An Automated Fall Detection System Using Accelerometer

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Abstract— The objective of this work is to provide brief review on the technologies proposed to predict the collision between vehicles, before the collision happens itself and smart activation of safety systems like air bag deployment, seat belt tightening. This paper also cover the review on the accident notification schemes proposed once the accident is predicted. At the later part of this paper, an ideal model for the accident prediction and notification system schematic is given. A prototype of fall detection system using accelerometer and piezoelectric sensors is presented in this paper. Accelerometer and piezoelectric sensors are embedded in this system to get the result of fall detection more accurately. This research also can distinguish condition of people between falls and activity daily living.In the current system we have sensor to identify vehicle is met with an accident or not.

Index Terms— Accelerometer, ADXL335, Automated, Detecting System, Fall, GSM, Piezoelectric Sensors.

1 Introduction

The growth of automotive vehicles has been increasing gradually day to day, which in turn lead to the increased growth of road accidents. In the current situation because of human errors and judgment thousands of lives are lost and this world is plagued by accidents. When the proper mechanism of alerting drivers are done this accidents can be avoided to certain extent. A person when travelling on vehicle has to take lot of security measures. In spite of taking security measures there are many situations where accidents occur. When accident occurs we generally opt for emergency services. In the present scenario when a person has met with an accident then the people in the surrounding areas will call for the emergency services if not the person is left all alone in that drastic situation. If proper measures are taken before only then we can avoid such type of situations. Proper Monitoring techniques are to be implemented to reduce accidents. . An efficient and accurate automatic fall detection system would be significant and necessary in an intelligent surveillance system and could improve their ability of independent living [1]

2 Fall Detection

For these fall detection applications, extremely precise gyroscopes measure and maintain orientation, while accelerometers measure all acceleration, or the rate of change of the velocity of the object relative to any inertial frame of reference, unless based on gravity. Common fall detection systems are based on a sensor detecting a strong vertical acceleration, launching an alarm when a fall event is recognized. [5]

In the case of fall detection, the sensor measures weight per unit of mass, or specific or "g" force. Both single axis and multi-axis accelerometers detect magnitude and direction of acceleration and can sense orientation. Not only can multi-axis accelerometers be used, but multiple units or pairs can detect the proper acceleration of a frame of references.

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By placing tri-axial accelerometers at precise body locations, systems easily recognize these patterns and the motions or transitions can be measured using both linear acceleration and angular velocity. Should someone fall who is being monitored, the goal would be to ascertain with certainty that it was really a fall, and provide assistance as soon as possible. Real-time detection of falls and their urgent communication to a telecare center may enable the rapid medical assistance that is needed. This article will examine all of the key design elements of a human fall detection system.

3 DESIGNING STRATEGY

Fall detection systems typically use one or more of the following methods:

- Analyzing acceleration to detect falls using a four-axis accelerometer or tri-axial accelerometer, typically using measurements from the waist or hip. The downside is that false positives occur when a person either jumps or sits down quickly.
- Using acceleration and body orientation data to detect falls. Three sensors, a gyro sensor that monitors body orientation, a piezoelectric accelerometer that monitors vertical acceleration shock and a vibration sensor monitor body movement. Accuracy is improved, but posture information is lacking, as only the trunk orientation is used.
- Finally, there is a help-button based medical alert, which works well when the person is conscious and able to touch the button – which is not always the case.

All of the forementioned methods have strong and weak points, but the most typical complaint is that, since by its very nature fall-detection technology must error on the side of caution, they are overly sensitive and can misinterpret normal

activities of daily living as a fall The process to detect a fall situation followed by sending notification to colleagues can be done in real-time manners while still maintain high accuracy for certain fall situations.[6]

4 DESCRIPTION OF HARDWARE

4.1 Accelerometer

An accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations. An accelerometer measures proper acceleration, which is the acceleration it experiences relative to freefall and is the acceleration felt by people and objects. Accelerometers are generally low-power devices. F=ma, this equation is the theory behind accelerometers: they measure acceleration not by calculating how speed changes over time but by measuring force.

TRI-AXIS ACCELEROMETER WITH REGULATOR-ADXL335

This Accelerometer module is based on the popular ADXL335 three-axis analog accelerometer IC, which reads off the X, Y and Z acceleration as analog voltages. By measuring the amount of acceleration due to gravity, an accelerometer can figure out the angle it is tilted at with respect to the earth. By sensing the amount of dynamic acceleration, the accelerometer can find out how fast and in what direction the device is moving. The accelerometer is very easy interface to an Arduino Micro-controller using 3 analog input pins, and can be used with most other micro controllers, such as the PIC or AVR. Accelerometers with an analog interface show accelerations through varying voltage levels. These values generally fluctuate between ground and the supply voltage level. An ADC on a microcontroller can then be used to read this value. These are generally less expensive than digital accelerometers.

ADXL335 is 3 axis accelerometer with on board voltage regulator IC and signal conditioned Analog voltage output. .For detecting a fall using accelerometers, currently there are two categories of detection methods: analytical methods and machine learning methods [2].The module is made up of ADXL335 from Analog Devices. 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. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axis, and a range of 0.5 Hz to 550 Hz for the Z axis. Accelerometers are generally low-power devices.The required current typically falls in the micro (μ) or milli-amp range.The ADXL335 is a triple axis accelerometer with extremely low noise and power consumption – only 320 μ A.

4.1.1 Theory of Operation

The ADXL335 is a complete 3-axis acceleration measurement system. The ADXL335 has a measurement range of ±3 g minimum. 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. Acceleration deflects the moving mass and unbalanced the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. When using accelerometer, which is composed of measure of acceleration of the body or parts of the body, it is one of the most extensively-used methods implemented for measuring physical activities to monitor activity patterns [4]

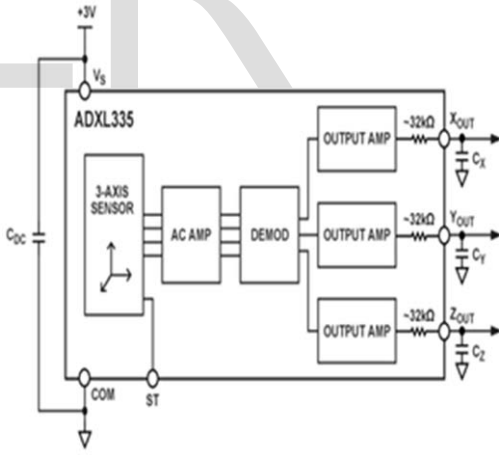

Fig. 1. Structure of ADXL335

4.2 Piezoelectric Sensors

A piezoelectric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge.

4.2.1 Sensor Design

Based on piezoelectric technology various physical quantities can be measured; the most common are pressure and acceleration. When the accelerometer experiences a motion, the invari-

ant seismic mass loads the elements according to Newton's second law of motion {display style F=ma}.The main difference in working principle between these two cases is the way they apply forces to the sensing elements. In a pressure sensor, a thin membrane transfers the force to the elements, while in accelerometers an attached seismic mass applies the forces.

Sensors often tend to be sensitive to more than one physical quantity. Pressure sensors show false signal when they are exposed to vibrations. Sophisticated pressure sensors therefore use acceleration compensation elements in addition to the pressure sensing elements. By carefully matching those elements, the acceleration signal (released from the compensation element) is subtracted from the combined signal of pressure and acceleration to derive the true pressure information. Vibration sensors can also harvest otherwise wasted energy from mechanical vibrations. This is accomplished by using piezoelectric materials to convert mechanical strain into usable electrical energy

4.3 GSM Module

Global System for Mobile Communications, is a standard developed by the European Telecommunications Standards Institute (ETSI).It was created to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones and is now the default global standard for mobile communications – with over 90% market share, operating in over 219 countries and territories. Intimation about that trouble is possible by sending SMS (Short message service) in GSM (Global system for Mobile communication) based and GPS (Global Positioning System) based mobiles even if the mobile is not receiving network signal with the help of location based services[7]

Fig. 2. GSM Module

4.4 Specfications

- Low power consumption
- Operating temperature range: -40 ° C ~ + 85 ° C
- Supply voltage range: 9V to 12V
- Switching Regulator Based Power Supply
- Operating temperature: -40C to +85C
- One SIM card interface.
- Audio channels which include a microphone input and a receiver output

5 CIRCUIT DIAGRAM

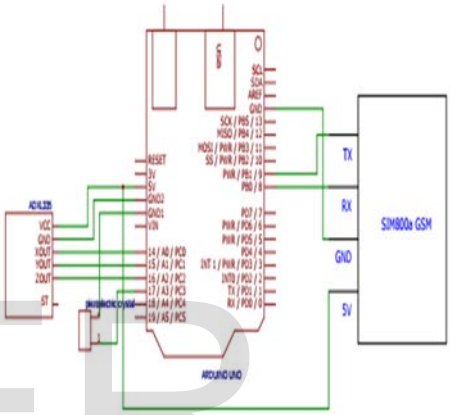

Fig. 3. The circuit diagram for fall detection system

4 Future work and Conclusion

In this project, a fall detection system prototype for accelerometer was proposed. Real time detection and notification of the of the fall have vital importance. The present study demonstrated that fall could be detected using this module. The proposed model is an inexpensive, highly reliable model for accident prediction and alert system. Extensive research work has been carried in the field of object based system ranging from GSM based location determination GPS based location determination.[3]

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