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Design and Implementation of GSM and GPS Based Vehicle Accident Detection System

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***Abstract* — In this Project, wireless black box using MEMS accelerometer and GPS tracking system is developed for accidental monitoring. The method consists of cooperative components of an accelerometer, GPS device, microcontroller unit and GSM module. In the occurrence of accident, this wireless device will send mobile phone short massage indicating the position of vehicle by GPS system to family member, emergency medical service (EMS) and nearest hospital. The threshold algorithm and the speed of motorcycle are used to determine fall or accident in real-time. The method is compact and easy to install under rider place. An accelerometer can be used in a car alarm application. Dangerous driving can be noticed with an accelerometer. It can be used as crash recorder of the vehicle movements before, during and after a crash. Among signals from an accelerometer, a severe accident can be recognized. In second application on an uncertain situation many of vehicle that has center locking system, Such as door looking system face many problem due to automatic looking system. At that situation there is no way to open the lock. Our project will present a suitable solution for this situation. This can be completed by using wireless or GSM Technology.**

***Index Terms* — EMS, MEMS, GPS, GSM.**

I. Introduction

The motorcycle accident is a major public problem in many countries, particularly Thailand. Even with awareness campaign, this problem is still rising due to rider's poor Behaviors such as speed driving, drunk driving and riding with no helmet protection, riding lacking sufficient sleep, etc. Then the number of death and disability are very high because of late assistance to people who got the accident. These reason huge social and economic burdens to people involved. Therefore, numerous research group and major motorcycle manufacturers including Honda have developed safety devices to protect riders from accidental injuries. However, good protection device for motorcycle is difficult to implement and very expensive. Alternatively, cleverness schemes such as fall or incident detection with tracking system have also recently been devised to notify the accident to related people so that quickest assistance can reach people who got the accident .Presently, tracking system is only installed in some high end motorcycles because these systems are still too expensive for most motorcycle's riders Thus, fall

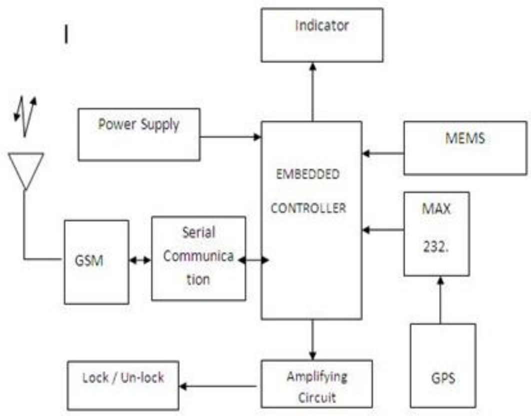

Figure1. Block Diagram Of The project.

Detection and accident alarm system for motorcycle has recently gained attention because these systems are expected to save life by helping riders to get medical treatment on time. In this employment, wireless black box using MEMS accelerometer and GPS tracking system is developed for accidental monitoring. In the occasion of accident, this wireless device will send mobile phone short massage indicating the position of vehicle by GPS system to family affiliate, emergency medical service(EMS) and nearest hospital so that they can provide ambulance and prepare treatment for the patients. The method consists of cooperative components of an accelerometer, microcontroller unit (MCU), GPS device and GSM module for sending a short massage. An accelerometer is useful for awareness and fall detection indicating an accident. Mobile short message containing position from GPS (latitude, longitude) will be sent when motorcycle accident is detected. In this work, wireless black box using MEMS accelerometer and GPS tracking system is developed for accidental monitoring. In the incident of accident, this wireless device will send mobile phone short massage indicating the position of vehicle by GPS system to family affiliate, emergency medical service(EMS) and nearest hospital so that they can provide ambulance and prepare treatment for the patients.

II. Related Work

A. System Overview

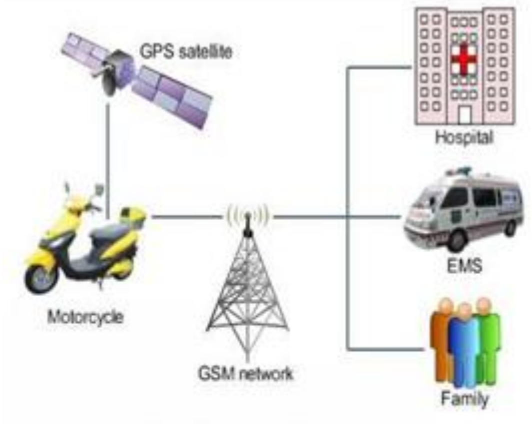

Figure 2.System Architecture

The system consists of cooperative components of an accelerometer, micro controller unit (MCV), GPS device and GSM module for sending a short friction. An accelerometer is applied for awareness and fall detection indicating an accident. Then the speed of motorcycle and threshold algorithm are used to decide a fall or accident in real-time. Mobile flottant massage containing position from GPS (latitude, longitude) will be sent when motorcycle accident is detected. The robust package stylisme is implemented so that it is safe from water's spray and dust in environment. The principle is aimed to be installed under the motorcycle seat. A high performance 16 bits MCV is used to process and store real-time signal from the accelerometer. This device is analogous to a black box in airplane. The police and insurance considerer can obtain accident history to investigate accident situation from data-logger in this device. Then the device keeps data log of track and acceleration data for1 minute before and after an accident. Whenever, this device can be used to track motorcycle after it was stolen but it can't operate in real-time in this case. In this cellule, user can send request command with alphabet "!" to device and the device will return the position with some basic information.

III. Methodology Of Detection

Our signal processing goal is to classify the original data into two classes, fall and not fall. In this scheme, the input data from 3-axis accelerometer was kept and processed in real-time with sampling rate of 60 Hz or higher. Then the signal from MEMs accelerometer was converted by 10 bits ADC into integer range between 0 and 1023. Then the sensor was embedded in a motorcycle seat to fix the accelerometers axis so that the response of acceleration data is well defined. The classification of the fall identification utilized the 3-axis acceleration signal from MEMs accelerometer and the ground speed from GPS module. In normal, motorcycle fall can be classified as linear fall and non- linear fall. Then the linear fall is concerned about fall without external force, which is free falling method that only z-axis acceleration changes. The non-linear fall applies by the external force. The non-linear fall identification is decided by all 3-axis acceleration data from accelerometer and the ground speed from GPS module. To illustrate the accelerometer output, then two frames of acceleration data, which includes 3-axis acceleration at present time (t) and prior time (t-1), are used for analysis. For a linear fall, the z-axis acceleration is follows free falling condition which is given by

$$|A_z| \geq 9.7 \quad m/s^2$$

where the Az is the z-axis acceleration. In a non-linear fall, two frames of acceleration data are used. From non-linear fall experiments under most likely situations, we identify that the change of acceleration between two consecutive frames should be more than 15.5 m/s^2. Thus, the non-linear fall condition is given by

$$|A_{n,t} - A_{n,t-1}| \geq 15.5 \quad m/s^2$$

Where the $A_{n,t}$ is acceleration from x, y or z coordinate at the current time frame and $A_{n\ t-1}$ is acceleration parameter from x, y or z coordinate in the past time frame. From instance, the difference of acceleration in two time frames is more than 15. 5 m/s2, the initial condition of non- linear fall accident of motorcycle is met. Then the ground speed from GPS module then used to decide whether actual non-linear fall accident occurs. If the ground speed becomes zero after detection of large acceleration change as indicated in equation non-linear fall detection in motorcycle is detected and fall alert message will be sent. Whenever, false detection may occur in case of a severe brake because data are not kept and processed over a long time frame.

Normaly, there is noise in z-axis while motorcycle rides over knotty 848 surfaces. The noise is filtered by averaging acceleration data all of three axes over five time frames. Then the fall detection and alarm system for motorcycle accident operates according to the flowchart as shown in Fig. 3. Next system start, microcontroller periodically gets 3-axis acceleration data from the accelerometer. If acceleration in z-axis satisfies the free falling condition in equation a linear fall is identified. If the system identifies linear fall, the position of accidental place will be saved and sent via SMS. If the situation of linear fall is not met, then the system will check for non- linear fall from 3-axis acceleration data. If the data from each axis is in line with equation (2), speed from GPS module and posture of motorcycle will be monitored. If motorcycle is still running (ground speed is more than zero) after 10 seconds or posture are not lying down on the ground, no motorcycle surprise is assumed. On other hand, nonlinear fall is detected and position data from GPS module will be sent via SMS. Though no fall condition is met, then the system will always return to starting point of the program. The numbers of death and disability are very high because of late assistance to people who got the accident. Then these cause huge social and economic burdens to people involved. Finally, several research group and major motorcycle manufacturers including Honda have developed safety devices to protect riders from accidental injuries. Through, good safety device for motorcycle is difficult to implement and very expensive.

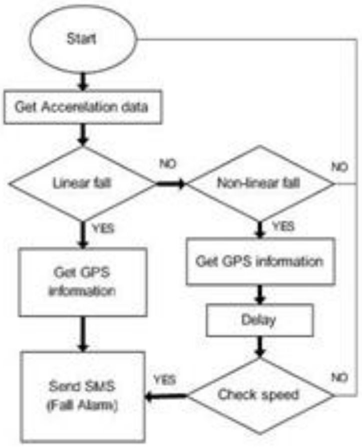

Figure 3.Flow chart for motor cycle fall & accidental alarm system

Figure4.(a) Robust case (b) device embedded under motor cycle seat

III. Robust System Design

The system for motorcycle fall detection using a tri axial accelerometer is shown in Fig.4a. The scheme was packed in robust aluminum case and embedded under motorcycle seat as illustrated in Fig.4b. The basic concept of the proposed system is to detect motorcycle accident from motorcycle fall or from collision with another car or motorcycle. The motorcycle fall detection system is based on a tri-axial accelerometer. Then the accelerometer provides analog acceleration output in three axes (x, y and z). Then acceleration sensor was positioned so that its z axis was aligned vertically and the coordinate was fixed when installed under motorcycle seat. A high gets 16 bits MCV was chosen as a control unit. The MCV performed real-time motorcycle fall detection using AID signal converted from accelerometer output at 60 Hz sampling rate. V-blox (LEA-5S) was GPS module that provided the location of accident. The MCV received data from GPS module operated at refresh rate of 1 Hz with VART interface and the GPS module communicated with 20 satellites to obtain geographic information. Then the data was decoded from GPRMC package using NMEA protocol, GPRMC or minimum recommended data consisted of basic GPS parameters including latitude (north or south), longitude (east or west), ground speed, present date and time, course over ground and magnetic variation. GSM module (GM862) was used to send short message to hospital or family member to help patients in case of accident. Then the GSM module is quad band 800, 900, 1800 and 1900 MHz and also it was controlled by AT-command from microcontroller. The normal AT-command was used to send instant massage, to check signal strength and get system commands and basic GSM parameters. The fluctuant massage shows position of motorcycle, time of surprise and type of accident (fall by themselves of crashed by other person). The entire system was packed in aluminum box with Li-ion backup battery. Then the power from backup battery was periodically charged from motorcycle battery. In case of surprise, backup battery may operate alone and its backup power is enough for signal processing and short message service.

A. Advantages

Replacing the man power
Continuous monitoring system
Cost effective

B. Disadvantages

Short Distance Communication Only

C. Applications

Industrial applications
Military applications
Mine detection applications

VI. Conclusions

In conclusion, an innovative wireless black box using MEMS accelerometer and GPS tracking system has been developed for motorcycle accidental monitoring. The system can identify type of accident (linear and nonlinear fall) from accelerometer signal using threshold algorithm, posture after deafening of motorcycle and GPS ground speed. After accident is detected, short alarm massage data (alarm massage and position of accident) will be sent via GSM network. The scheme has been tested in real world applications using bicycles. The test results illustrate that it can identify linear fall, non-linear fall and normal ride with no false alarm.

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