research about systems for the automatic detection of falls gained momentum, pushed by the growing number of elderly citizens in a large fraction of the world. The techniques for the automatic detection of falls can be substantially divided into two categories. The first category includes the approaches based on instrumenting the environment; examples include equipping rooms with cameras able to track the movements of people or placing pressure sensors in specific areas (e.g., in the vicinity of beds). The second category includes techniques based on wearable sensors: accelerometers and/or gyroscopes are used to collect kinematic information about the monitored person and then to detect falls. The advantage of using wearable sensors is that almost no installation or set-up is required and the system is immediately available for deployment. In this paper, we describe the design rationale and the implementation of a fall detection system based on sensors. The system relies on commercially available smart phones and is capable of automatically sending an alarm message with location. The acquisition of kinematic data can be carried out either using the accelerometer[9][10].

A. Drawbacks of Existing System

- High Movement Cost
- High Network Traffic
- Algorithm Overhead
- Load Imbalance & uncomfortable
- Security difficulties

IV. Proposed System

A new Fall detection syste includes tri-accelerometer and a microcontroller to process the sensor inputs. The acceleration of the aged people will be monitored by the accelerometer . Based on the accelerometer inputs the microcontroller decides whether the aged people is in normal position or fell down. The fall detection is identified by an algorithm called Fall detection algorithm. The proposed system identifies the elder people condition by the fall detection algorithm. If the angle and acceleration are larger than the threshold or a sudden change in the angle and acceleration within the threshold time, then it is defined as fall. The sensors used in the

proposed fall detection system are 3-axial accelerometer. Data output is analogue value and can be measured.

A. Block Diagrams:

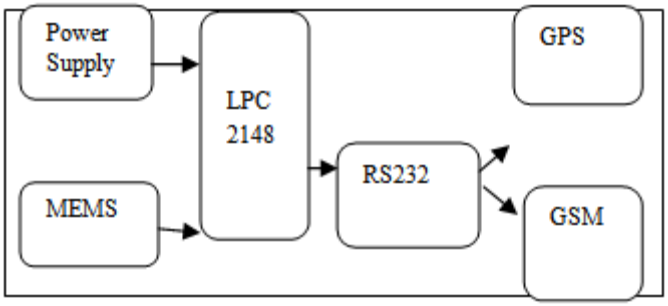

Fig.1 Block diagram

1] The first part of this system consist of a fall-detecting circuit for extracting and processing signals obtained from the tri-axial accelerometer. Here an accelerometer will be used for detection the fall in a x, y and z axis. Here this sensor will send the analog signal to the microcontroller for its logical manipulation for detecting the status of the body & update the display information. The device consist of emergency help button to display the fall alert and emergency signal.
2] The second part of the system consists of a GSM modem and a GPS system is used with the microcontroller for sending the message to the respective places along with the location of user.
3] In the fall detection technique the extracted acceleration values by the tri-axial accelerometer will be input to microcontroller to compute its signal vector magnitude .The all axes i.e. x, y, z will produce a different acceleration value, based on these users movement signals will be evaluate. Human movements are classified into normal movements and abnormal movements. Using acceleration signals, normal movements will be continuous, while abnormal movements shall be recognized as fall signals. Fall often happens unexpectedly and is difficult to predict. When falling, the user's body can hardly hold on to its usual place and the user himself cannot help but stumble onto the ground. According to directional difference, falls can be further classified into forward fall, backward fall, rightward fall and leftward fall.

Whenever the accelerometer is tilted on any of its axis or accelerated in any direction it produces voltage outputs in accordance with it. Analog accelerometer provides voltage output and digital accelerometer provides direct binary outputs. Accelerometer basically detects the acceleration forces and thus can detect any changes in velocity, orientations etc. The output of accelerometer can be provided to ADC which will sample the value and will convert it into digital data by comparing it to its predefined voltage levels. After that it will be provided to control unit built around a microcontroller. We have to set a threshold level for Accelerometer's output to determine whether the tilt or acceleration change of vehicle is enough and exceeding the safe value to cause an accident or not. If the control unit senses an accident situation it collects the information about that location from the GPS unit. GPS is serially interfaced with the microcontroller control unit through serial port. It serially sends data to controller about the latitude and longitude coordinates of that position. Using GSM service the control unit sends a message to the hospital's medical services and family of the person about the accident and also send the location information collected from the GPS. The GSM modem can be easily interfaced with microcontroller through serial port. We can use the message service to automatically send a message in the predefined format. Then the medical services can quickly rush to that spot and attend the injured.

A. Algorithm

1) Initialize the controller and its peripherals
2) Calibrate the MEMS value.
3) Within a forever loop
4) Read ADC of X ,Y,Z
5) Calculate the accelerometer displacement in X ,Y,Z axis
6) Set threshold to remove drift i.e. value is drifted only if it is above 10 and below 255.
7) As threshold crossed fetch values of latitude and longitude from UART0 and send it to UART1 so that message will be sent to user

B. Flowchart

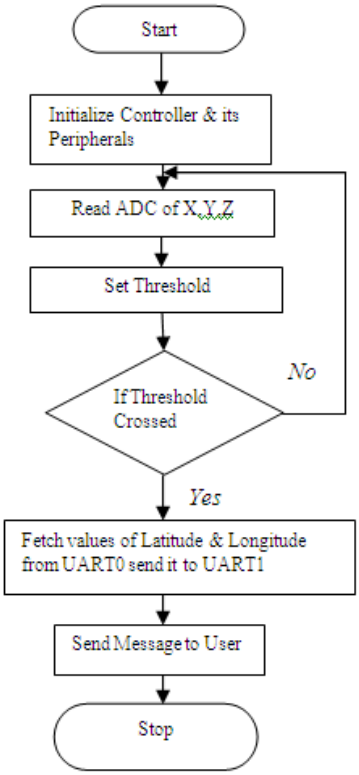

Fig.2 Flow chart

C. Advantages of Proposed System

- Reduce Network Traffic or Movement Cost
- Improve overall System Performance
- Utilizes Physical Network Locality
- Better throughput and response time
- System consistency (i.e., avoid data loss)
- Excellent security

V. Conclusion

There are various fall detection systems which perform well for the detection, the proposed system will be a portable device for user, having sensors consisting of accelerometer sensor and a simple algorithm using posture classification fall detection. The propose fall detection system can be regarded as alternative device to the existing detection approaches, is less complex as compared to other devices, fast fall response and will be more accurate and economical. GPS tracking system has been developed accidental place monitoring. The system can detect type of fall from accelerometer signal using threshold algorithm. After fall is detected, short massage data (a massage and position of accident) will be sent via GSM network. The test results show that it can detect linear fall, non-linear fall and normal ride with no false alarm.

VI. Future Scope & Application

- Medical field
- Emergency Patient monitoring in hospital , home etc
- Military
- Homecare unit
- Sports training

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