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Design of EV with fault detection and Monitoring in low voltage system

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Abstract - Electric vehicles first appeared in the mid-19th century. An electric vehicle held the land speed record around 1900. The higher prize, small range of battery electric vehicles, compare to combustion of engine vehicles, Causes worldwide decline in their use; although electric vehicles have continued to be used in the form of trains and other uses.

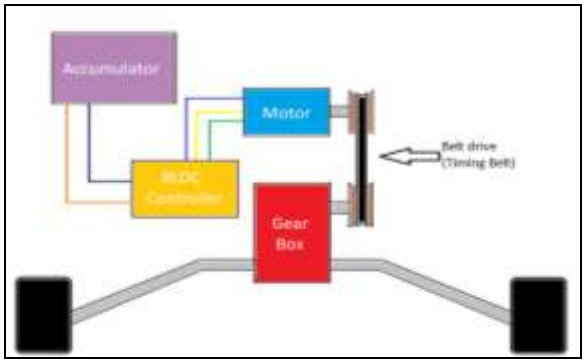
Taking considerations of recent events of major resources and facilities at their disposal, over increasing traffic, snags problem of parking and the need to make automobile a more environmental friendly, to overcome from that, designer came with new concepts and ideas that is electric vehicle. The required amount of torque which is required for vehicle, For designing electric vehicle the most important component to be selected is motor, which depends on the traction power require for the vehicle. The size of the motor is also an important consideration which depends on the rating of the motor. Therefore, to achieve all the traction characteristics in compact size, a proper selection of motor rating should be done based on the load.

Key Words: 1.E-Vehical. 2. BLDC motor. 3. Lithium ion Battery. 4.Bldc Controller. 5. Monitoring system.

1. INTRODUCTION:

Electric vehicle are environment friendly technology which helps in reducing pollution of harmful gases. In electric vehicle there are many components like Traction motor, Motor controller, Traction batteries and other ECU's which monitor vehicle parameters such as SOC, SOH, battery voltage, motor and battery temperature etc. electrical system of vehicle is divided in to two major categories tractive system and control system.

Traction system consist of High voltage components such as battery, motor, motor controller, main contactors.



Above block diagram shows the electrical power transmission and conversion to mechanical power, from battery to the wheels of the vehicle (power train).

Section 2 explains the selection of battery, motor controller.

Section 3 explains the calculation of traction motor form vehicle dynamics parameters such as rolling resistance force, grad ability, aerodynamic drag, etc. the calculation is performed by considering the vehicle top speed as 50km/hr.

Section 4 explains the monitoring system of the vehicle. In this all the vehicle parameters are feed back to the monitoring device. It here also explained about I^2C communication protocol used. And finally

Section 5 concludes the report.

2. DESCRIPTION OF THE PROJECT

In this design the hardware components that we use are:

- Battery
- BLDC Motor
- Controller
- Converter
- Monitoring System using Arduino and I2C protocol

2.1 BATTERY (48V, 110 AH)

Fig: Battery 48V, 110Ahr Li-Ion Battery

Table-1: Specification of Battery.

BATTERY SPECIFICATIONS	
Type	Lithium ion
Voltage (v)	51.8
Current rating (Ah)	110

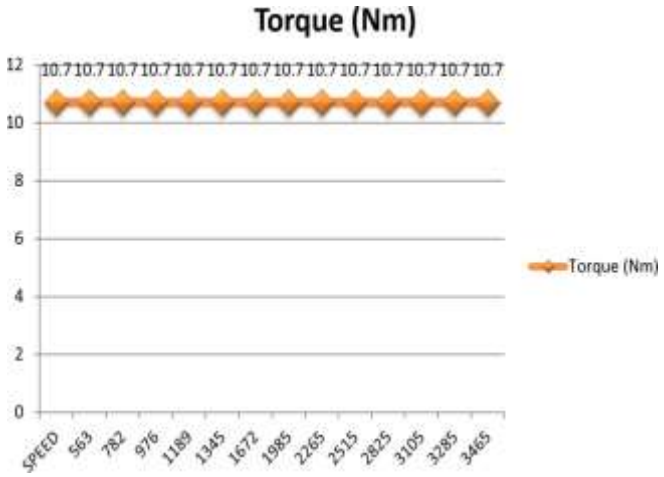
2.2 BLDC MOTOR (4.5KW)

The BLDC motor is extensively used in applications including

Different types of vehicles and other application which is related to the motor.

Table-2: Specification of Motor.

TYPE	BLDC Motor
POWER	4500 watt
VOLTAGE	48 volts
CURRENT	94 Amp
TORQUE	10.7 Nm
RPM	4500



Torque vs speed characteristics

Advantages:

- Higher efficiency and reliability
- Smaller and lighter
- Greater dynamic response
- Better torque vs speed characteristics

2.3 Controller

Generally all new E-Vehicles are developed with the help of controller. Different types of controllers used in E-Vehicles. The motor controller allows the motor to rotate at diff speed. It takes input from battery and gives ouput to the motor. We use KLS 7245H Motor controller

- Battery Pack Compatibility: Works with 48 Volt Battery Packs
- Motor Compatibility: Works with 4500 Watt Brushless DC Motors
- Current Limit: 94 Amps (94 Amps Maximum Current Output)
- Low Voltage Protection: 39.2Volts Dc

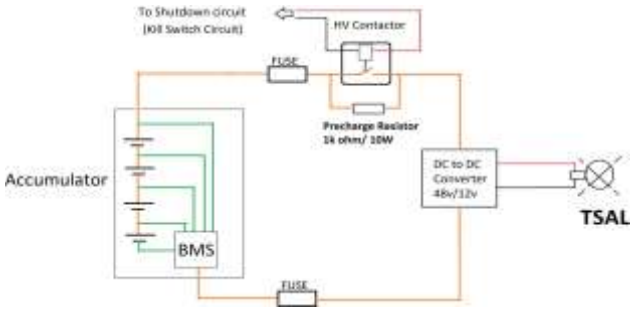
2.4 Converter

A DC-DC Converter is a category of power converter and it is an electric circuit which convert a source of direct current from one voltage level to another (48v to 12v).

Specifications

Input Voltage: 48 Volt to 72 Volt

Output Voltage: 12 Volt



Block dia. of DC-DC converter

3. CALCULATIONS

1)Aerodynamic drag can be calculated using the following formula.

$$F_{drag}=0.5CdA*1.225*(V+V0)^2$$

Where,1.225=Density of air

Cd-Coefficient of drag

A-Frontal area of vehicle in m^2

V-Speed in m/s.

2)Rolling resistance can be calculated as follows:

Frr=Crr*g*m

Where,

Crr-Coefficient of rolling resistance

g-Acceleration due to gravity($9.81 m/s^2$)

m-Mass in kg.

3)Gradient force can be calculated as follows:

Fg=m$\sin\theta$

Where, m-Mass in kg

θ-Road or hill climbing angle

FT=Fdrag +Frr +Fg

Where, FT-Total Force

Total power required to travel electric scooter

PT= FT*V

Where, PT- Total Power,

V-Velocity (m/s)

Table-3: Specification of Vehicel.

Coefficient of drag	1.28
Rolling resistance	0.030
Mass with rider	318kg
Frontal area	2.25 m^2
Density of air	1.225
Road or hill climbing angle	25º
Velocity	50kmph
Radius of tire	11.5"=0.2921m

Fdrag=0.5*1.28*2.25*1.225*50=88.2N

Frr=0.030*9.81*318=93.58N

Fg=318*sin(25)=134.394N

FT=88.2+93.5+134.39=316.09N

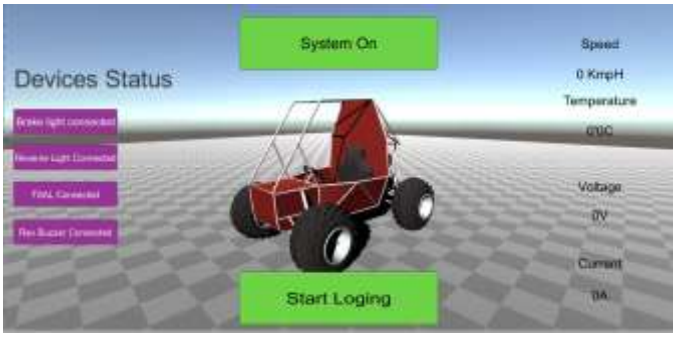
PT=316.88*13.88=4387.32Watt (Approximately= 4.5KW)

4. Data and Fault monitoring system:

To monitor system parameters and fault and their location, we have developed a sub system that will take parameters from our high voltage system and display it on display or smart phone or desktop monitor.

Initially I2C communication is established between two Arduino Uno. From this two Arduino one Arduino act as master and another as slave. Depending on parameters required we can increase the no of slave Arduino in the system. Arduino Master is placed at the front side of the vehicle; it will perform the action of initiation of slave arduino's. Based on the algorithm programmed on slave it will perform parameters check.

If all the parameters are within limit it will start main contactor which starts the system. If any parameter exceeds beyond the limit them it will display error on monitor and shutdown main contactor.



The monitoring system is developed in such a way that it support 3d rendering. As is shown in above figure. If the fault occurs and system shutdown then if user clicks on any of the button, then the application shows the location of that fault and associated components within the circuit.

Development flow:

1. Initially I2C communication is established between master and slave.
2. Than slave is connected to system and algorithm is developed.
3. User Interface of Android application is developed in Unity 3d.
4. Java library is developed in Android Studio for establishing USB serial communication between android phone and Arduino master.
5. Library is then imported to unity 3D and final application is developed.

Algorithm of Slave Arduino.

Step 1. Establish I2C communication.

Step 1. Master initiate slave.

Step2 . Slave check system parameters and connected component

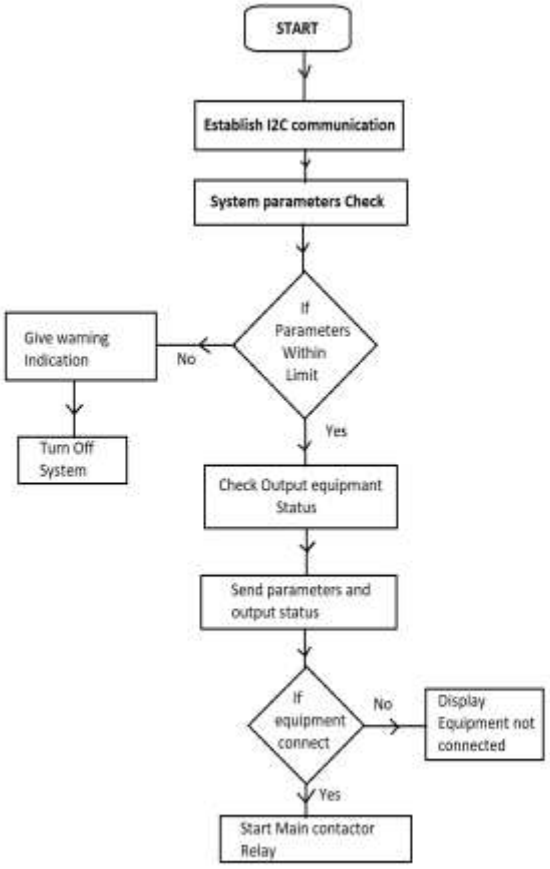
Step 3. Send Data back to master.

Step 4. Master setup USB serial communication with monitoring device.

Step 5. Master Sending serial data packets to monitoring device.

Step6. Based on the received data UI elements and 3d environment are constantly changed.

Flowchart:



5. CONCLUSIONS

- From this we can conclude the basic requirements of electric vehicle electrical system.
- We can also conclude the procedure to be followed for motor selection based on the dynamics of vehicle.
- Additionally more control is provided over the system by developing an algorithm by implemented I²C communication by using Arduino, so we can detect fault in system.

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BIOGRAPHIES

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