A Report on

Intelligent Vehicle Black Box

For

Mini Project - 2A: Embedded System Project (ECM501)
(REV- 2019 ‘C’ Scheme) of Third Year (Semester-V)

Bachelors in Engineering

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MINI PROJECT - 2A APPROVAL

Project entitled by ________________________ by

____ is approved for the

degree of Bachelor of Engineering.

Examiners

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Place:

CERTIFICATE

This is to certify that **Trisha Gaur, Advait Kulhada, Sharvani Sawant and Shubham Sangani** have completed the project report on the topic **Intelligent Vehicle Black Box** satisfactorily in partial fulfilment of the requirements for the award of **Mini Project 2A (REV- 2019 'C' Scheme) of Third Year, (Semester-V)** in **Electronics and Telecommunication** under the guidance of **Dr. Monali Chaudhary** during the year **2021-2022** as prescribed by University of Mumbai.

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Examiner 2

DECLARATION

We declare that this written submission represents our ideas in our words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date:

ABSTRACT

Accidents, one among leading causes of loss of life, are unplanned, unpredictable, and circumstantially avoidable. Vehicular accidents account for one of the leading causes of deaths in the metropolis, owing mostly to the carelessness or absent-minded driving techniques of the victim(s). Substance abuse and alcohol are also leading causes of road crashes. Accidents call for dire need for urgency in acquiring help during the emergency. This requirement for quick solutions to such high-risk situations calls for the involvement of innovation.

The main purpose of this paper is to provide vehicle safety and a solution that automatically alerts the driver to be cautious. In this paper we continuously monitor the vehicle performance using sensors and the behavior of the driver with the use of IoT Technology. The Vehicle black box receives the information from various sensors like the breath analyzer, acceleration and the distance of surrounding vehicles along with push and panic buttons. When the driver's alcohol consumption reaches maximum limit, the messages are sent to emergency contacts. If the accident occurs, by using GSM and GPS the vehicle location is traced and the information is sent to the local hospital and police. With the IoT Technology, this location is always traced in the cloud platform service. The push and panic button are used to alert the 24/7 Governance to call out for emergency help.

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ABBREVIATIONS

IoT	Internet of Things	10
GSM	Global System for Mobile communications	10
GPS	Global Positioning System	10
MCU	Microcontroller Unit	10
MySQL	My Structured Query Language	10
SMS	Short Message Service	13
RISC	Reduced Instruction Set Computer	13
SIM	Subscriber Identification Module	15
COS	Card Operating System	15
IMSI	International Mobile Subscriber Identity	15
DC	Direct Current	16
CCS	Code Composer Studio	18
IDE	Integrated Development Environment	18
TI	Texas Instruments	18
OS	Operating System	18
PCB	Printed Circuit Board	19
VCC	Voltage Common Collector	21
GND	Ground	21
LED	Light Emitting Diode	21
USB	Universal Serial Bus	21
COM	Communication	21
UART	Universal Asynchronous Receiver-Transmitter	23
APN	Access Point Name	24
3G	Third Generation	24
4G	Fourth Generation	24

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Accidents, one among the leading causes of loss of life, are unplanned, unpredictable, and circumstantially avoidable. Vehicular accidents account for one of the leading causes of deaths in the metropolis, owing mostly to the carelessness or absent-minded driving techniques of the victim(s). Substance abuse and alcohol are also leading causes of road crashes. One of the many problems also includes car entrapment due to sudden jamming of the doors and many other factors. Millions of people die due to the accidents. Accidents call for dire need for urgency in acquiring help during the emergency. This requirement for quick solutions to such high-risk situations calls for the involvement of innovation.

As a result, we decided to make a system, called **Intelligent Vehicle Black Box** to help cater these problems. The purpose of this project is to provide vehicle safety and a solution that automatically alerts the driver to be cautious. This system is made using MSP430 as the main controller along with a vibration sensor, GSM and GPS modules and push and panic buttons. Since MSP430 microcontroller unit is widely used in automation applications and is an ultra-low powered MCU due to its architecture, it is used in this project as the main controller.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Intelligent Vehicle Black Box using IoT & STM32

An STM32 board is used which collects the data and sends it to cloud ESP32. A report is sent, after a collision. Alerting the driver from the Collision and using Cloud Computing, the location can be easily traced. GSM and GPS modules used consume high power which can be reduced by using a rechargeable battery. [2]

2.2 Smart Vehicle Automation with Blackbox using IoT

Reporting the location of the incident with a system consisting of Arduino mega and six different sensors. Reporting the location of the incident with a system consisting of Arduino mega and six different sensors. Unnecessary use of similar kinds of sensors to detect the same problem which makes the system too complex. [3]

2.3 Implementation of Vehicle Tracking and Accident Detection System Design using MSP430 MCU with MySQL

This System uses an MSP430 board enabling the detection of the accident, pinpointing the location, and subsequently documenting as well as alerting the customers’ emergency contacts. Proposed framework provides a smart and efficient manner of detecting accidents, providing a methodology of detecting accidents. The issue with this system is the accuracy problem with their sensors which can give rise to false alarm conditions and do not detect all the accidents efficiently. The issue with this system is the accuracy problem with their sensors which can give rise to false alarm conditions and do not detect all the accidents efficiently. [5]

2.4 Intelligent Vehicle Black Box using IoT & MSP430

Finally, after reading all the above papers, we decided to make the Intelligent Vehicle Black Box using MSP430. Along with it, a vibration sensor was decided to be used for sensing accident-like situations; GSM and GPS modules, for sending a message to the driver's provided contact list in accident-like situations providing the driver's location; push buttons for the driver to use in case of emergency and an alarming component to notify the people in the nearby surroundings to offer immediate assistance.

CHAPTER 3

PROJECT DESCRIPTION

3.1 Problem Statement

The main purpose of this paper is to provide vehicle safety and a solution that automatically alerts the driver to be cautious. In this paper we continuously monitor the vehicle performance using sensors and the behavior of the driver with the use of IoT Technology. The Vehicle black box receives the information from various sensors like the breath analyzer, acceleration and the distance of surrounding vehicles along with push and panic buttons. When the driver's alcohol consumption reaches maximum limit, the messages are sent to emergency contacts. If the accident occurs, by using GSM and GPS the vehicle location is traced and the information is sent to the local hospital and police. With the IoT Technology, this location is always traced in the cloud platform service. The push and panic button are used to alert the 24/7 Governance to call out for emergency help.

3.2 Steps Involved

The purpose of this project is to provide safety to the people inside the vehicle by automatically alerting the driver in situations of danger along with a message being sent to the trusted people of the driver's provided contact list. The vehicle's performance is monitored using a vibration sensor to indicate a situation of accident along with the use of IoT Technology and Embedded systems. The Vehicle Black Box receives the information from the vibration sensor which is used to alert the driver with the help of the GSM and GPS modules along with a panic button. The panic button will be used by the driver in case of an emergency or if he/she is trapped inside the vehicle for a long time to send a message with the vehicle's location to the driver's provided contact list along with an alarming buzzer to notify the people nearby.

3.3 Block Diagram of Proposed Project:

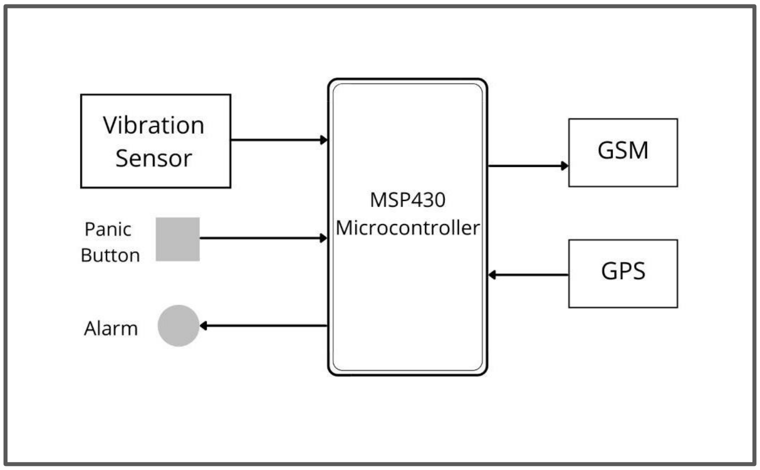


Figure 3.3. 1 Block Diagram of the Proposed System

The **MSP430 Microcontroller** acts as the central controlling unit for the system. The **Vibration Sensor** (primary Sensing Element) connected to MSP430, senses any vibration or harsh movement occurring during the accident and sends this signal to the microcontroller. The **GPS module** traces the location of the accident and sends the information signal to the microcontroller. The **GSM module** with a sim card inserted in it, receives serial data from the microcontroller containing the information of the location of the accident and transmits it as a text SMS to the provided contact numbers of the driver/owner's family as well as emergency contacts. The **Panic Button**, when pressed, sends a signal to the microcontroller and an **Alarming component** such as a buzzer notifies people in the vicinity of an emergency for immediate help.

3.4 Component Description

3.4.1 Hardware

- **MSP430**

  MSP430 16-bit microcontrollers are ultra-low-power RISC mixed-signal MCUs with integrated analog and peripherals for sensing and measurement applications. A MSP430G2553 (Lunchbox Kit) is used as a microcontroller in this project. [6]

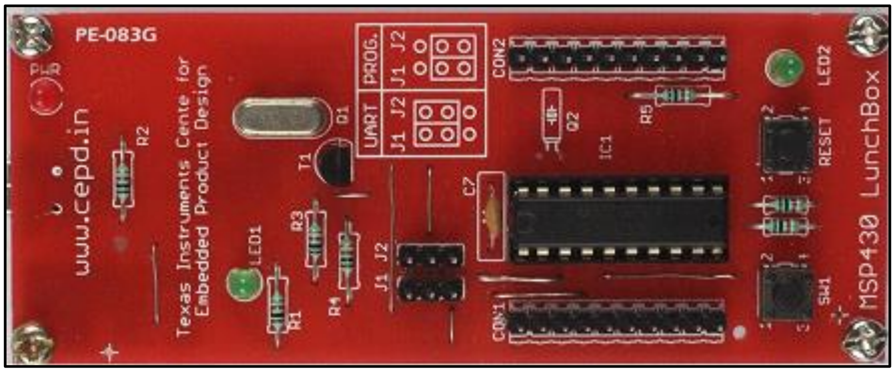


Figure 3.4.1. 1 MSP430G2553 Microcontroller

- **Vibration Sensor**

  A vibration sensor is a device that measures the amount and frequency of vibration in a given system, machine, or piece of equipment. Those measurements can be used to detect imbalances or other issues in the asset and predict future breakdowns. SW-420 Vibration Sensor is being used. [9]

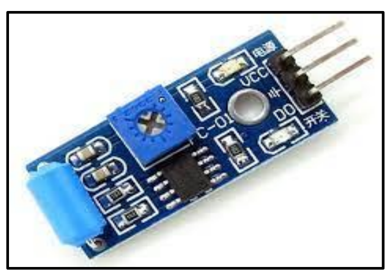


Figure 3.4.1. 2 SW-420 Vibration Sensor Module

- **GPS Module**

The Global Positioning System (GPS) is a satellite based navigation system that provides location and time information. The system is freely accessible to anyone with a GPS receiver and unobstructed line of sight to at least four of GPS satellites. A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites. A Neo-6M GPS Module is used. [8]

Figure 3.4.1. 3 Neo-6M GPS Module

- **GSM Module**

A GSM modem or GSM module is a hardware device that uses GSM mobile telephone technology to provide a data link to a remote network. From the view of the mobile phone network, they are essentially identical to an ordinary mobile phone, including the need for a SIM to identify themselves to the network. SIM900A GSM Module is being used.[9]

Figure 3.4.1. 4 SIM900A GSM Module

- **SIM Card**

A SIM card, also known as subscriber identity module or subscriber identification module (SIM), is an integrated circuit running a card operating system (COS) that is intended to securely store the international mobile subscriber identity (IMSI) number and its related key, which are used to identify and authenticate subscribers on mobile telephony devices (such as mobile phones and computers).

Figure 3.4.1. 5 3G/4G Mobile SIM card

- **DC Power Supply**

A DC power supply is a type of power supply that gives direct current (DC) voltage to power a device. Because DC power supply is commonly used on an engineer’s or technician’s bench for a ton of power tests, they are also often called a "bench power supply”. A 12V DC power supply is being used to give power to the GSM Module.

Figure 3.4.1. 6 12V DC Power Supply

- **Push Button**

A push-button (also spelled pushbutton) or simply button is a simple switch mechanism to control some aspect of a machine or a process. [10]

Figure 3.4.1. 7 Push Button

- **Buzzer**

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. [11]

Figure 3.4.1. 8 Buzzer

- **Jumper Wires**

  A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

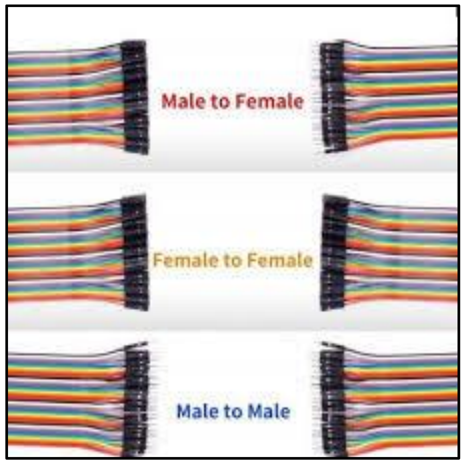


Figure 3.4.1. 9 Jumper Wires

3.4.2 Software

- **Code Composer Studio (CCS)**

  Code Composer Studio™ software is an integrated development environment (IDE) that supports TI's microcontroller (MCU) and embedded processor portfolios. Code Composer Studio software comprises a suite of tools used to develop and debug embedded applications. The software includes an optimizing C/C++ compiler, source code editor, project build environment, debugger, profiler and many other features. The intuitive IDE provides a single-user interface that takes you through each step of the application development flow. Familiar tools and interfaces let you get started faster than ever before. Code Composer Studio software combines the advantages of the Eclipse software framework with advanced embedded-debug capabilities from TI resulting in a compelling feature-rich development environment for embedded developers.

Figure 3.4.2. 1 Code Composer Studio

- **Energia**

  Energia is open-source electronics prototyping platform started by Robert Wessels in January of 2012 with the goal to bring the Wiring and Arduino framework to the Texas Instruments MSP430 based LaunchPad. The Energia IDE is cross platform and supported on Mac OS, Windows, and Linux. Energia uses the mspgcc compiler by Peter Bigot and is based on the Wiring and Arduino framework. Energia includes an integrated development environment (IDE) that has its foundation in the Processing IDE (Processing→Wiring→Arduino→Energia). Energia is also a portable framework/abstraction layer that can be used in other popular IDEs.

Figure 3.4.2. 2 Energia Integrated Development Environment

- **Proteus Design Suite**

  Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. It is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

Figure 3.4.2. 3 Proteus Design Suite

3.5 Working of proposed project

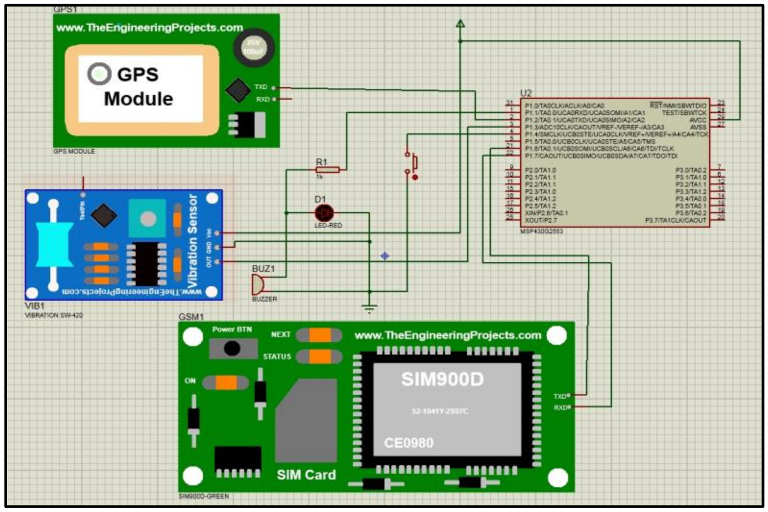


Figure 3.5. 1 Circuit Diagram of the System

The Vehicle Tracking and Accident Detection System uses MSP430 board enabling the detection of the accident, pinpointing the location, and subsequently documenting as well as alerting the customers' emergency contacts, be it their friends, relatives, hospitals and so on about the same. The respective system circuit is shown in the figure. The vibration sensor, GPS module, GSM module are connected to the MSP430G2553 and used for subsequent programming and implementation. The vibration sensor module is used to interface and sense vibration of collision during the accident. The location of the vehicle in the crash, with the device installed, is pinpointed using a GPS module that provides the latitude and longitude, constituting the coordinates. Then, the GSM module, with the help of a SIM (Subscriber Identification Module) card, sends a text message to all the mentioned recipients by the end user, warning them about the accident and providing a message of the location at which the crash has occurred.

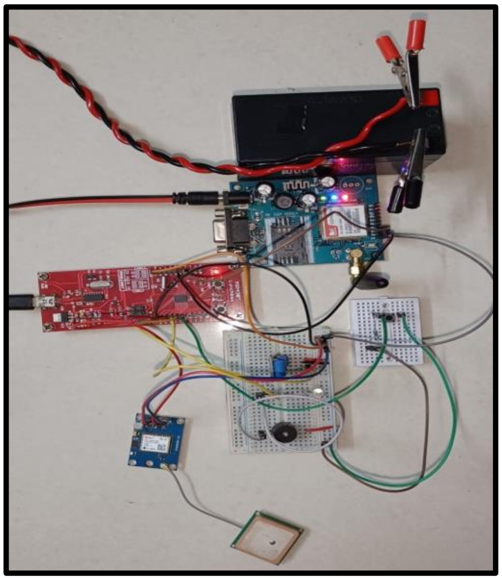
In addition to that a Push Button is added which will be placed beside the driver's seat. The Push Button will be connected to the MSP430 and a Buzzer in the car. So, if the driver is trapped inside the car or in any other emergency situation; the driver can push the button which will generate an alarming sound from the buzzer and it will get notified to the end user.

CHAPTER 4

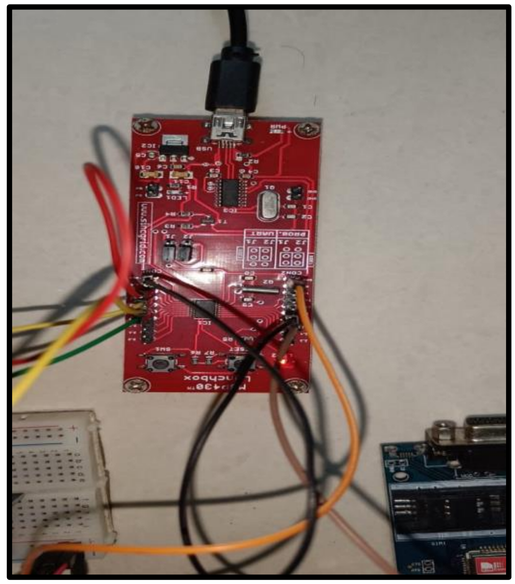
IMPLEMENTATION

4.1 Hardware

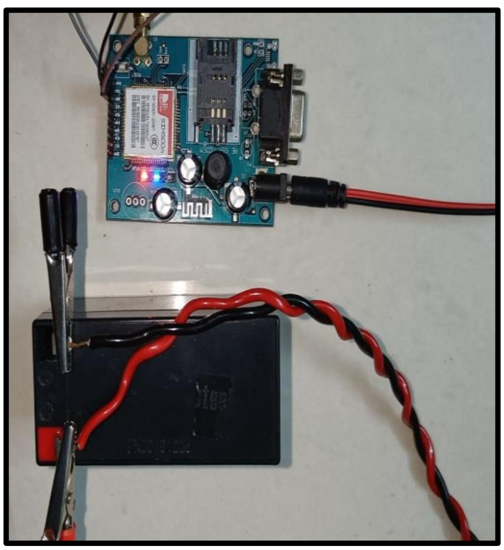
1. Mount the MSP430G2553 on a breadboard.
2. Take jumper wire and connect the Tx pin of GPS Module and connect it to the digital pin number P1_1 of MSP430 (hardware serial) which uses 5V power supply.
3. Next, for the GSM Module, by using a software serial library, connect the serial communication pin P_6 with the Rx and pin P1_7 with the Tx of the GSM Module with jumper wires. Provide 12V power supply to the GSM module.
4. Now, take the Vibration Sensor (SW-420) and connect its terminal to the P1_3 pin of the MSP430. Connect the VCC and GND terminals of the Vibration Sensor on the breadboard.
5. Then connect the LED and the Buzzer along with 1k resistor to the P1_2 pin of the MSP430; which is also used for the indication of the accident.
6. Thereafter connect the push button to the P1_4 pin of the MSP430 which is an additional indicator besides the vibration sensor used by the user manually and the output connected to the LED and the buzzer.
7. Now using a USB Cable, connect the MSP430 to the computer.
8. Next, open the Energia IDE and enter the entire project code.
9. Next, in the Tools section, select the board as MSP430G2553 and the port as COM.
10. Finally verify and upload the code to the MSP430 board and run the entire system.



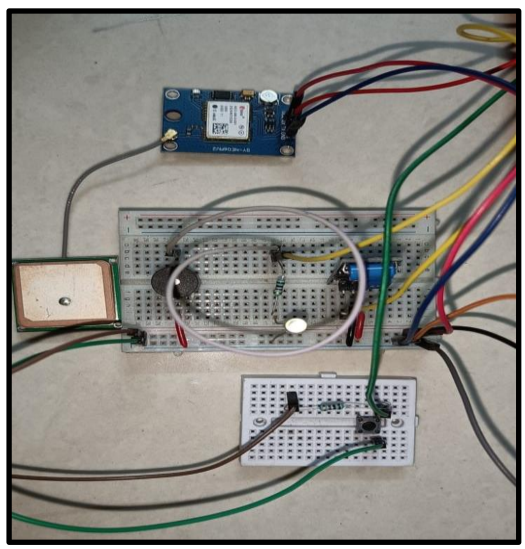
(a) Complete Assembly



(b) MSP430 Microcontroller connections



(c) Power Supply and GSM Module



(d) Sensing and Alarming components

Figure 4.1. 1 Hardware Implementation

4.2 Software

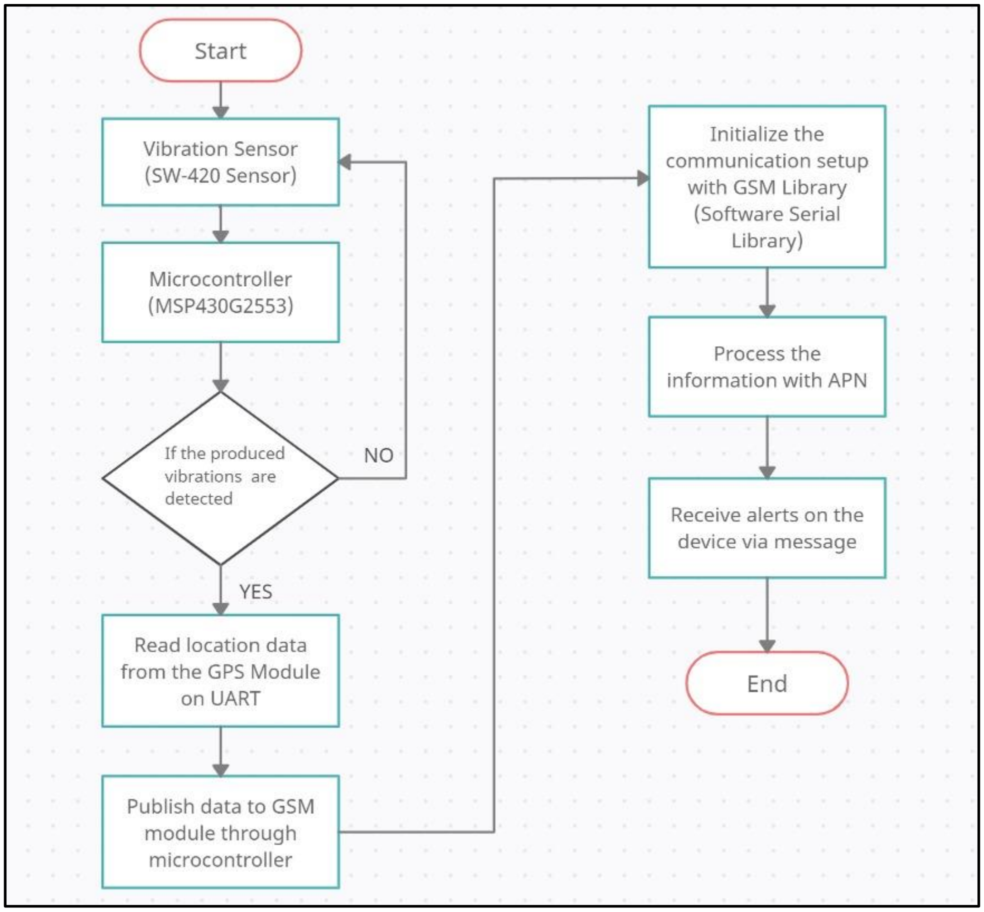


Figure 4.2. 1 Flowchart of the System

1. The Vibration Sensor module (SW-420 Sensor) is used for detecting vibrations or sudden modulations of a vehicle during an accident and transmitting a signal to the microcontroller.
2. The MSP430G2553 microcontroller (Lunchbox kit) receives signals from the vibration sensor, acting as the central control unit of the entire system.
3. When produced vibrations are detected and the signal is sent to the microcontroller, the data containing the location of the accident is received from the GPS module (Neo-6M GPS module) using the UART module of the microcontroller.

4. The MSP430 microcontroller then publishes the data received from the GPS module to the GSM module (SIM900A GSM module).
5. After receiving the data, the GSM module initializes the communication setup between the GSM Library (Software Serial Library which is used in the code for the microcontroller) and the sim card inserted into the GSM module.
6. Using the Software Serial Library, the GSM module processes the information with Access Point Name (APN), which is a gateway between the GSM, GPS, 3G/4G mobile network and another computer network, frequently the public internet.
7. After establishing a connection between the GSM, GPS and the public internet, an alert text message is received by the provided contact numbers containing the location of the accident in the form of Google Map link, derived from the latitude and longitude from the GPS module.

CHAPTER 5

RESULTS

- We have been successful in creating a system to detect vehicle accidents and alert concerned individuals as well as notify the people in the vicinity at the time of an accident or an emergency.
- The Ideation Phase has been completed, including the Work flow of the system, Circuit Design and System Architecture Planning of the proposed solution.
- Finally, the Hardware Implementation of the System has been completed. The implemented system is able to detect any sudden modulation of the vehicle and send the accident's location to the provided contact numbers of the driver or the owner as well as a few emergency help contacts. The system is also able to alert the people nearby at the time of an emergency to offer immediate help.

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[10] "IEC Push Button Specifications", Rockwell Automation, Aug.2014

[11] "Buzzer", Pro-Signal, Nov.2016.

APPENDIX

● MSP430G2553 Lunchbox

2.2 Hardware Features

2.2.1 MSP430G2553 MCU

The MSP430G2553 is a member of the MSP430 family of ultra-low-power MCUs. MSP430 MCUs features different sets of peripherals targeted for various applications. The MCU architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications.

Device features include:

- 1.8-V to 3.6-V operation
- 16-bit RISC architecture up to 16-MHz system clock
- 16KB of flash memory and 512 bytes of SRAM
- 8-channel 10-bit ADC
- 8-channel comparator
- Two 16-bit timers with three capture/compare registers (Timer_A)
- 24 GPIOs
- One universal serial communication interface (USCI_A) supports UART, IrDA, and SPI
- One USCI (USCI_B) supports SPI and I^2C

Figure 4 shows the pinout of the MSP430G2553 20-pin N (PDIP) package.

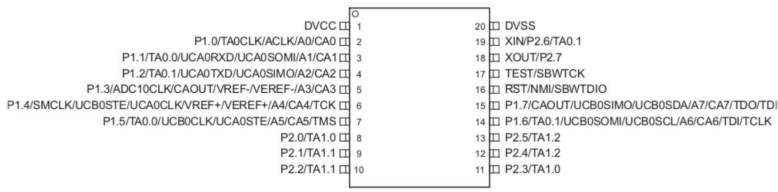


Figure 4. MSP430G2553 20-Pin N Package (Top View)

6 Schematics

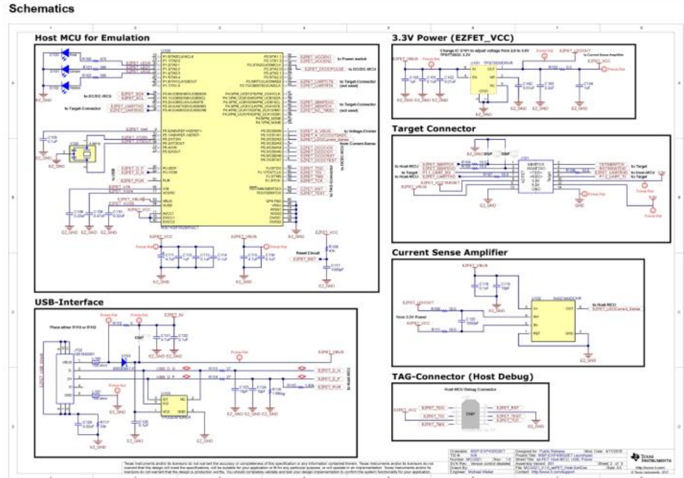


Figure 17. Schematics (1 of 3)

TEXAS INSTRUMENTS

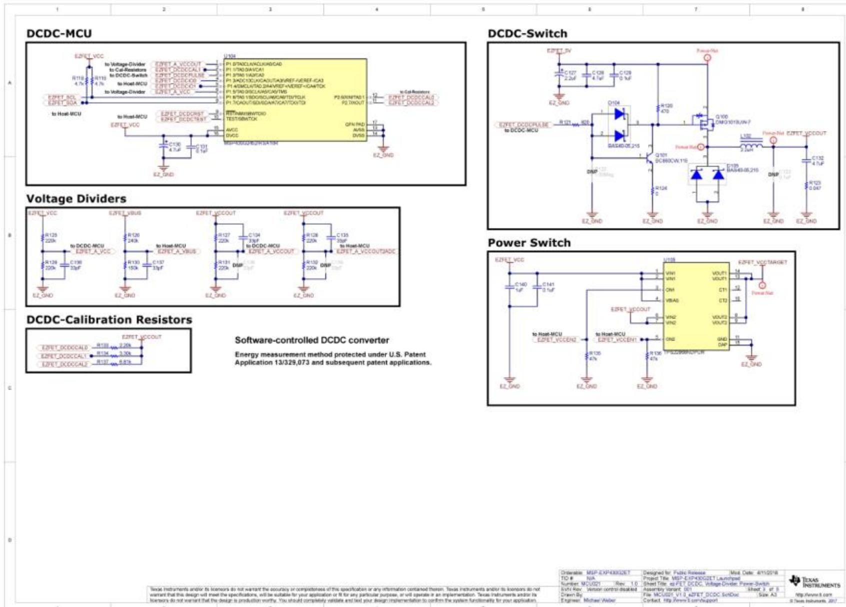


Figure 18. Schematics (2 of 3)

- **Vibration Sensor (SW-420)**

Specification

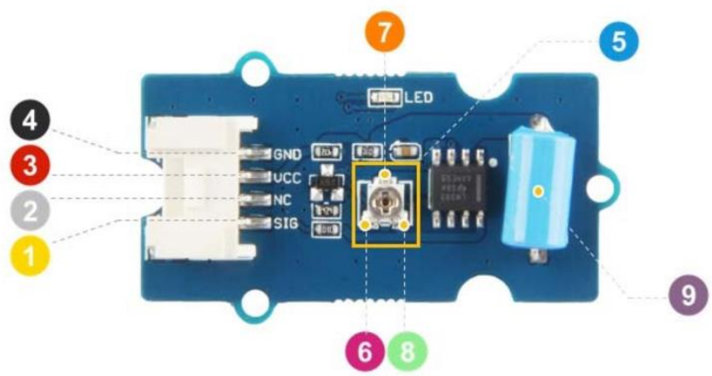
Item	Value
Operating voltage	3.3V / 5V
Interface	Digital

Applications

- Car, bicycle, motorcycle burglar alarm
- Game control
- Vibration detection

Hardware Overview

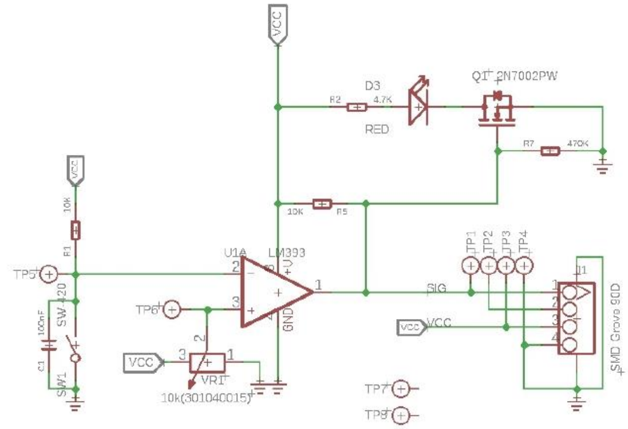
Pin Map



4 GND: connect this module to the system GND
3 VCC: you can use 5V or 3.3V for this module
2 NC: none connected in this module
1 SIG: output the Vout voltage signal

5 Potentiometer: you can use a screwdriver to rotate the potentiometer which controls the sensitivity of this sensor.
6 GND: the GND pin of the potentiometer.
7 Vsen: the lower the voltage of Vsen, the higher the sensitivity
8 VCC: the VCC pin of the potentiometer.
9 SW-420: the Vibration Sensor

Schemaitc



First, let's begin with the **SW1** which at the lower left corner. Actually, the **SW1** is the vibration module **SW-420**. When the module is in a stable state, the module is turned on. **Pin2** of **U1A** is connected to the **GND** though **SW1**.

The **VR1** is the potentiometer, the **Pin2** of the potentiometer is connected to the **Pin3** of the **U1A**

The **U1A** is a comparators. For the comparators,

$V_{out}=\{High, if\ V_+>V_- Low, if\ V_+<V_-$ Vout={High,if V+>V−Low,if V+<V−

V+ connects to **Pin3**, **V-** connects to **Pin2**, **V_{out}** connects to **Pin1**.

For the **V+** you can adjust it by rotate the potentiometer, for instance, we can make it $VCC/2$VCC/2.

For the **V-**, it depends on the **SW1(SW-420)**:

- If this module is in a stable state, the **SW1** is turned on, Pin2 of **U1A** is connected to the **GND**through **SW1**. It will be:

$V_-=0V V_+=VCC/2\} V_{out}=High$ V−=0VV+=VCC/2}Vout=High

- If the module vibrates or tilts, the **SW1** will be turned off, the voltage of **V-** will be pulled up by the **VCC** through R1. Once the **V-** is higher than the VCC/2, then:

$V_->VCC/2 V_+=VCC/2\} V_{out}=Low$ V−>VCC/2V+=VCC/2}Vout=Low

Now you can set the **V+** to adjust the sensitivity, just remember: the lower the voltage of **V+**, the higher the sensitivity😆

- **Neo-6M GPS Module**

NEO-6 - Data Sheet

1 Functional description

1.1 Overview

The NEO-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints.

The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

1.2 Product features

Model	Type					Supply		Interfaces				Features						
	GPS	PPP	Timing	Raw Data	Dead Reckoning	1.75 V - 2.0 V	2.7 V - 3.6 V	UART	USB	SPI	DDC (I^2C compliant)	Programmable (Flash) FW update	TCXO	RTC crystal	Antenna supply and supervisor	Configuration pins	Timepulse	External interrupt/ Wakeup
NEO-6G	•					•		•	•	•	•		•	•	o	3	1	•
NEO-6Q	•						•	•	•	•	•		•	•	o	3	1	•
NEO-6M	•						•	•	•	•	•			•	o	3	1	•
NEO-6P	•	•		•			•	•	•	•	•			•	o	3	1	•
NEO-6V	•				•		•	•	•	•	•			•	o	3	1	•
NEO-6T	•		•	•			•	•	•	•	•		•	•	o	3	1	•

o = Requires external components and integration on application processor

Table 1: Features of the NEO-6 Series

☞ All NEO-6 modules are based on GPS chips qualified according to AEC-Q100. See Chapter 5.1 for further information.

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2 Pin Definition

2.1 Pin assignment

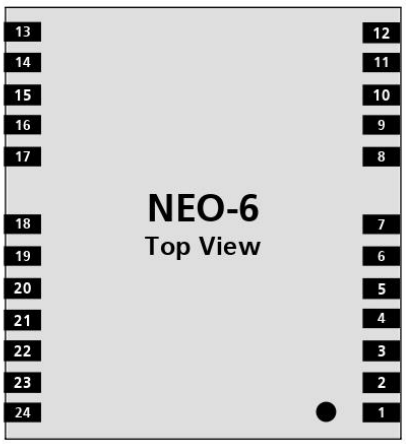

Figure 2 Pin Assignment

No	Module	Name	I/O	Description
1	All	Reserved	I	Reserved
2	All	SS_N	I	SPI Slave Select
3	All	TIMEPULSE	O	Timepulse (1PPS)
4	All	EXTINT0	I	External Interrupt Pin
5	All	USB_DM	I/O	USB Data
6	All	USB_DP	I/O	USB Data
7	All	VDDUSB	I	USB Supply
8	All	Reserved		See Hardware Integration Manual Pin 8 and 9 must be connected together.
9	All	VCC_RF	O	Output Voltage RF section Pin 8 and 9 must be connected together.
10	All	GND	I	Ground
11	All	RF_IN	I	GPS signal input
12	All	GND	I	Ground
13	All	GND	I	Ground
14	All	MOSI/CFG_COM0	O/I	SPI MOSI / Configuration Pin. Leave open if not used.
15	All	MISO/CFG_COM1	I	SPI MISO / Configuration Pin. Leave open if not used.
16	All	CFG_GPS0/SCK	I	Power Mode Configuration Pin / SPI Clock. Leave open if not used.
17	All	Reserved	I	Reserved
18	All	SDA2	I/O	DDC Data
19	All	SCL2	I/O	DDC Clock
20	All	TxD1	O	Serial Port 1
21	All	RxD1	I	Serial Port 1

- **SIM900A GSM Module**

2 SIM900A Overview

Designed for global market, SIM900A is a dual-band GSM/GPRS engine that works on frequencies EGSM 900MHz and DCS 1800MHz. SIM900A features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.

With a tiny configuration of 24mm x 24mm x 3mm, SIM900A can meet almost all the space requirements in your applications, such as M2M, smart phone, PDA and other mobile devices.

The physical interface to the mobile application is a 68-pin SMT pad, which provides all hardware interfaces between the module and customers' boards.

- The keypad and SPI display interface will give you the flexibility to develop customized applications.
- Serial port and Debug port can help you easily develop your applications.
- One audio channel includes a microphone input and a speaker output.
- Programmable General Purpose Input & Output.

The SIM900A is designed with power saving technique so that the current consumption is as low as 1.5mA in SLEEP mode.

The SIM900A is integrated with the TCP/IP protocol; extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is very useful for those data transfer applications.

2.1 SIM900A Key Features

Table 3: SIM900A key features

Feature	Implementation
Power supply	Single supply voltage 3.4V – 4.5V
Power saving	Typical power consumption in SLEEP mode is 1.5mA (BS-PA-MFRMS=5)
Frequency Bands	● SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the 2 frequency bands automatically. The frequency bands also can be set by AT command. ● Compliant to GSM Phase 2/2+
GSM class	Small MS
Transmitting power	● Class 4 (2W) at EGSM 900 ● Class 1 (1W) at DCS 1800
GPRS connectivity	● GPRS multi-slot class 10 （default） ● GPRS multi-slot class 8 (option) ● GPRS mobile station class B

Temperature range	● Normal operation: -30°C to +80°C ● Restricted operation: -40°C to -30°C and +80 °C to +85°C(1) ● Storage temperature -45°C to +90°C
DATA *GPRS:*	● GPRS data downlink transfer: max. 85.6 kbps ● GPRS data uplink transfer: max. 42.8 kbps ● Coding scheme: CS-1, CS-2, CS-3 and CS-4 ● Supports the protocols PAP (Password Authentication Protocol) usually used for PPP connections. ● Integrates the TCP/IP protocol. ● Support Packet Switched Broadcast Control Channel (PBCCH)
CSD:	● CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent ● Unstructured Supplementary Services Data (USSD) support
SMS	● MT, MO, CB, Text and PDU mode ● SMS storage: SIM card
FAX	Group 3 Class 1
SIM interface	Support SIM card: 1.8V, 3V
External antenna	Antenna pad
Audio features	Speech codec modes: ● Half Rate (ETS 06.20) ● Full Rate (ETS 06.10) ● Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80) ● Adaptive multi rate (AMR) ● Echo Cancellation ● Noise Suppression
Serial port and Debug port	Serial Port: ● 8-wire modem interface with status and control lines, unbalanced, asynchronous. ● 1.2kbps to 115.2kbps. ● Serial Port can be used for AT commands or data stream. ● Supports RTS/CTS hardware handshake and software ON/OFF flow control. ● Multiplex ability according to GSM 07.10 Multiplexer Protocol. ● Autobauding supports baud rate from 1200 bps to 115200bps. Debug port: ● 2-wire null modem interface DBG_TXD and DBG_RXD. ● Can be used for debugging and upgrading firmware.
Phonebook management	Support phonebook types: SM, FD, LD, RC, ON, MC.
SIM Application Toolkit	Support SAT class 3, GSM 11.14 Release 99
Real time clock	Implemented
Timer function	Programmable via AT command
Physical characteristics	Size: 24mm x 24mm x 3mm Weight: 3.4g
Firmware upgrade	Firmware upgrade by debug port.

2.2 SIM900A Functional Diagram

The following figure shows a functional diagram of the SIM900A and illustrates the mainly functional part:

- The GSM baseband engine
- Flash and SRAM
- The GSM radio frequency part
- The antenna interface
- The Other interfaces

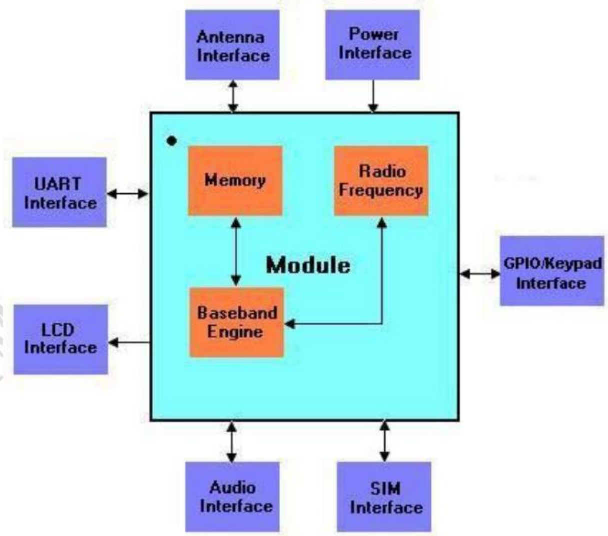

Figure 1: SIM900A functional diagram

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