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MODELLING OF BLDC MOTOR AND IOT BASED VEHICLE ACCIDENT DETECTION AND RESCUE SYSTEM FOR ELECTRIC VEHICLE

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Abstract:

In a world where protection of environment and conservation of energy are giving primary importance, the growth and mercenary of electric vehicle have taken on an accelerated pace. The present and predictable future most importance in the development issue of electric vehicles is how to evolve different energy sources in electric vehicles. Nowadays we are able to track vehicles using many applications which helps in securing personal vehicles, public vehicles, feet units and others. Furthermore, there is a rapid increase in the occurrence of the road accident. This project is about a system which is developed to automatically detect an accident and alert the nearest hospitals and medical services about it. This system can also locate the place of the accident so that the medical services can be directed immediately towards it. The goal of this paper is to build up vehicle accidental monitoring system using MEMS, GPS and IOT technology. The system comprises of accelerometer, MCU, GPS & IOT module support in sending message. The accelerometer is used to detect fall and threshold algorithm are used to detect accident. Short message will contain GPS [latitude, longitude] which helps in locating the vehicles.

***Index Terms* – Accident Detection, BLDC Motor, MEMS Sensor, GPS, IoT.**

I. INTRODUCTION

[1] Electric vehicles (EV) first came into existence in the mid-19th century when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. It is known that electric vehicle technology has been gaining importance at both military and commercial vehicle systems for the last decades. So, it is recognized that wide applications of electric vehicles will bring tremendous social, economic and ecological benefits. [2] The BLDC Hub motor is placed in the rear wheel of e-Walker. The input voltage of 24 volts is given from boost converter to the stator part of the motor. Here the actual speed of 5 the BLDC Motor is sensed and it is compared with the reference speed and produce error signal. [3] The error signal is given to PID controller. The PID controller modifies the error signal and produces the control signal. The control signal is given to converter circuit to control the speed of motor. And also, the projected system is employed to scale back the time delay between the accident and providing emergency services. The vehicle pursuit and accident detection device are often put in in any vehicle.Whenever a vehicle is taken or associate accident happened to the vehicle the coordinates is taken through international positioning system (GPS) module and is regenerate into Google map link through the formula within the Node MCU. The formula is preinstalled within the Node MCU. In the event of associate accident, the traveler should receive facilitate promptly and also the folks related to the person should be notified immediately. The paper proposes a system wherever Mems Accelerometer sensors mounted on the vehicle will observe a crash and signal the small controller that successively passes the information containing the coordinate location of the crash beside the identification details to the cloud server. The google map link is distributed through International

System of Units for mobile Application to a predefined mobile sort of members of the family and near police headquarters. The friend will get the exact location of the vehicle by clicking on the google map link provided among the SMS.

II.LITERATURE SURVEY

From the past event and the existing approach, the below Drawback are been noted:

- Manual system is adopted.
- Tracking of accident is a crucial process in the system.
- Required medical attention cannot be given to the needed person.
- Life loss and Property loss were not stopped in large scale. Considering all the drawbacks into account we have formulated a proposed system which covers all the above-mentioned drawbacks.
- An Automated system is used once the accident occurs.
- This system gives the Latitude and Longitude of the system accident occurred area without any delay.
- More Human life can be saved using this automated system

III.BLOCK DIAGRAM

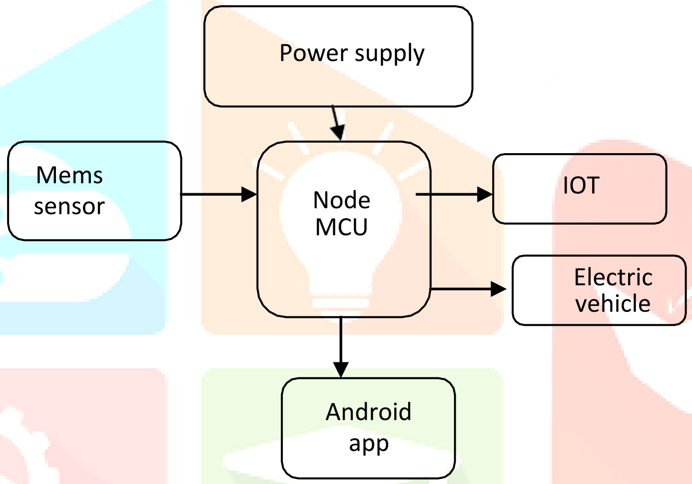


Fig 1: Block Diagram

IV.EQUIPMENT AND METHODOLOGY

A. BLDC MOTOR:

[2] Brushless DC motors (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous electric motors powered by direct-current (DC) electricity and having electronic commutation systems rather than mechanical commutators and brushes. The current-to-torque and voltage-to-speed relationships of BLDC motors are linear. BLDC motors may be described as stepper motors with fixed permanent magnets and possibly more poles on the rotor than the stator or reluctance motors. Brushless DC Motors (BLDC) consists of stator and rotor similar to any electrical machine. It is easier to control (6 steps) and only dc currents are required. They are electronically controlled and the current carrying stator windings are excited in a particular pattern. The position of rotor has to be known so as to realize which winding has to be energized next and hence three hall sensors will be fixed into the stator. The BLDC motor equivalent circuit is as shown in fig 2.

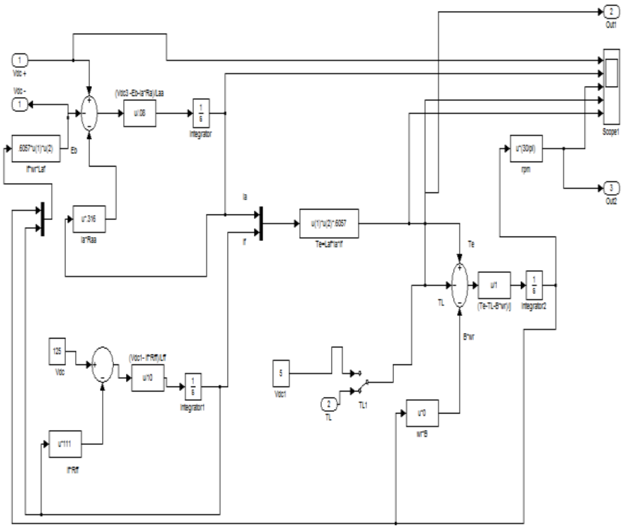


Fig 2 Simulation model for BLDC motor.

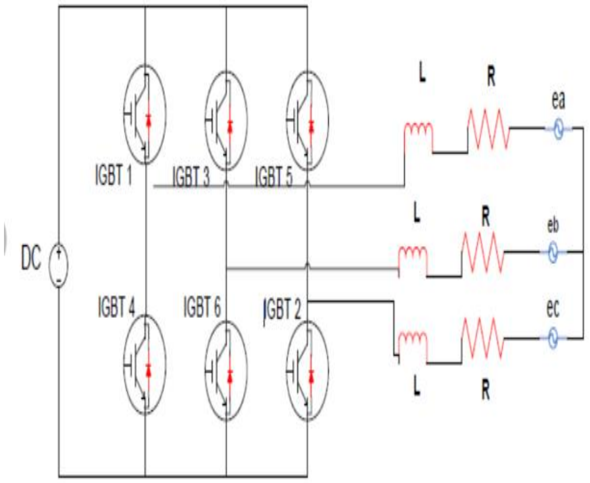


Fig 3 Equivalent circuit of BLDC motor

Equations for voltage of phases a, b, c are given by

$V_a = Raia + L\,(i_a\, dt\,) + ea$ (1)

$V_b = Rbib + L\,(i_b\, dt\,) + eb$ (2)

$V_c = Rc\, ic + L\,(ic\, dt\,) + ec$ (3)

Where:

R_a = Stator resistance of phase A

i_a = Phase current

L = Inductance

e_a= Back EMF of phase a

e_b= Back EMF of phase b

e_c = Back EMF of phase c

ω = Rotor Speed Electromagnetic

torque equation is given by $Te= (eaia+ebib+ec\, ic\,)/\omega$ (4)

The mechanical torque is given by $Tm = J\, d\omega\, dt + B\omega + TL$ (5)

B= Damping Constant

J= Rotor Inertia

TL= Load Torque

Table:1 Parameters of BLDC Motor

Sl.no	Parameter	Design Parameters
1	Voltage	24volt
2	Torque	5 N-m
3	Maximum Speed	350rpm
4	Current	7Amps
5	Maximum Current	14Amps
6	Motor type	Hub
7	Motor size	22cm
8	Power	300Watts

B.PID CONTROLLER:

[3] The PID-controller produces an output signal consisting of three terms-one proportional to error signal, another one proportional to integral of error signal and the third one proportional to derivative of error signal. In PID – controller,

$$u(t)\alpha\left[e(t)+\int e(t)dt+\frac{d}{dt}e(t)\right] \tag{6}$$

$$\therefore u(t)=K_p e(t)+\frac{K_p}{T_i}\int e(t)dt+K_p T_d\frac{d}{dt}e(t) \tag{7}$$

Where,

K_p -Proportional gain

T_i - Integral time

T_d - Derivative time

On taking Laplace transform of equation (7) with zero initial conditions we get,

$$U(s) = K_p E(s)+\frac{K_p}{T_i}\frac{E(s)}{s}+K_p T_d sE(s) \tag{8}$$

$$\therefore \frac{U(s)}{E(s)}=K_p\left[1+\frac{1}{T_i s}+T_d s\right] \tag{9}$$

The equation (8) gives the output of the PID-controller for the input E(s) and equation (9) is the transfer function of the PID controller .The block diagram of PID controller is shown in Fig.2.

1.Design Specification

Proportional, Integral and derivative gain are chosen as

K_p = 11.8 or 2, K_i =8.15 or 2.5 and K_d = 0

Where,

K_p - Proportional gain or constant

K_i - Integral gain or constant and

K_d - Derivative gain or constant

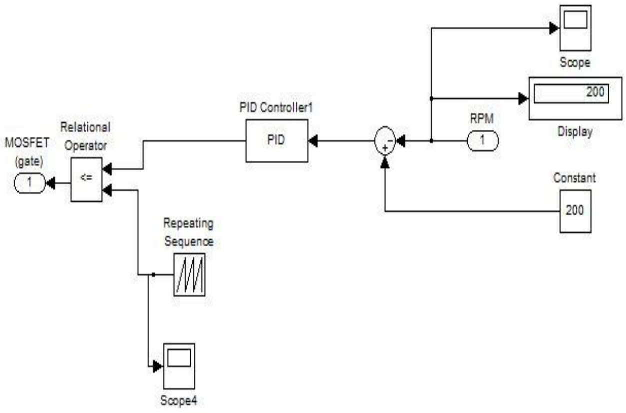


Fig 4 simulation model for PID controller.

C.BOOST CONVERTER:

[4] In boost regulator the output voltage is greater than the input voltage, hence the name "boost".[7] A boost regulator using a power MOSFET is shown in the figure. The circuit operation can be divided into two modes. Mode 1 begins when transistor M_1 is switched at t=0. The input current, which rises, flows through inductor L and transistor Q_1. Mode 2 begins when transistor M_1 is switched off at $t=t_1$. The current that was flowing through the transistor would not flow through L, C, load and diode.

The inductor current falls until transistor M_1 is turned on again in the next cycle. The energy stored in inductor L is transferred to the load The equivalent circuits for the modes of operation are shown in the figure.

The waveforms for voltages and currents are shown in figure for continuous load current, assuming that the current rises or falls linearly.

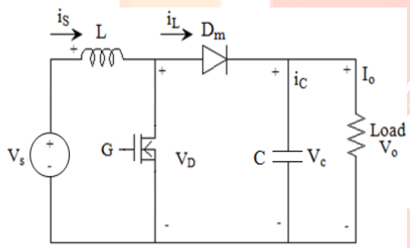


Fig 5 Equivalent Circuit for Boost Converter

Table 2 Parameters of Boost Converter

Sl.	Parameters	Values
1.	Duty Cycle	60%
2.	Resistor	2.667Ω
3.	Inductor	6.44×10^{-4}
4.	Capacitor	2.245×10^{-4}
5.	Filter Capacitor	0.112 F
6.	Filter Inductor	3.2×10^{-4} H

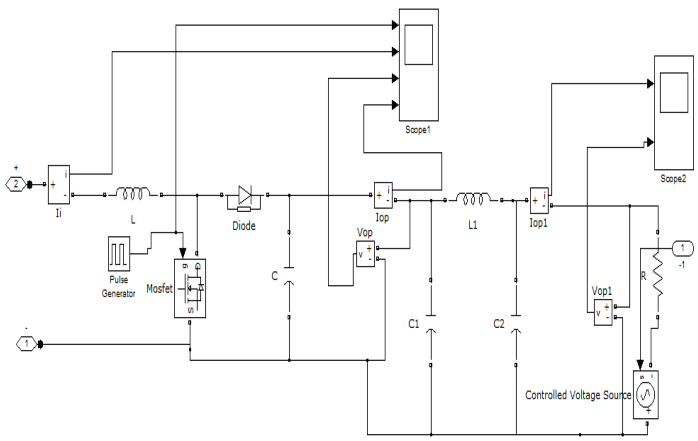


Fig.6 Simulation Model for Boost Converter.

D.VEHICLE KINETICS:

[5] Motion of vehicle can be decided by the forces exerting on it in the motion of direction. The forces exerting on a vehicle, moving up a grade, are shown in fig. 3

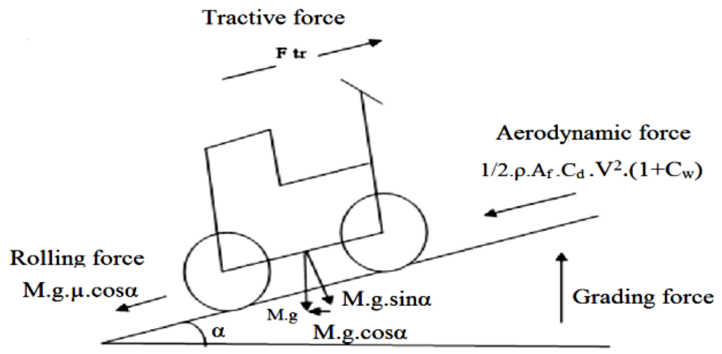


Fig. 7 Vehicle Kinetics.

Let:

Mv = Mass of the vehicle

V= Vehicle speed

Trf=Rolling resistance moment of front wheel

Trr=Rolling resistance moment of rear wheel

Frf= Rolling resistance of front wheel

Frr= Rolling resistance of rear wheel

Fw= Aerodynamic drag

Fa=Acceleration resistance

Fg =Grade climbing resistance

Ftf= Tractive effort of front wheel

Ftr= Tractive effort of rear wheel

G=Acceleration due to gravity

α= Road Angle

The dynamic equation of motion of vehicle may be expressed as:

$$M\ dV\ dt = (Ftf + Ftr) - (Frf + Frr + Fw + Fg + Fa) \quad (10)$$

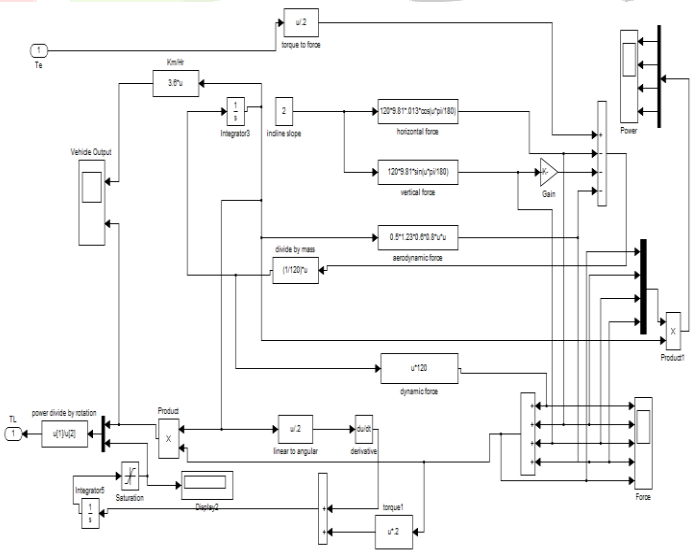


Fig. 8 Simulation Model for Electric vehicle.

E.WIFI MODULE:

[8] The unit that makes this project Internet of Things compatible is ESP8266 Wi-Fi module. This module is a self-contained OC having an integrated TCP/IP protocol stack which gives any microcontroller- based board an access to the internet. It come with a pre- programmed AT command set firmware. The maximum operating voltage of ESP8266 is 3.6V But to make the Arduino Uno and ESP8266 communicate, a Logic Level Converter is needed since ESP8266 is not capable of 3-5V logic shifting. The Rx and Tx pins of ESP8266 are connected to the logic level converter which is connected to the Arduino Uno. With the help of this module, we can set up the Arduino board to the cloud platform and the transfer of data can be done wirelessly.

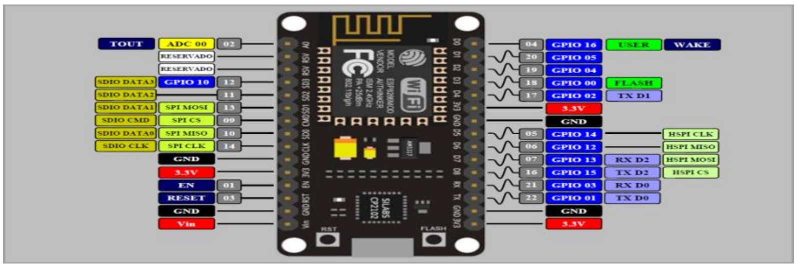


Fig 9 Node MCU Wifi Module.

F.MEMS ACCELEROMETER

[9],[10] ADXL335 complete, low-power 3-axis accelerometer measures dynamic acceleration (motion, shock, or vibration) and static acceleration (tilt or gravity) over a ±3 g range with 0.3% nonlinearity and 0.01%/°C temperature stability. [11] The user selects the bandwidth of the accelerometer using the CX, CY,

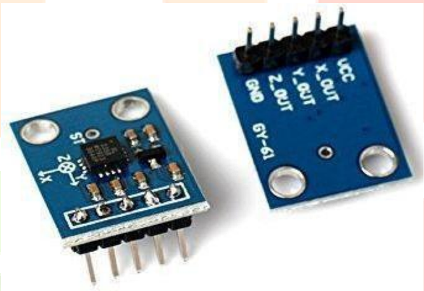
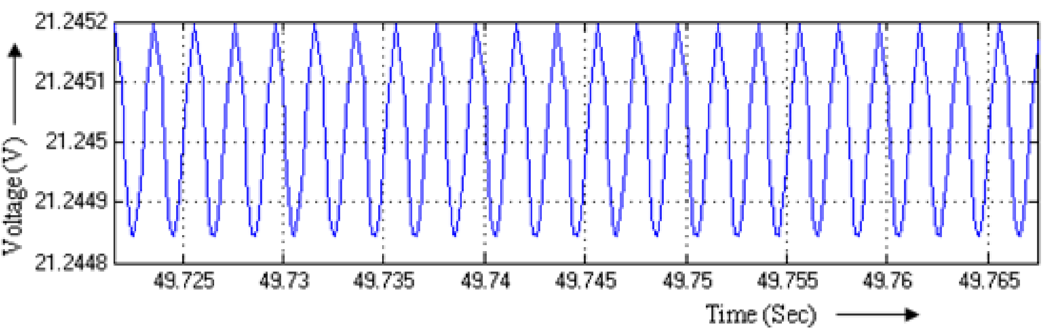


Fig.10 Mems Accelerometer

and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Measurement bandwidth can be selected to suit the application from 0.5 Hz to 1600 Hz for X- and Y- axes and from 0.5 Hz to 550 Hz for the Z-axis. Operating on a single 1.8 V to 3.6 V supply, the ADXL335 consumes 350 µA. Available in a 16-lead LFCSP package, it is specified from -40°C to +85°C

V.SIMULATION RESULTS AND DISCUSSIONS OF ELECRTIC VEHICLE.

The simulation study of the BLDC motor and PID controller and boost converter in each mode was validated in MATLAB-SIMULINK environment and overall representation is shown in the below figures and results are presented to demonstrate its behavior at different conditions.



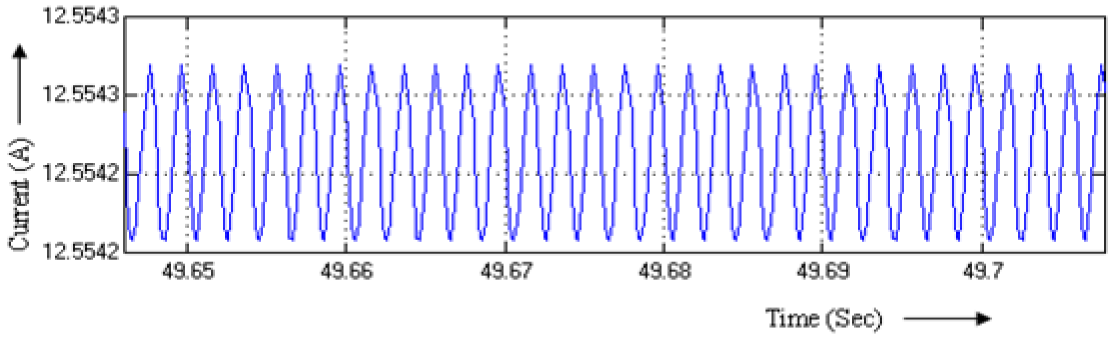


Fig 11 Voltage and current of Boost Converter

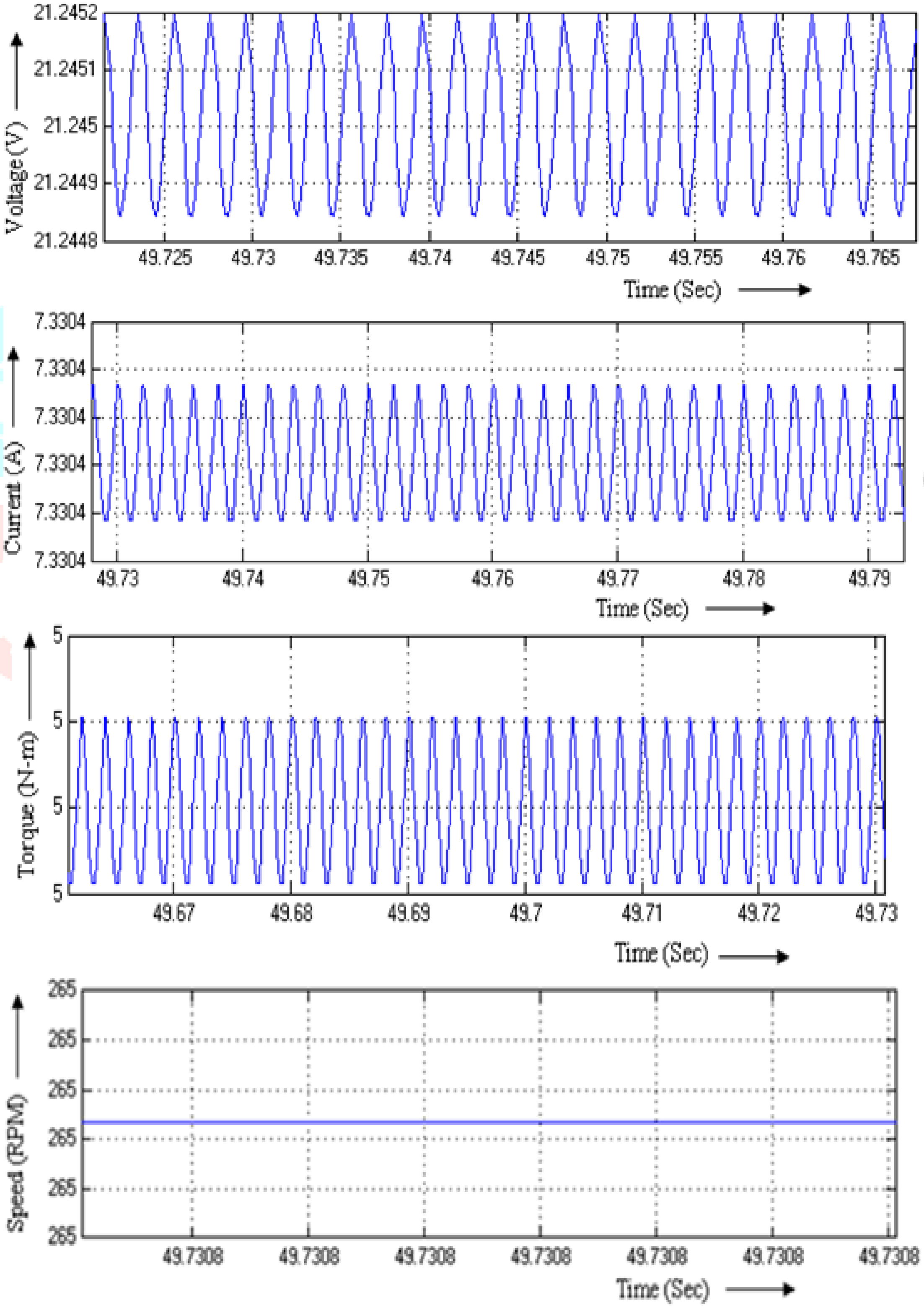


Fig 12 Voltage, Current, Torque and Speed of BLDC Motor

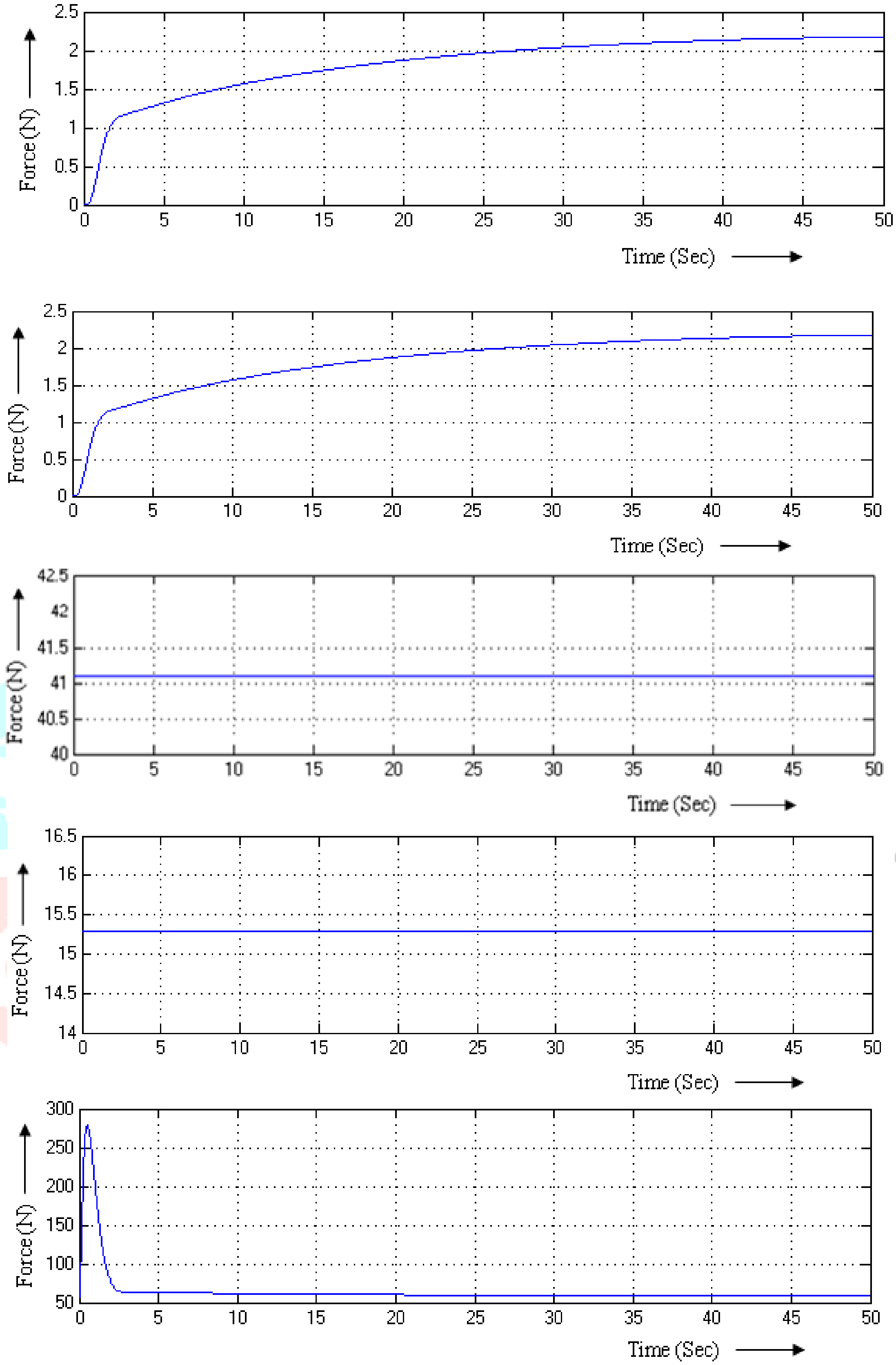


Fig 13 Aerodynamic, Gradient, Road Resistance and Tractive Force output of Electric Vehicle

VI.WORKING OF THE ACCIDENT DETECTION AND ALERM SYTEM

1. When accident is occurred, the location details of vehicle/object collected by the GPS module from the satellite, this information is in the form of latitude and longitude scale.

2. Thus, collected information is then fed to Nod mcu. Necessary processing is completed and therefore the information is passed to the wifi module.

3. The wifi module Antenna collects the information for Mode mcu and then transfer it to the mobile phone through the SMS which is in text format.

A. FLOW CHART

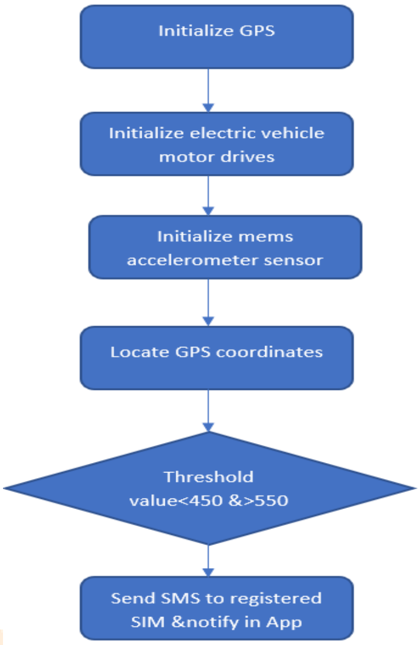


Fig 14 Flow Chart of GPS based System

CONMPARISION OF SENSOR VALUE WITH THE THRESHOLD VALUE

S. No.	*Threshold Value of Accelerometer*	*Accident Severity*	*Message Send*
1	x>450	No Accident	NO
2	x<450	Accident	YES

VII. CODE FOR GPS SYSTEM:

```
#include<ESP8266WiFi.h>
 #include<Firebase Arduino.h>
 #include <Software.serial.h>
#Define FIREBASE "jbitvechil-default-rtdb.firebaseio.com"
 #Define FIREBASE "GW3tlf2349gIhFrh26m8RT6tNzBNtgIOMMuay8Ck"
 #Define WIFI_SSID "iotproject"
#Define WIFI_PASSWORD "iotproject01"
 int sen=A0;
String msg;
int acc_v, s_v;
float latitude;
float longitude;
float spd; //Variable to store the speed
float sats; //Variable to store no. of satellites response
String bearing; //Variable to store orientation or direction of GPS
```

```
int x, i, g, m, v, s, k;
long int distance;
long int distance, duration;
void setup ()
{
 Serial. Begin (9600);
pin Mode (Sen, INPUT);
WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
 Serial.print("Connecting....");
while (WiFi.status()! = WL_CONNECTED)
 {
 Serial.print(".");
 delay (500);
 }
 Serial.println();
 Serial.print("connected: ");
 Serial.println(WiFi.localIP());
Firebase. Begin (FIREBASE_HOST, FIREBASE_AUTH);
 }
 void loop ()
 {
 Serial.print("SEN:");
 Serial.println(analog Read(A0));
Serial.println(); delay (500);
 }
 void display Info ()
 {
 if (gps. location. is Valid ())
 {
  latitude = (gps.location.lat ()); //Storing the Lat. and Lon.
 longitude = (gps.location.lng ());
}
 Serial.println();
 }
```

VIII. SYSTEM SET-UP PROTOTYPE:

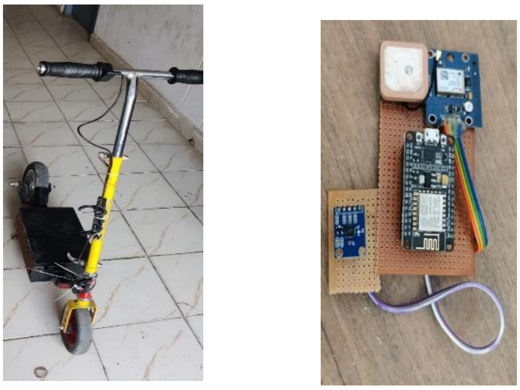


Fig15: Prototype.

IX. TEST RESULTS:

The device was tested in rural areas and located those things of the vehicle was expected effectively in most of the cases. However, the exact location link shown at intervals the message interfaces. In this protype we have achieved accident detection for electric vehicle and also location sharing using IOT technology. In this project we have mems sensors for identification of accident. This mems sensor has predetermined value of 530 whenever the predetermined value of mems sensors goes beyond 450 or raises above 550 mems sensor will activate and the accident occurred location is shared to concerned persons using a mobile application and also displays the exact live location of the accident in the mobile application.

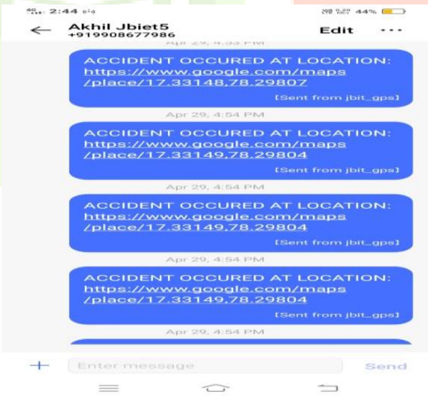


Fig 16 accident alert message.

X.CONCLUSION:

In this project Modeling of an innovative prototype e-Walker is made in Simulation as well as in hardware. From the results obtained it is evident that e-Walker is the best suited for an EV propulsion system for meager and medium distance transportation as it offers higher efficiency, reliability and most economic than the existing models. Furthermore, for an e-Walker the expected output characteristics of PV panel, Converter, BLDC Motor and electric vehicle are presented in this project. And also expected performance is achieved through implementation of the proposed system. The sensor and other required components are distributed throughout the vehicle providing more optimal results to detect accidents. The proposed system can also be used for traffic estimation and system performance estimation to prevent loss of life to its maximum.

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