CAR BLACK BOX

Contents

A. Abstract

According to the World Health Organization, more than a million people in the world die each year because of transportation-related accidents. In order to react to this situation, the black box system draws the first step to solve this problem that crosses national boundaries and threatens the safety and health of people worldwide. In addition to improving the treatment of crash victims and the road status in order to decrease the death rate, constructing safer vehicles, and helping insurance companies with their vehicle accidents investigations, the main purpose of this project is to develop a black box system that can be installed to any vehicle all over the world. The main purpose of this project is to develop a prototype of the Vehicle Black Box System VBBS that can be installed into any vehicle all over the world. This prototype can be designed with minimum number of circuits. This project implements how to detect and record data from the vehicle and to present the data to the user. For that different type of sensors were used. For data recording as a memory element we use SD card. This program receives the data serially from the black box memory and finally saves it to a formal excel report for future use. In order to know what type of sensors should be installed into the vehicle, research was carried out to identify the main information needed for better accident analysis. After filtering the information and taking into consideration what could be done and what could help the most, the following data were found to be the most important ones needed after an accident.

B. List of Figures

C. List of abbreviations

- USB- Universal Serial Bus
- ICSP- In Circuit Serial Programming
- PWM- Pulse Width Modulation
- AVR- Automatic Voltage Regulator
- GSM- Global System for Mobile Communication
- GPRS- General Packet Radio Service
- EGSM- Extended Global System for Mobile Communication
- DCS- Distributed Control Systems
- UART- Universal Asynchronous Receiver-Transmitter
- AT- Attention
- SD- Secure Digital
- SPI- Serial Peripheral Interface
- USART- Universal Synchronous Asynchronous Receiver-Transmitter
- FAT32- File Allocation Table32
- TTL- Transistor- Transistor Logic
- SPDT- Single Pole Double Throw

1. Introduction

In day to day life vehicle accident is a major problem in many cities. This problem is still increasing in number due to poor riding behaviors such as driving at high speed, drunk driving, riding without safety etc. Car black boxes is having logical feature and functions considering that more people die in car accidents than an airplane crashes. Black box in aircraft help to determine the cause of an airplane accident and car black box helps us to determine what has caused a car accident. The causes of car accident are not too difficult to investigate as plane crashes. They are particularly valuable when no witness is present during the accident and when each drivers has his/her own version of event. Car black box is a digital electronics device, which is used during the investigation of the accident which records and store vehicles speed, vehicle temperature, vibration, distance from obstacles, real time and vehicle other status information. SD card is used for recording the data. Event data recorder holds the proof of the accident and it is useful for the police in investigation and for Insurance Company, as they can find out what really caused the accident.

1.1 Motivation

The increase in accidents are a fear for today's society. So if this prototype can be implemented in vehicles it can somehow save the life of drivers. Even though accidents occur the cause of accident can be found out therefore favors insurance claiming.

1.2 Problem Definition

The problem here is that whether we can reduce the rise of accidents? How can we inform about the drivers negligence? That is whether he is drunken or the door is open? If an accident occur sometimes there are chances it occur in an abandoned place. How can he inform about the accident?

1.3 Objective of the Project

The ultimate objective of the project is the reduction of accidents and saving human life. This includes how we can inform the driver about the unexpected mistakes he made before starting the car i.e. whether car is open or any issues is present in the car and so on. Also it helps to inform his belongings that he met with an accident if it somehow occur.

1.4 Limitations of the Project

Here we are using a 12V 2A DC Adapter to power our circuit. A normal 12V battery cannot power this circuit since it require high current to drive all these components. If a battery which can provide a minimum of 2A current this circuit works well. But this will not be an issue when you implement it in car itself since the power can be taken from the battery of the car itself.

2. Literature Survey

2.1 Introduction

A highly efficient product is developed after so many evolutions. Currently existing car black box needs an evolution to include more advanced features. In luxury countries the above proposed system was introduced, and its success rate is high. This helps to find out the cause of the accident is needed information related with those accidents and that information useful for to investigate the accident and inform to family member.

2.2 Existing System

Currently we use a system which alerts the driver when the car encounters any surface. During an accident, the insurance company is not able to check the exact reason of the accident. The company assures the safety of drivers by implementing air bags and alarm when the seatbelt is not properly used.

2.3 Limitation of Current system

We currently use a system which does not have a capability of storing data or detect the presence of alcohol which leads to increase in number of drunk driving accidents. Currently the insurance companies cannot verify the exact cause of accidents which leads to unnecessary losses from their side. We couldn't know about the time and place of incident.

2.4 Proposed work

The proposed system is designed such that, the device itself sends a message to the concerned person when an accident is met. Proposed system uses Arduino board that provides an easy access to input/output and analog pins and easy burning/uploading of a program. This system which can recode the amount of CO2 and amount of alcohol during the point of accidents. It also detects the amount of alcohol and checks whether the driver is drunk or not. At the point of accident, a message is also sent to the owner at the point of accident

3. Design Phase

3.1 Introduction

In our project car black box, we have used alcohol sensor, CO2 sensor and door sensor to check the initial conditions of the car. When collision occurs it is detected by collision sensor and the alert of accident is send to the preprogrammed mobile number via GSM modem. Also all the last minute condition of the car i.e. data from all the sensors is stored in the SD card just when accident occur. We use Arduino UNO to perform the operations and coding is done in Arduino IDE.

3.2 Block Diagram

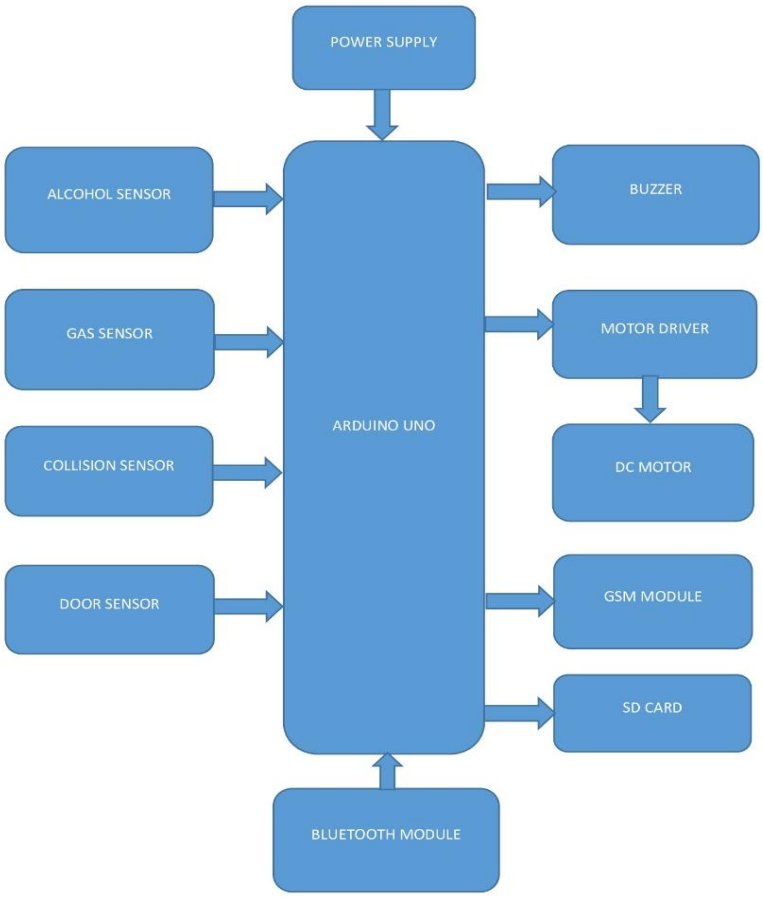

FIG1 Block Diagram

3.3 Software Requirements

3.3.1 Arduino IDE

The Arduino integrated development environment (IDE) is a cross - platform application (for Windows, macOS, Linux) that is written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It works in conjunction with an Arduino controller to write, compile and upload code to the board. It includes a code editor with features such as text cutting and pasting, searching, and replacing text, automatic indenting, brace matching and syntax highlighting and provides simple one click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. Designs can be verified and compiled, with an error log displayed in the lower part of the UI that allows to review the code. The Arduino IDE supports the languages C and C++ using special rules of code structuring. ARDUINO Software 1.8 is used to implement the proposed system.

3.3.2 Bluetooth RC Controller App

The application allows you to control an Arduino based RC car over Bluetooth. This is done using a Bluetooth enabled Android phone. The app lets you control the car with either buttons or the phone's accelerometer. There are also two buttons for front and back lights. A flashing light lets you know when the phone is connected to the car, and arrows light up letting you know the car's driving direction.

3.4 Hardware Requirements

The various Components used in this car black box are as follows:

3.4.1 Arduino UNO

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5 V
Recommended Input Voltage	7-12 V
Input Voltage Limits	6-20 V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Boot loader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

PIN OUT

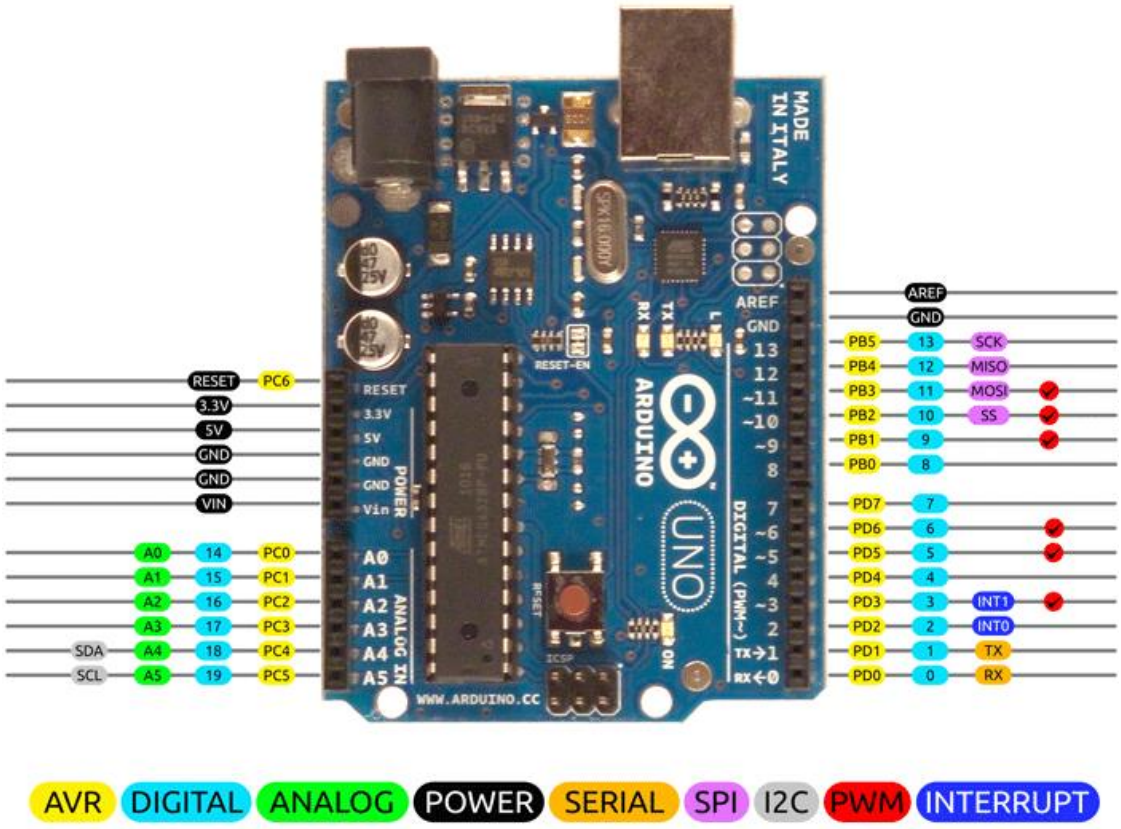

FIG2 Arduino UNO Pin out

3.4.2 L298 Motor Driver

This **L298N Motor Driver Module** is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. **L298N Module** can control up to 4 DC motors, or 2 DC motors with directional and speed control.

Features and Specifications

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heat sink for better performance
- Power-On LED indicator

PIN OUT

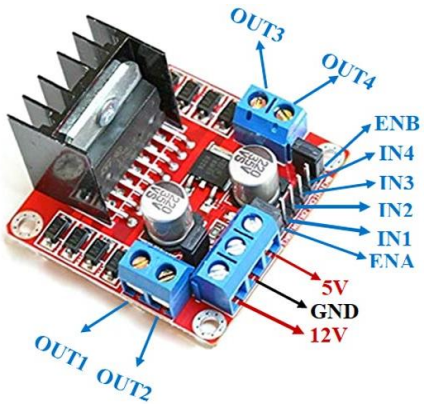

FIG3 L298 Motor Driver Pin out

IN1 & IN2	Motor A input pins. Used to control the spinning direction of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinning direction of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 & OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power Source
5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

3.4.3 SIM 900A GSM Modem

The **SIM900A** is a readily available **GSM/GPRS module**, used in many mobile phones and PDA. The module can also be used for developing IOT (Internet of Things) and Embedded Applications. SIM900A is a dual-band GSM/GPRS engine that works on frequencies EGSM 900MHz and DCS 1800MHz.

Features and Specifications

- Single supply voltage: 3.4V – 4.5V
- Power saving mode: Typical power consumption in SLEEP mode is 1.5mA
- Frequency bands: SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the two frequency bands automatically. The frequency bands also can be set by AT command.
- GSM class: Small MS
- GPRS connectivity: GPRS multi-slot class 10 (default) , GPRS multi-slot class 8 (option)
- Transmitting power: Class 4 (2W) at EGSM 900, Class 1 (1W) at DCS 1800
- Operating Temperature: -30ºC to +80ºC
- Storage Temperature: -5ºC to +90ºC
- DATA GPRS: download transfer max is 85.6KBps, Upload transfer max 42.8KBps
- Supports CSD, USSD, SMS, FAX
- Supports UART interface
- Supports single SIM card
- Communication by using AT commands

PIN OUT

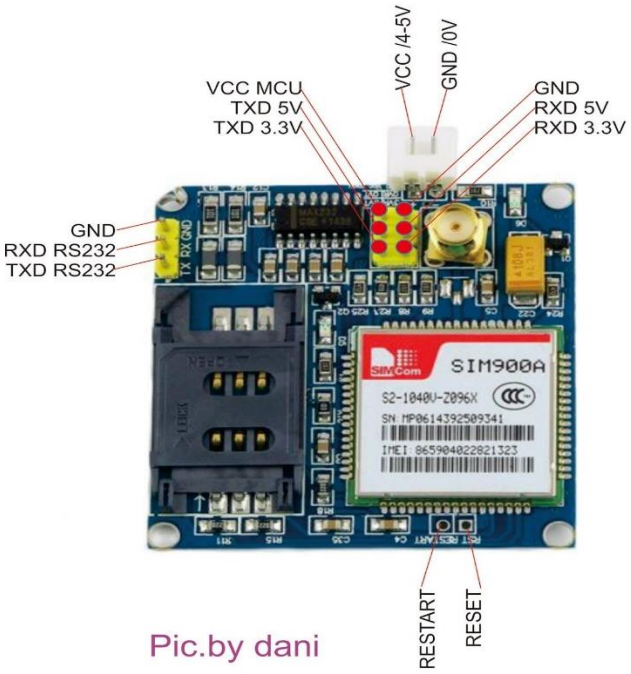

FIG4 SIM 900A GSM Modem Pin out

- VCC5 = 5V supply in
- GND = Ground
- 3VT = TXD (Output, 3.3V)
- 3VR = RXD (Input, 3.3V)
- 5VT = TXD (Output, 5V) : Connect this pin to Arduino receive pin
- 5VR = RXD (Input, 5V) : Connect this pin to Arduino transmit pin
- VCC = Unused
- GND = Ground
- DB9-2 = RS232 TX (Output)
- DB9-3 = RS232 RX (Input)
- GND = Ground

3.4.4 SD Card and SD Card module

A Micro SD Card is a flash based, removable memory device. It is non-volatile memory and is often used in mobile phones and other consumer electronic devices. Almost all Micro SD Cards work in a voltage range of 2.7V to 3.6V (typically, 3.3V). A Micro SD card supports SPI Communication.

FIG5 SD Card

An SD Card Module or a Micro SD Card Adapter is a simple board which facilitates connection between a Micro SD card and a Microcontroller like Arduino. Since Arduino operates at 5V and the Micro SD Card operates at 3.3V, a typical Micro SD Card Adapter or an SD Card Module basically consists of two important components. They are the 3.3V Voltage Regulator IC and a 5V to 3.3V Level Converter IC for the communication pins.

PIN OUT

- VCC – 5V
- GND – GND
- MOSI – Master OUT Slave IN (Input)
- MISO – Master IN Slave OUT (Output)
- SCK – SPI Clock (Input)
- CS – Chip Select (Input)

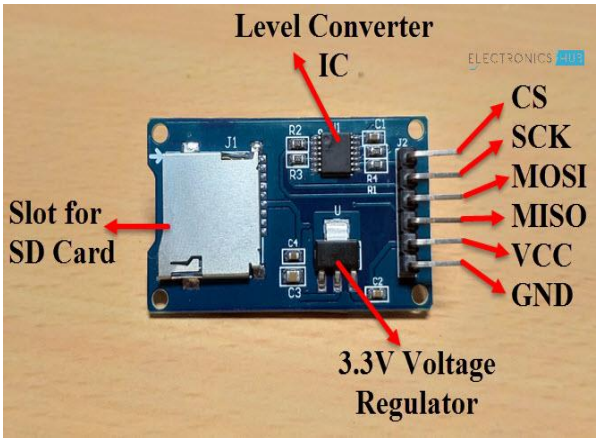

FIG6 SD Card Module Pin

3.4.5 MQ-2 Gas Sensor

The **MQ-2 Gas sensor** can detect or measure gasses like LPG, Alcohol, Propane, Hydrogen, CO and even methane. The module version of this sensor comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. When it comes to measuring the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers.

Specifications

Operating voltage	5V
Load resistance	20 KΩ
Heater resistance	33Ω ± 5%
Heating consumption	<800mw
Sensing Resistance	10 KΩ – 60 KΩ
Concentration Scope	200 – 10000ppm
Preheat Time	Over 24 hour

FIG7 MQ2 Sensor

Pin No	Pin Name	Description
1	VCC	This pin powers the module, typically the operating voltage is +5V
2	GND	Used to connect the module to system ground
3	Digital Out (DO)	Can use digital output from this pin, by setting a threshold value using the potentiometer
4	Analog Out (AO)	This pin outputs 0-5V analog voltage based on the intensity of the gas

3.4.6 MQ-3 Sensor

MQ-3 module is suitable for detecting Alcohol, Benzene, CH_4, Hexane, LPG, CO. This sensor provides an analog resistive output based on alcohol concentration. When the alcohol gas exist, the sensor's conductivity gets higher along with the gas concentration rising.

Technical Data and Features

- Concentration : 0.05 mg/L ~ 10 mg/L Alcohol
- Operating Voltage : 5V ±0.1
- Current Consumption : 150mA
- Operation Temperature : -10°C ~ 70°C
- Digital output and Analog output 0V or 5V

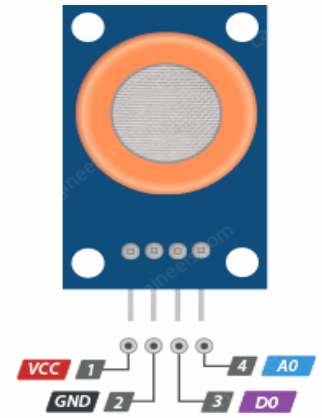

FIG8 MQ3 Sensor Pin out

Pin Name	Description
VCC	This pin powers the module, typically the operating voltage is +5V
GND	Used to connect the module to system ground
Digital Out (DO)	Can use digital output from this pin, by setting a threshold value using the potentiometer
Analog Out (AO)	This pin outputs 0-5V analog voltage based on the intensity of the gas

3.4.7 MC-38 Door Sensor

FIG9 MC-38 Door

MC-38 Wired Door Window Sensor Magnetic Switch can be used as a door or window security system. It produces the signal when moved away from each other which can be fed to the micro-controller to perform the desired action as per requirement. This wired sensor is trigger by the magnet. When the magnet is closed by, the circuit is closed or open if the magnet far from the sensor. The switch is non polar, so you can plug in the wires in any way.

Specifications

- Connecting Mode: N.C.
- Rated current: 100mA
- Rated voltage: 200VDC
- Operating distance: more than 15mm, less than 25mm
- Rated power: 3W
- Dimension: 28x15x0.9cm
- Cable Length: 30.5cm ± 12mm
- Switch output: normally closed (switch and magnet are together when the switch is closed)

3.4.8 Collision Sensor

Collision Sensor used is a spdt switch used to detect the collision and sent back a signal to microcontroller. There are three pins: C, NO, NC. C for controlling, NO stands for normally open, NC stands for normally closed.

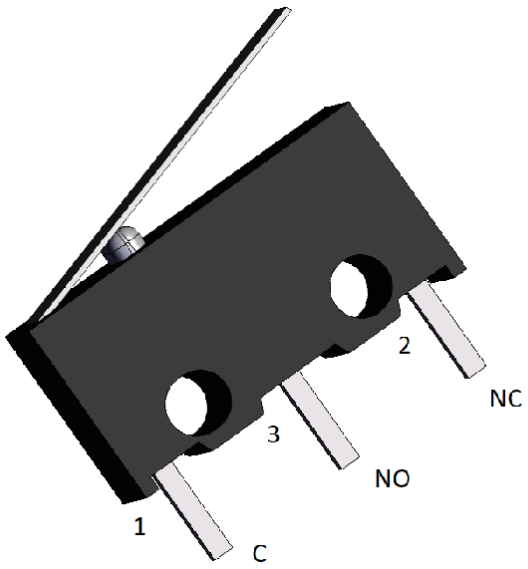

FIG10 Collision Sensor

Pin Name	Description
C (Common terminal)	Input
NC (Normally Close)	Output 1
NO (Normally Open)	Output 2

3.4.9 HC-05 Bluetooth Module

The **HC-05** is a very cool module which can add two-way wireless functionality. This module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any microcontroller that supports USART .The **HC-05** has two operating modes, one is the Data mode in which it can send and receive data from other Bluetooth devices and the other is the AT Command mode where the default device settings can be changed.

HC-05 Technical Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

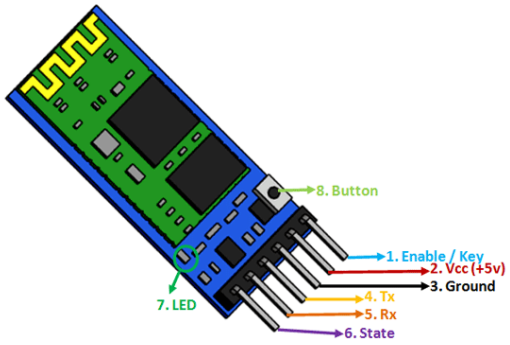

FIG11 HC-05 Bluetooth Module

Pin Name	Description
Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
Vcc	Powers the module. Connect to +5V Supply voltage
Ground	Ground pin of module, connect to system ground.
TX – Transmitter	Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.
RX – Receiver	Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
State	The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.

3.4.10 12V,2A DC Adapter

The adaptor is used to supply power to the entire model. It is connected to one of the inputs of the modules. The input to the adaptor is 90-265V, frequency of 50-60Hz and 0.6A. The output of the adaptor is 12V, 2A.

3.5 Circuit diagram

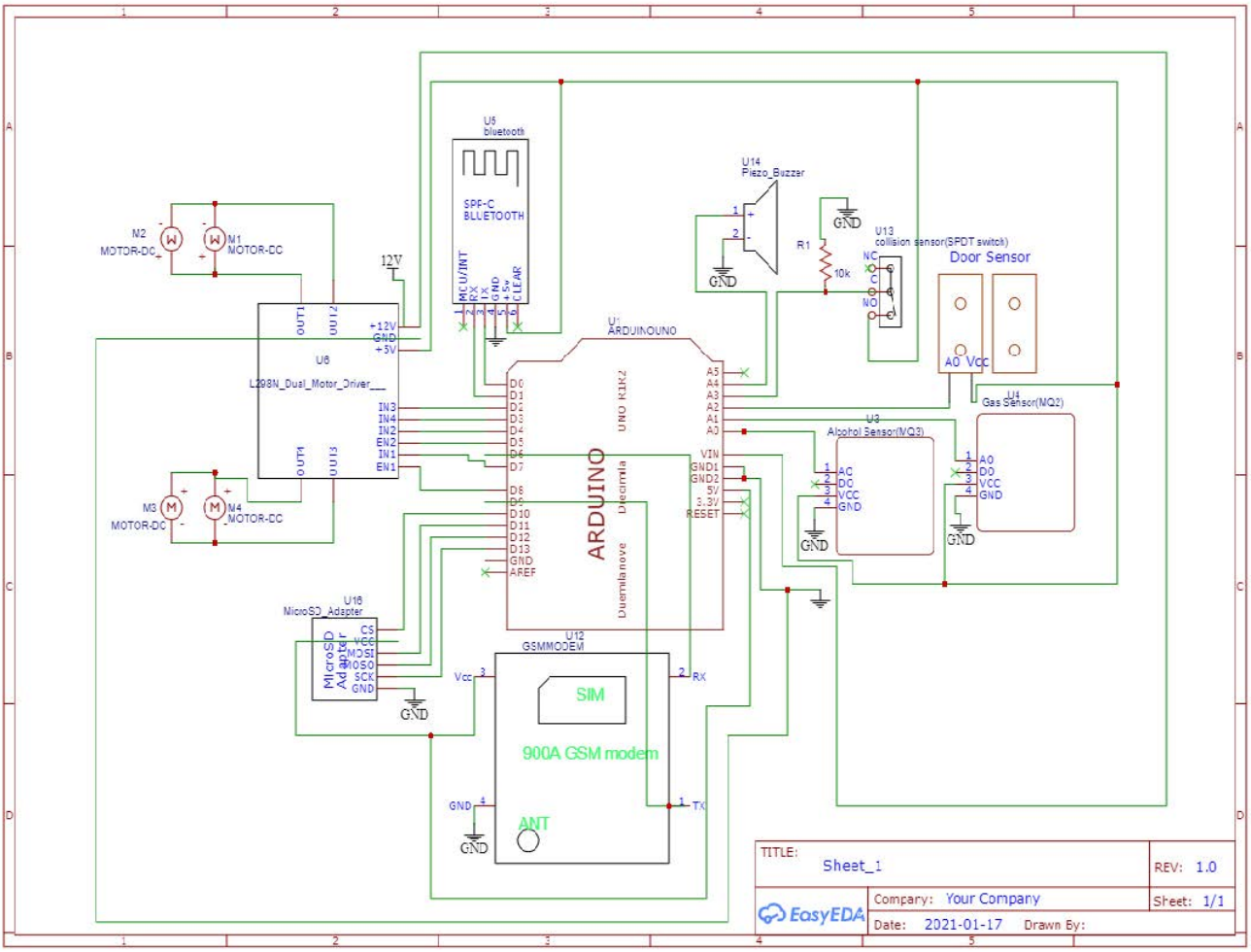

FIG12 Circuit Diagram

4. Implementation

4.1 Interfacing GSM with Arduino

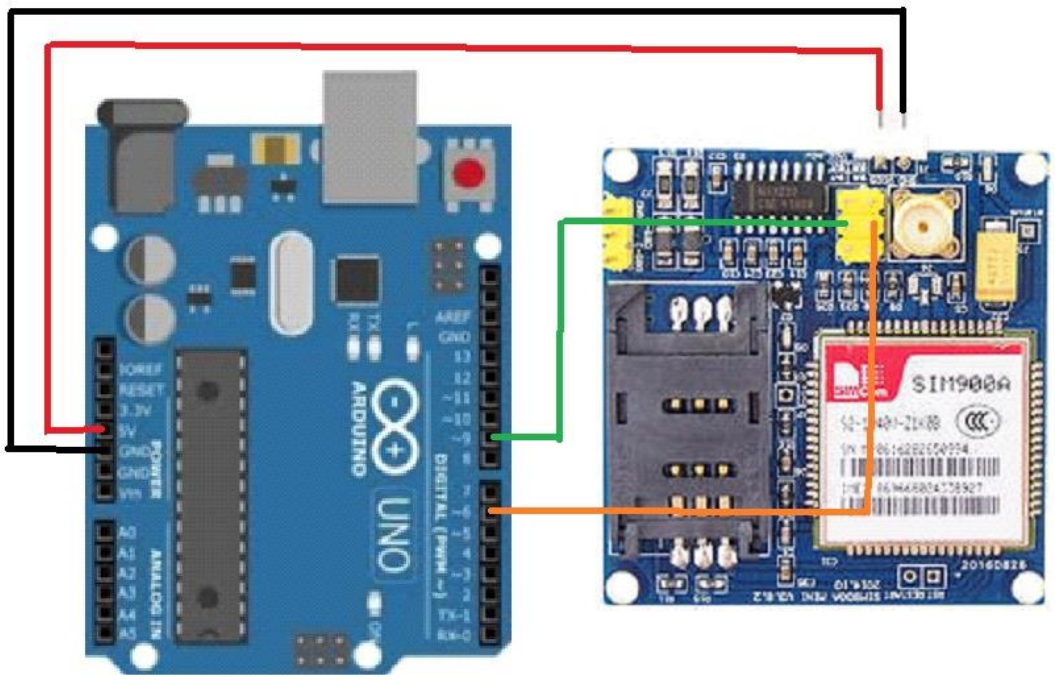

FIG13 Interfacing GSM with Arduino

Connect 5VT to pin 9 and 5VR to pin 6. The 5V supply is given from Arduino and ground is connected to GND of Arduino. The 2G sim is inserted in sim slot.

GSM external antenna is used in GSM like SIM 900. It is mainly used for mobile communication, wireless applications. The message is sent via GSM. When the collision occur, it send a signal to interrupt the Arduino. Then Arduino sends a signal to GSM module which prepares the GSM module to send the message to preprogrammed number. The antenna in GSM act as a transmitter to send the message.

4.2. Interfacing motor driver and Bluetooth Module

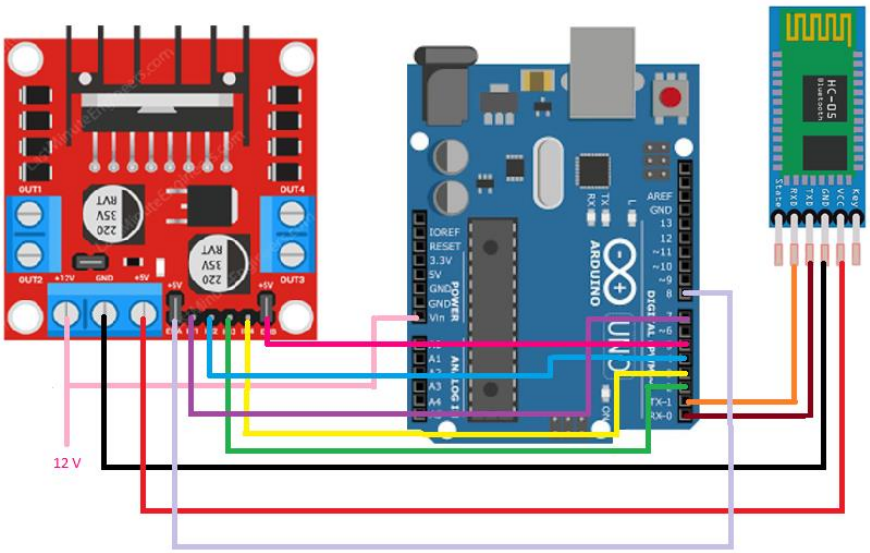

FIG14 Interfacing Bluetooth Module and Motor Driver with Arduino

The Bluetooth module and L298 motor driver is used to movement of car. The Bluetooth module is used to control the direction of the car and L298 motor driver is used to control the speed and control of the motor. The TXD of the Bluetooth is connected to RX of Arduino (pin0) and RXD is connected to TX of Arduino (pin1).When the module is on, the led will blink continuously and when it get connected, it blinks with 3s interval. The module sends signal to Arduino to move in accordance with the directions given.

In L298 motor driver, the input is 12V which is given to the module via adapter. This motor driver module works on 5V. So the input 12V needs to be regulated to 5V which is done by 7805 voltage regulator IC. The input pins IN1, IN2, IN3 and IN4 is connected to D7, D4, D2 and D3 respectively. BO motor is connected to the output pin of the module. Heat sink is placed in the module to reduce heat dissipation. Two pins ENA and ENB are enable pins that is used to turn motor ON or OFF and speed of the motor. These pins are connected to D8 and D5 respectively. The pins are kept shorted, when the speed is not to be controlled.

4.3. Interfacing sensors with Arduino

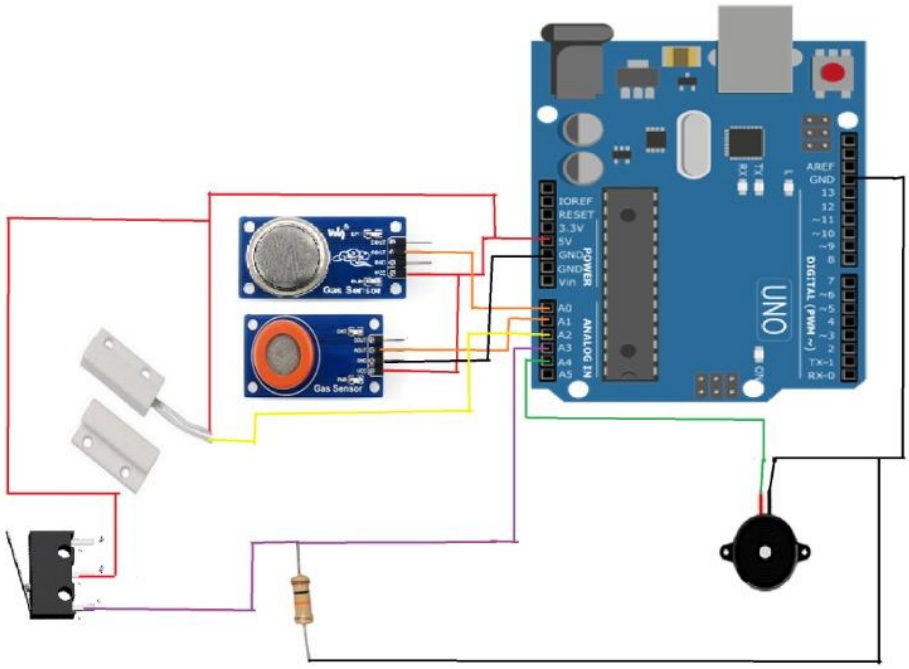

FIG15 Interfacing Sensors with Arduino

Here we have use alcohol sensor, door sensor, carbon dioxide sensor and collision sensor in the project. Alcohol sensor is to detect the content of alcohol. Carbon dioxide sensor is to detect the level of carbon dioxide.

Door sensor is to check whether the door is locked or unlocked. Collision sensor is to detect the collision. Buzzer is placed for detection of each sensor.

In alcohol sensor, the AO pin is connected to A0 pin of Arduino. This sensor reads the analog value of alcohol sensor in ppm which is sent to arduino. If the analog value of alcohol sensor is greater than 700ppm, Arduino will control the motor driver to stop the movement of vehicle.

In door sensor, the output pin is connected to A2 pin of Arduino. This door sensor is simply a magnetic reep switch. This also reads the analog out of door sensor and if the analog value is greater than 1000, the value goes to Arduino and it stops the movement of car.

The checking of alcohol content and door sensor is done at the time of initialization. If the condition is satisfied only, the car will move otherwise the car stops.

Carbon dioxide sensor is to check the value of carbon dioxide. The AO of CO2 sensor is connected to A1 of arduino. It continuously reads the value of CO2 in ppm. The carbon dioxide is for checking the level of CO2 during combustion.

The collision sensor is to detect the impact of collision through vibration. It is simply SPDT switch with three pins: C(control), NO(normally open) and NC(normally closed). The control pin is connected to 5V and NO is connected to A3 through 10k resistor. It is designed that the output is high when the normally open is closed. So when the output goes high interrupt is received by Arduino and Arduino sends signal to GSM module that sends the message to the preprogrammed number. It also writes the data to the SD card.

The buzzer is piezoelectric beeper which produces beep sound when the condition is satisfied. In this project, it is used to produce sound according to the data from alcohol sensor and door sensor. When the alcohol is present, the buzzer produces a beep sound. In case of door sensor, if the door is unlocked, it produces similar beep sound. The one end is connected to GND and other end is connected to A4 of Arduino.

4.4. Interfacing Memory module with Arduino

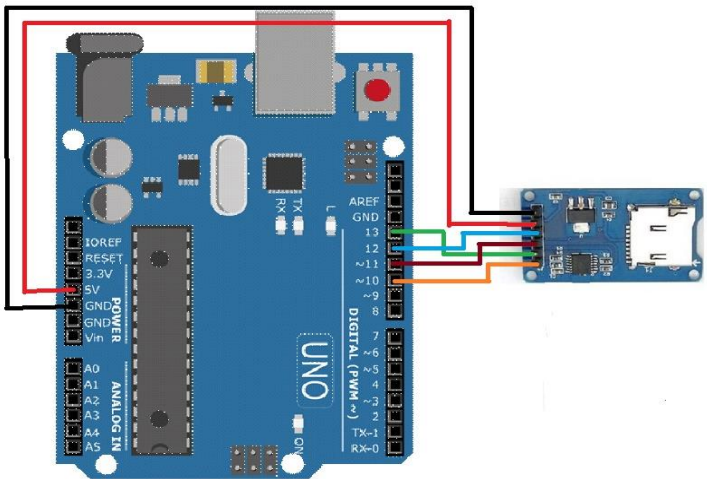

FIG16 Interfacing SD Card module with Arduino

The SD card is the memory module used to store the data. For storing data in SD card, we use a SD card module. Here, CS is connected with D10, MOSI with D11, MISO with D12, and SCK with D13. CK stands for Chip select to select whether to read from SD card or write to SD card. CS is to select whether MISO or MOSI is to be done. MOSI stands for Master OUT Slave IN. MOSI is the SPI input to the Micro SD Card Module i.e., it reads data from microcontroller and stores it into SD card. MISO stands for Master IN Slave OUT. MISO is the SPI output from the Micro SD Card Module i.e., it reads the data from SD card and gives to microcontroller. SCK (Serial Clock) pin accepts clock pulses from

Arduino which synchronizes data transmission between SD card Module and Arduino.

Before inserting the SD card, the card must be formatted to FAT32 file. When the card is inserted it is initialized first. If initialization is completed successfully SD card is fit for reading or writing data. In this project, the data in microcontroller is written to the SD card.

When collision occurs, the values of CO2 sensor and alcohol sensor in the time of incidence is taken and Arduino which is interfaced with SD card module, writes the data to the SD card.

4.5 Result

The proposed work can send an alert through an SMS to the pre-coded number, the mobile number of the user should be included in the software programming in order to receive the accident location values from the SIM card which we are using in GSM modem. The data from the sensors can also be saved in the SD card during the collision.

This is how the data is stored in the SD card.

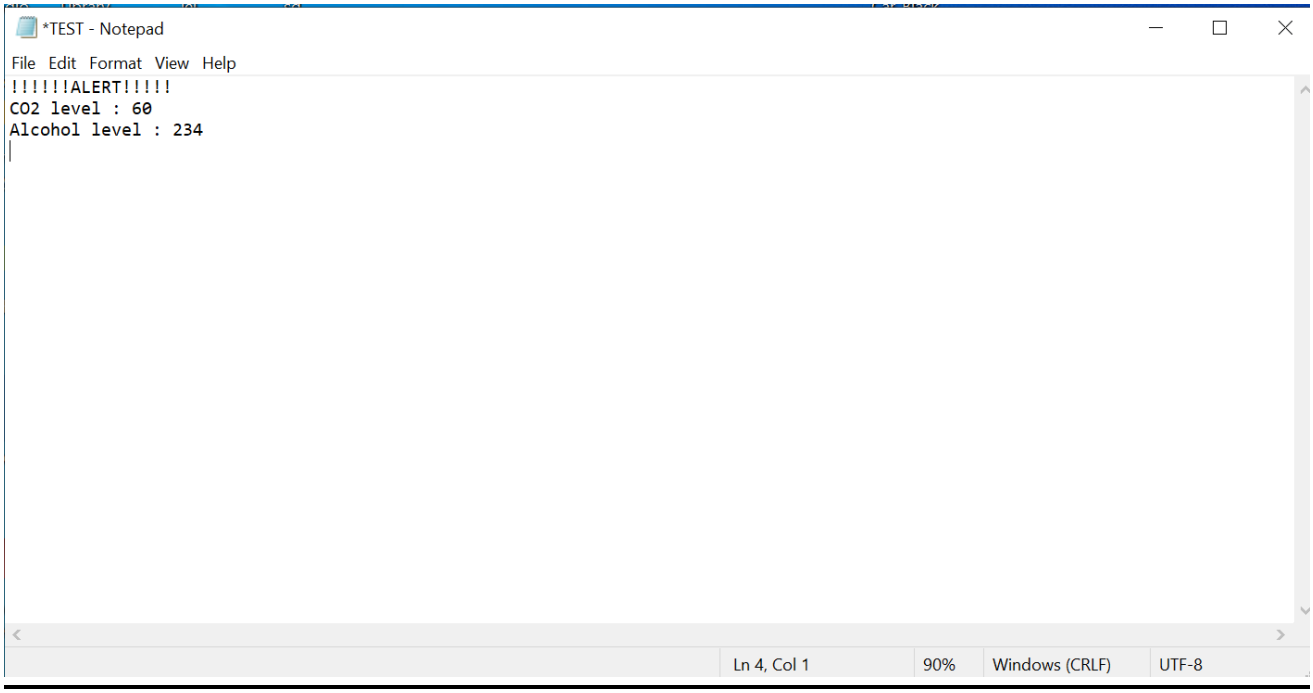

FIG17 Data written in SD Card

This is the message seen in mobile

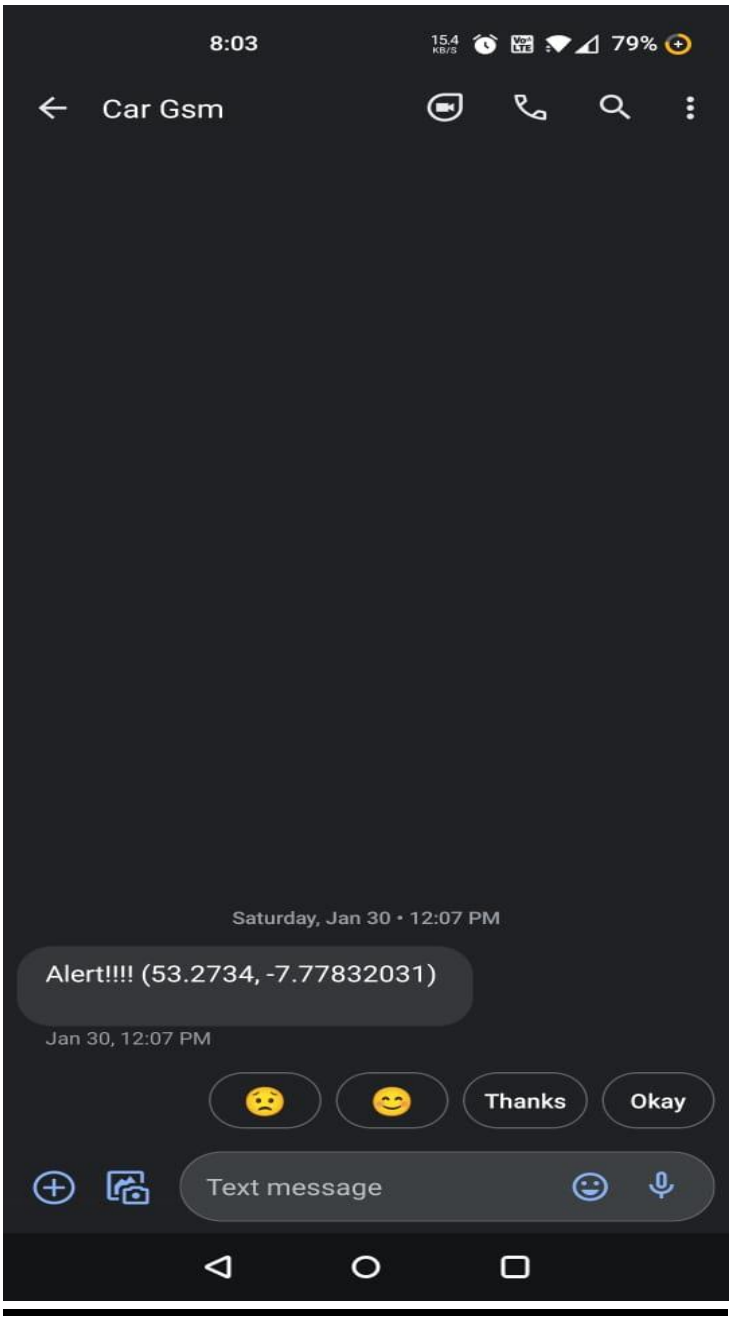

FIG18 Accident Detection Message

5. Conclusion and Future Scope

The project Black Box is successfully implemented on embedded system which gave required results and expected functioning. The black box also gains an importance in investigation of car accidents. We can easily retrieve the data from the Black Box. By recording the events and actions of the driver including speed, braking, turning, etc. seconds before the collision, the car black box will undoubtedly help both the police and insurance companies in reconstruction of the events before the accident. This data also has the potential to augment data in crash databases, by providing information especially relating to system performances. This is also very helpful as emergency medical services can be provided.

There are scope for improvement in this project too. Introducing new sensors in the car will increase the car black box system performance. If the exact location of the car needs to be found out we can incorporate GPS Module in it. The introduction of camera module and voice recorder can record both audio and video which may be helpful for visualizing the accident. The data from camera and voice recorder can be saved in the SD card. ABS sensor can be used to detect whether the braking system was in good condition or not.

With rapid expansion of technology nothing is permanent. So, any product or service should be updated with existing technologies. This product can also made better in future.

6. References

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