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Intelligent Accident Detection and Alert System for Emergency Medical Assistance

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Abstract—Road accidents rates are very high nowadays, especially two wheelers. Timely medical aid can help in saving lives. This system aims to alert the nearby medical center about the accident to provide immediate medical aid. The attached accelerometer in the vehicle senses the tilt of the vehicle and the heartbeat sensor on the user's body senses the abnormality of the heartbeat to understand the seriousness of the accident. Thus the systems will make the decision and sends the information to the smartphone, connected to the accelerometer and heartbeat sensor, through Bluetooth. The Android application in the mobile phone will sent text message to the nearest medical center and friends. Application also shares the exact location of the accident that can save the time.

Keywords- accident detection; alert system; heartbeat sensor; accelerometer; Bluetooth; Android application.

I. INTRODUCTION

The motor vehicle population is growing at a faster rate than the economic and population growth. Accidents and the death rate due to road accidents, especially two wheelers are also increasing at an alarming rate. Most of the accident deaths that happens are due to the lack of immediate medical assistance, on the roads like express highways. A facility for providing immediate medical assistance to the accident area can reduce the fatality to a greater extend. Thus comes the idea of an alert system that senses the accident and its seriousness to alert the nearby medical center for providing ambulance or medical aid to the accident area.

The proposed system will check whether an accident has occurred and identify the seriousness of the injury to the accident victim/driver. Once the decision of serious accident has taken, the system will check for the nearest medical center and notify them about the incident. The rescue team can rush to the spot immediately without any delay as the correct location

will be communicated by the mobile phone of the accident victim. The system will also send message to the friends and relatives to inform them about the incident.

Accident detection and alert system has been extensively studied over the past several years. Research work in this field has proposed a Telematics model which has three main modules [1]. The system is intended to capture the location of the vehicle through GPS receiver, send the location information to vehicle owner's mobile number through SMS and also to the telematics operator server through GPRS. Another prototype proposes a system to detect and provide faster assistance to traffic accident victims [2]. A prototype architecture to improve the chances of survival for passengers involved in car accidents has also been proposed [3]. The proposed system offers automated detection, reports, and assistance to passengers involved in road accidents by exploiting the capabilities offered by vehicle to vehicle communication technologies. Here a low cost alert system is proposed to provide immediate medical aid to the accident victims by alerting the nearby medical assistance center with the exact place of accident and the details of the patient through SMS. This system also takes the medical condition of the accident victim by checking the heartbeat to understand the seriousness of the accident and inform the medical aid center.

II. SYSTEM FEATURES

A. Architecture of the Proposed System

The proposed system consist of an accident detection system and an Android smartphone. The accident detection system will constantly monitor the bike and detect whether the vehicle is in normal driving posture or has fallen down. When the bike fall is detected, the body condition or heartbeat rate of the driver is checked. If any abnormality is found, the Android

application connected to the accident detection system, through Bluetooth, will send alert to the nearby medical center about the accident. The system will inform the basic details of the person and the place of the accident using GPS coordinates from the mobile. The system will also inform friends and relatives of the driver, whose contact numbers are already stored in the Android application. The high level architecture of the proposed system is as shown in the Figure 1.

B. Accident Detection System

The Accident Detection System consist of two main modules. The first module detects whether the vehicle has fallen down. It is mounted on the vehicle itself. This module consist of an accelerometer, MSP430 micro-controller and a Bluetooth module. Once the vehicle fall is detected the information is send to the second module. The second module consists of a Heartbeat sensor MSP430 microcontroller, Buzzer and Bluetooth module. Once the fall is detected the heartbeat of the driver is checked and if any abnormality is detected the decision that a serious accident has occurred is taken. Then the Buzzer in the Accident Detection System is turned ON and it will communicate with the Smart phone to alert the medical center.

The Android application in the Smart phone will search for the nearest medical center and sends message about the accident location and accident victim details. The Application will also send the information to the emergency contact numbers of the friends and family that has been already saved in the application.

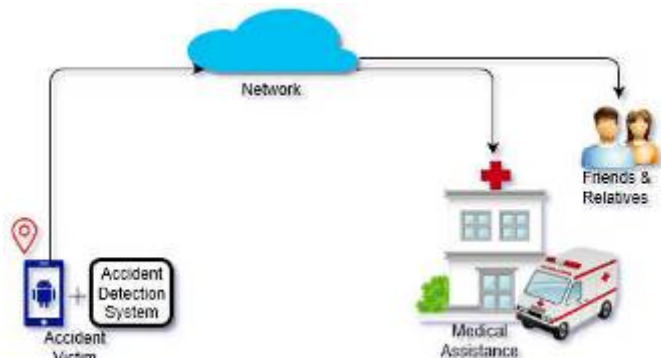


Figure 1: High level architecture of the proposed System

III. DESIGN OF ACCIDENT DETECTION SYSTEM

In this project bike accidents are being monitored. In the case of bikes, in the accident, the vehicle will fall either left side or right side, if the perpendicular axis is taken as the reference. Here accelerometer is used to detect the tilt of the vehicle. The X-axis of accelerometer is taken for checking whether bike has fallen or not. The output voltage of the accelerometer is made low, when the angle of inclination is more than the critical value. Thus when a low signal output is being produced and send to the microcontroller, microcontroller will confirm an accident being occurred. Then an interrupt is generated and the information is send to the heartbeat sensing module to check whether the heartbeat is abnormal. If the heart beat is more than or less than the normal

range then it will confirm the seriousness of the accident. Thus the decision that serious accident has being occurred is taken.

The accelerometer fall detection module is mounted on the vehicle and the heart beat sensor module is attached to the body. It can be integrated as a smart watch. The Android application in the smart phone controls and connects both the accelerometer module and heartbeat sensor module by using Bluetooth.

A. Accelerometer based fall detection module

The fall detection module will constantly monitor the posture of the bike. It consist of an accelerometer and Bluetooth module controlled by MSP430G2452 as shown in the Figure 2. The 3-axis accelerometer ADXL335 is used in this module [7]. The power module provides the power to the whole circuit using 9V battery through regulator IC LM117.

The accelerometer ADXL335 IC has three pins X, Y and Z that gives acceleration in terms of voltage. The signals from the X axis is the one used to find the tilt angle of the bike towards its left or right side. This analog voltage signal is fed into the ADC module of MSP430 microcontroller and mapped corresponding to the angle of the tilt. The angle below 10 degree or greater than 170 degree is considered as the fall of bike. Once MSP430 detects the fall, an interrupt is generated and sends a control signal to the Smart phone application. Application will send the control signal to activate the heartbeat sensing module to check if there is abnormality in the heartbeat. The Bluetooth module used here is HC-06 connected to MSP430 using serial communication.

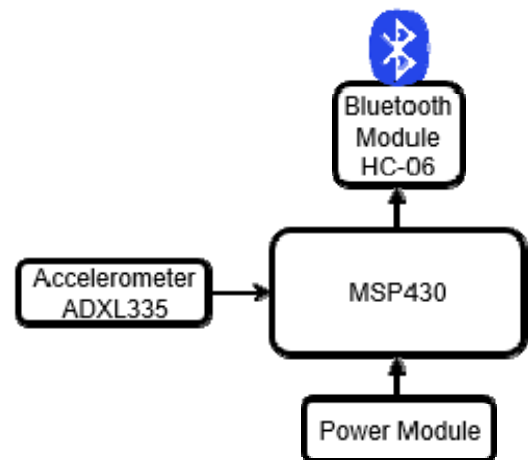


Figure 2: Accelerometer based fall detection module

B. Heartbeat Sensing Module

The Heartbeat sensing module is activated after the fall is detected. It consist of heartbeat sensor, MSP430G2452, Buzzer and Bluetooth module HC-05 as shown in the Figure 4. The power module is provided to power the whole circuit using 9V battery through regulator IC LM117.

Heartbeat sensor detect the heartbeat and help to count the heartbeat to check whether the rate is normal or abnormal [6]. With the idea of low cost system in mind [9], the heartbeat sensor is designed and developed using IR LEDs and

photodiode as shown in the Figure 3. The principle of Reflectance Photo Plethysmography is utilized in the design of heartbeat sensor [10]. Light from IR LED is allowed to fall on the body part especially finger or wrist and the reflected light intensity is observed. The change in the volume of blood through the body region causes the change in the reflected light intensity. Heartbeat beat or systolic peak gives the highest amount of light reflected. The reflected light is captured by the Photodiode and corresponding electric signal is produced. This signal is first amplified and the noise present in the signal are then filtered out using a low pass filter. Thus obtained signal is passed to the base of the transistor to obtain the spike of the heartbeat using the switching function of transistor. The final signal is then fed to MSP430 to count the number of pulse per minute to check whether the heartbeat rate is normal.

If the heart beat is in the abnormal range the MSP430 will sent a message to the user's smart phone through the Bluetooth module HC-05 through Bluetooth. This message is to inform that an accident had occurred and the heartbeat of the victim is abnormal.

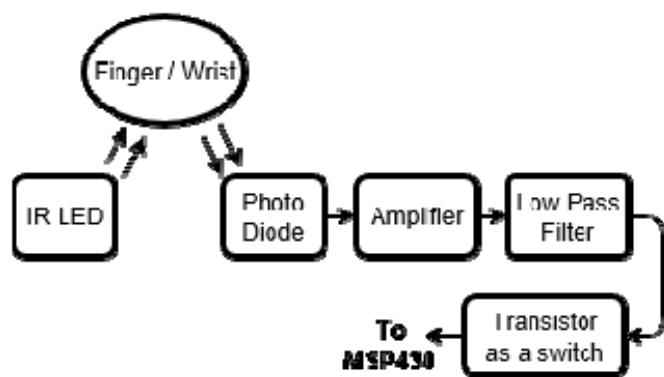


Figure 3: Heartbeat sensor

A Buzzer is also provided to alarm the nearby passengers that an accident has occurred there, in case the vehicle and the victim are thrown inside the bushes along the roadside. Thus the chances of offering the help from the fellow passengers on the road can also be explored. Buzzer is controlled by the GPIO pins of MSP430.

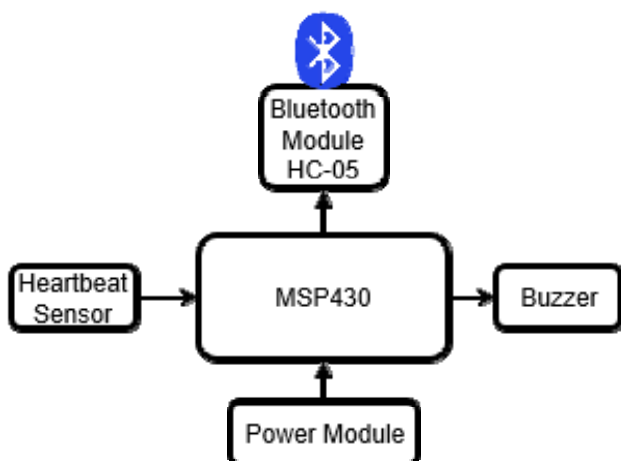


Figure 4: Heartbeat sensing module with buzzer

C. Why MSP430 microcontroller?

The MSP430 is a family of 16-bit RISC mixed-signal microcontrollers produced by Texas Instruments. Its low power consumption feature, the flexibility of its peripheral modules and the easy way to use it makes the MSP430 the suitable microcontroller for these kind of applications. The proposed system uses MSP430G2452, the series of MSP430 designed for medical signal related applications.

D. Bluetooth Connection with Mobile Phone

The fall detection module and the Heartbeat sensing modules are connected to the Android mobile application through Bluetooth [4]. So both the modules are equipped with Bluetooth communication. Fall detection module is using HC-06 Bluetooth module and the Heart beat sensing module is using HC-05 respectively.

The mobile phone will work as the master controller, the Bluetooth modules of two boards are connected to the mobile phone. When the vehicle fall is detected by the microcontroller, it sends this information to the mobile phone, which in turn activates the heartbeat sensing module. The heartbeat rate is counted and checked for any abnormality. If any abnormalities detected, then a message alert is send to the nearby medical assist center and the emergency contact numbers of friends and family and with GPS location.

E. Android Application

An Android application is used to communicate with Bluetooth device and this Android application will search the nearest medical assist centre and send messages with the GPS location of the accident [5] [8]. MIT App Inventor is used to develop the Android application as shown in the Figure 5. MIT App Inventor for Android is an open-source web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT). It uses a graphical interface which allows users to drag-and-drop visual objects to create an application that can run on Android devices.

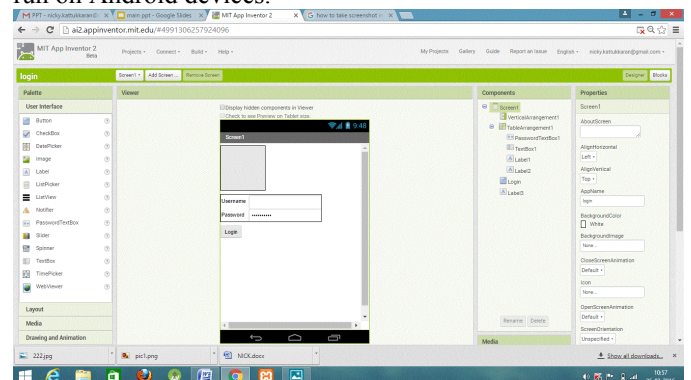


Figure 5: Creation of Android Application



Figure 6: Screen shot of Android Application

The Android application allows the user to set the connection with fall detection module and heartbeat sensing module with the help of the button “Bluetooth-1” and “Bluetooth-2” button respectively as shown in the Figure 6. Mobile number shown in the application screen is the emergency contact number of friends and family. Message option provides the user to add any extra information within the message alert.

IV. ALGORITHM FOR ACCIDENT DETECTION AND ALERT

The flowchart describing the operation of the proposed system is as shown in the figure 7.

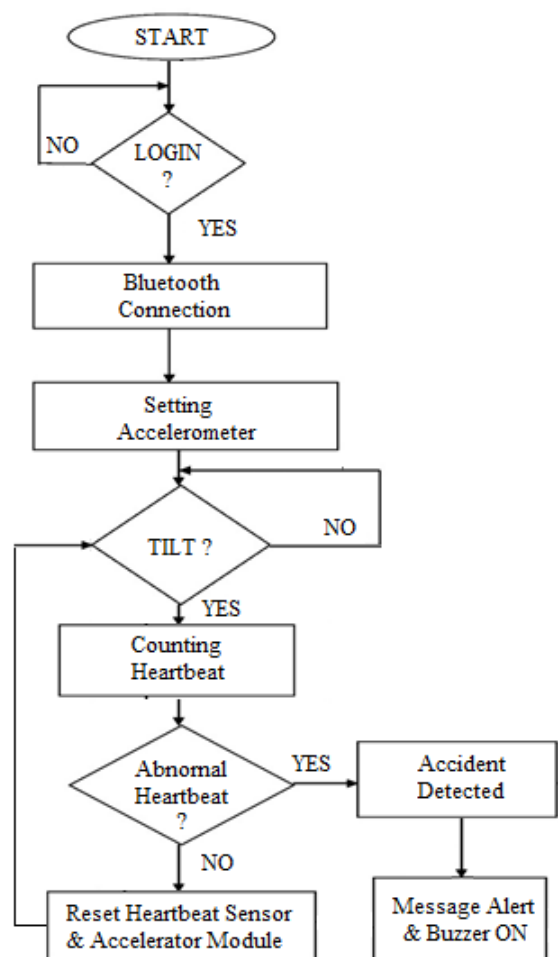


Figure 7: Flow chart of the Accident Detection and Alert System

V. FABRICATION, TESTING AND ANALYSIS

Each modules in the system are designed and fabricated separately and tested. Finally all the modules are interconnected together and tested for the complete functionality.

A. Fall Detection

The fall detection module is fabricated and tested for various angles. The accelerometer ADXL335 MSP430G2452 and Bluetooth modules are integrated and fabricated on a single board to mount on the bike as shown in the Figure 8. The Green and Red LEDs are used for testing purpose. The accelerometer is calibrated and mapped to corresponding voltage with MSP430. From the experiments the voltage level of the fall detection is found to be 0.33V and that of normal riding posture is about 3.24V as shown in the Table1.

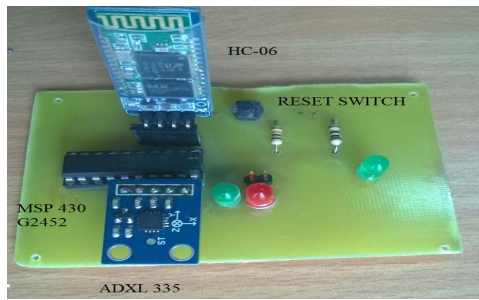


Figure 8: Accelerometer Module

Table 1: Accelerometer readings at various angles

Axis	Angle of Tilt (Degree)	Voltage level (Voltage)	Decision
X	0 – 10	0 – 0.33	Accident
X	90	3.24	Normal
X	170 – 180	0 – 0.35	Accident

B. Heartbeat sensing

The heartbeat sensor is designed and fabricated to detect the heartbeat as shown in figure 9. The board consists of IR LED, Photodiode, and LM324 operational amplifier IC as main components. This board can be designed as a wearable smartwatch or smart-wristband on the user's hand. The heartbeat is detected as a spiking signal which is filtered, amplified and converted to pulse signal before giving to MSP430 micro-controller. This heartbeat sensor board can be integrated with the sensing module through the heartbeat sensor socket in the module in the Figure 10.

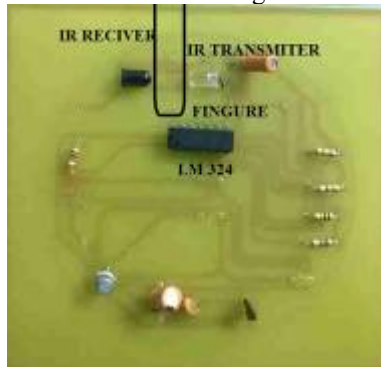


Figure 9: Heart beat sensor board

The fabricated heartbeat sensing module shown in the Figure 10 consists of the socket for connecting heartbeat sensor board, Bluetooth module HC-05, Buzzer and MSP430G2452 micro-controller. The buzzer is tested for the alarm sound when the accident is detected. The Bluetooth communication with the smartphone is also tested. It will send the decision that whether the heartbeat rate is low or high comparing to the normal rate. LEDs are also provided for testing purpose at the time of design.



Figure 10: Heartbeat sensing module with Buzzer

C. Message Alert to Medical Assist Center and Friends

Once the accident is detected and its seriousness is confirmed the Android application will alert the medical assist center with the basic victim details such as name, age and blood group together with the location of the accident. The Android application will also inform the victim's friends and relatives about the incident and the location of the accident as shown in the Figure 11.



Figure 11: Screen shot of the message received by medical assist center and friend respectively

D. Buzzer and Alarm operation

Two types of alarms are used, one is the visible alarm and the other is audible alarm. The audible alarm is a buzzer. The buzzer will make sound when the microcontroller detects and confirms the accident. The visible alarms are the two LEDs, one LED is Red in colour and the other is Green. These LEDs are mainly used for the testing purpose of the board.

VI. CONCLUSION

The system can detect the accident and confirms the seriousness of the accident and then alert the nearest medical assist center to provide emergency medical aid to accident victim. Accelerometer and heartbeat sensor are used to

determine whether an accident had occurred. The communications between the modules are done by using Bluetooth. The smart phone with the android app will send message to the nearest medical center. The system will also inform the friends and family of the victim through message. A buzzer is also provided to alert the fellow passengers on the road that an accident has occurred to invite their help. Accident detection and alert systems are highly relevant in these days and this project aims at developing a low cost solution for the same for the benefit of the society.

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