SERIES HYBRID IN TWO WHEELER

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Abstract : The issue of petrol depletion and emission of greenhouse gases are most prominent and adversely affecting the world today. The petrol depletion and hike in petrol prices are affecting the people negatively. To improve the social values in two wheeler marketing and improve the count of Zero Emission Vehicles (ZEV) we are fabricating a new system which is nearly similar to ZEVs. This system is SERIES HYBRID in TWO WHEELERS. The idea of this system is adapted from working of series hybrid locomotives, in a better way. The concept is implemented on an electric scooter which has a PMDC motor which drives the wheels. The motor is much better than the usual way of drive considering the efficiency. The drive using the ICE is efficient only when we have a constant speed for the vehicle. In this system the engine have no direct drive with the wheels. Engine is only used for generating the current. The motor is the only driving component that drives the wheels. The flow of power goes like this: the ICE is used to generate the emf on the generator and this generated emf is taken to the inverter which steps up the voltage and also converts to DC. This DC is then stored in the battery and according to the requirement the stored energy is taken from the battery to the motor. Thus we can reduce the emissions of a conventional engine and also can save the power used by electric vehicles.

***IndexTerms* – HEV, ZEV, Series Hybrid Vehicle.**

I. INTRODUCTION

Everyone knows the great contributions the automobiles have made in the growth of the modern societies; they helped satisfying many of its needs for mobility in every day's activities. The newest developments in automobiles technology considering lessening the fuel, as well as minimizing its environmental disadvantages, become later important news to hear, and even sometimes, more important than its newest models or styles. All that and more made the "Hybrid Electric Vehicle" one of those vital technologies, worth to be studied, especially, after it has been considered by the biggest automobiles manufacturers in the world. Not only that, but also it has become a competitive field among them. The dominant means for this transportation has been in the form of the automobile. However, the extensive use of automobiles has begun to show some detrimental environmental effects such as poor air quality and a drain on natural energy resources. In order to improve the air quality, the amount of harmful emissions produced by automobiles must be reduced. The dependence on foreign oil dependence will not encroach on the freedom of transportation. Concerns such as these have started new ways of thinking about personal transportation. The most important challenge in hybrid system is the battery, its weight, efficiency and the amount of energy stored in it are all taken into account when the selection is made.

II. HYBRID CLASSIFICAIONS

Types of hybrids include series, parallel, and blended hybrids. Blended hybrids use a combination of the two types of drive systems. Next to this a differentiation is made between conventional and plug-in hybrids. In a parallel hybrid the engine powers the drive axle and a generator that can either charge the battery pack or directly drive the axle. The combustion engine and the electric motor are connected to the transmission independently. The electric motor is designed to provide power during stop and go traffic while at highway speeds the vehicle is powered solely by the internal combustion engine. In addition, through a process called regenerative breaking, energy lost due to braking is recovered and utilized to charge the battery. In a series hybrid there is no mechanical link between the internal combustion engine (ICE) and the drive axle. The engine powers a generator that charges the battery pack. The electricity powers a motor which turns the wheels of the vehicle. Since the ICE is not connected to the wheels it can operate at an optimum rate.

III. PROPOSED TYPE

Our proposed vehicle is a series hybrid scooter, here we use alternator which is coupled to the engine through chain drive is used to generate electrical energy and charge the battery system. The motor used is a high torque PMDC motor based on the weight the vehicle should carry. In this fabrication project we use a 24v, 500w motor which is powered using two separate battery packs in which each battery pack contains two set of 12v battery(26ah) in the case of lead-acid battery or a 24v single battery in the case of li-ion batteries. Li-ion batteries are less weight when compared with lead-acid batteries hence they can be more preferred for fabrication.

In the proposed fabrication we use two separate battery packs in which only one battery pack will run the motor and at that time the other battery pack can be charged by using the IC engine set up. This above setup is done using two electromechanical relays(12v,80amp). When one battery pack gets fully charged or the other battery pack get empty the battery status data is controlled using an ATmega328 microcontroller and it provides signal to the relay to switch between the battery packs. The motor we used here is controlled by a 500w controller and acceleration is controlled using a throttle with key switch.

IV. MECHANICAL FABRICATION

The mechanical power from the engine is transferred to the alternator through chain transmission set up. The alternator is bolted above the engine to the chassis of the vehicle. The pulley setup of the alternator converted to chain setup by removing the pulley and replacing it with sprocket same as that of the engine sprocket. The sprocket has 13 number of teeth.

fig 1.Alternator engine coupling

Power from the motor is transmitted to the rear wheels through chain transmission. The motor is fitted vertically upward above the rear wheel drum. The motor is placed over carrier area of the chassis. The motor is provided with a sprocket contains 13 number of teeth and the rear wheel sprocket contain 50 number of teeth.

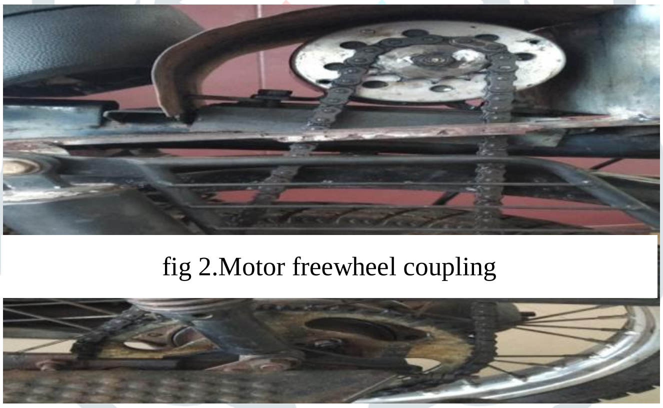

fig 2.Motor freewheel coupling

The figure below shows the entire mechanical system after complete assembly.

fig 3.Entire setup

V. ELECTRICAL CIRCUIT

Rectifier system is used in alternator to convert the alternating current produced to direct current used to charge the battery. The process is known as rectification, since it "straightens" the direction of current. The alternator's charging output flows through six diodes in the rectifier assembly before it goes to the battery and electrical system. The charging output of the alternator drops when diodes fail.

This circuit provides sufficient voltage of two set of batteries to ATmega328 which process the information and display the charge status of two batteries. The batteries voltages are reduced using resistors and supplied to ATmega328. The resistors used are R3,R5(10kΩ) and R4,R6(1kΩ).

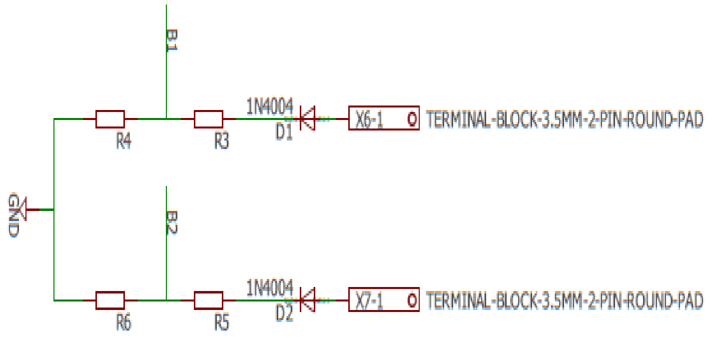

fig 4.Battery circuit

The positive terminal of alternator is connected to the H1 terminal and H2 terminal is connected to common negative. ACS770 process the current and provide the output to alternator status ATmega328 in a range of 0-5V.

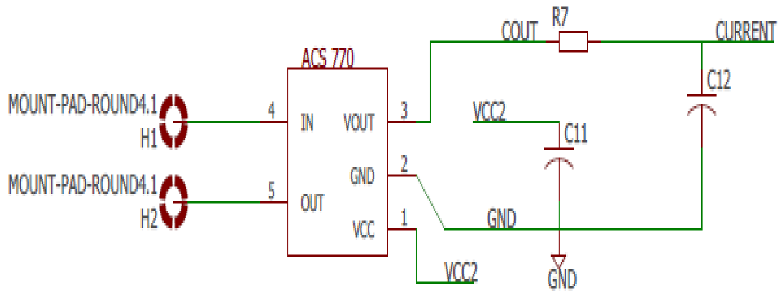

fig 5.ACS770 circuit

Terminals T1 and T2 are connected to battery status ATmega328 which controls the opening and closing of the electromechanical relay by use of voltage application (5V).

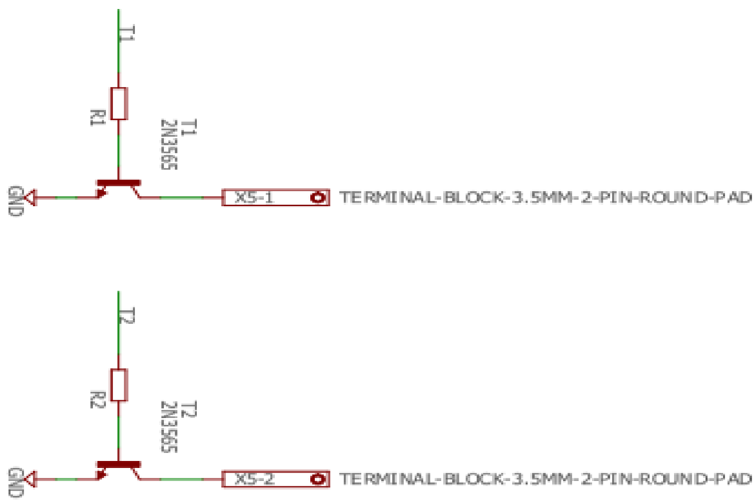

fig 6.Relay control circuit

This ATmega328 is used to control battery status information. Also it is used to control the relays. SD1 and SC1 ports control the display in battery status oled.

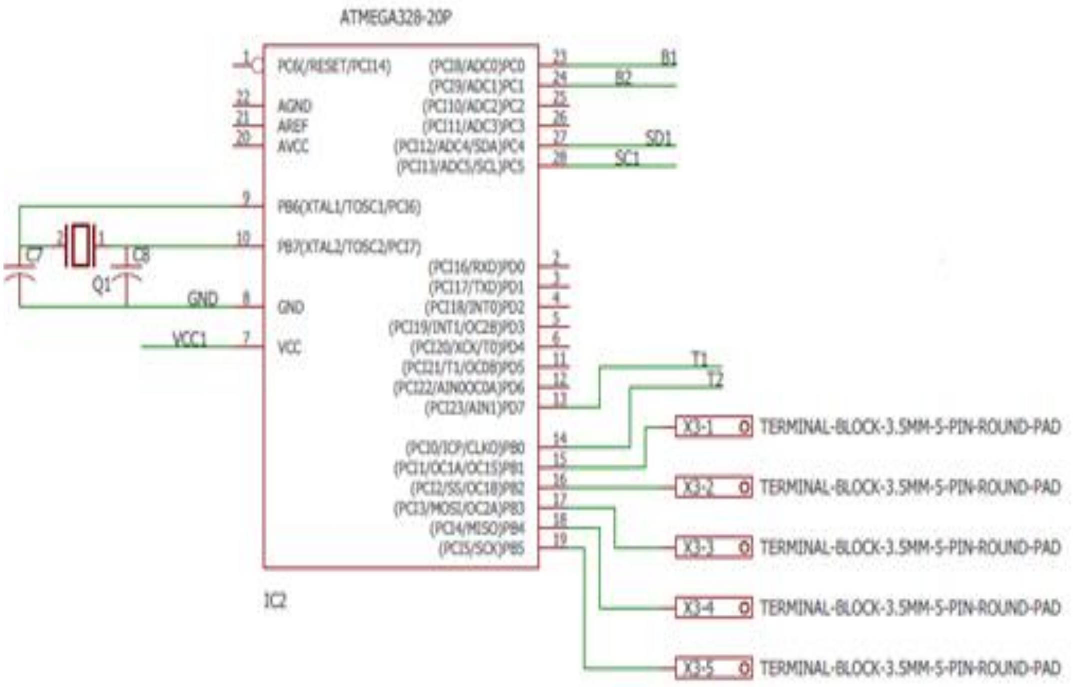

fig 7.Battery status circuit

This ATmega328 control the alternator status of the vehicle. SD2 and SC2 ports control display of alternator oled.

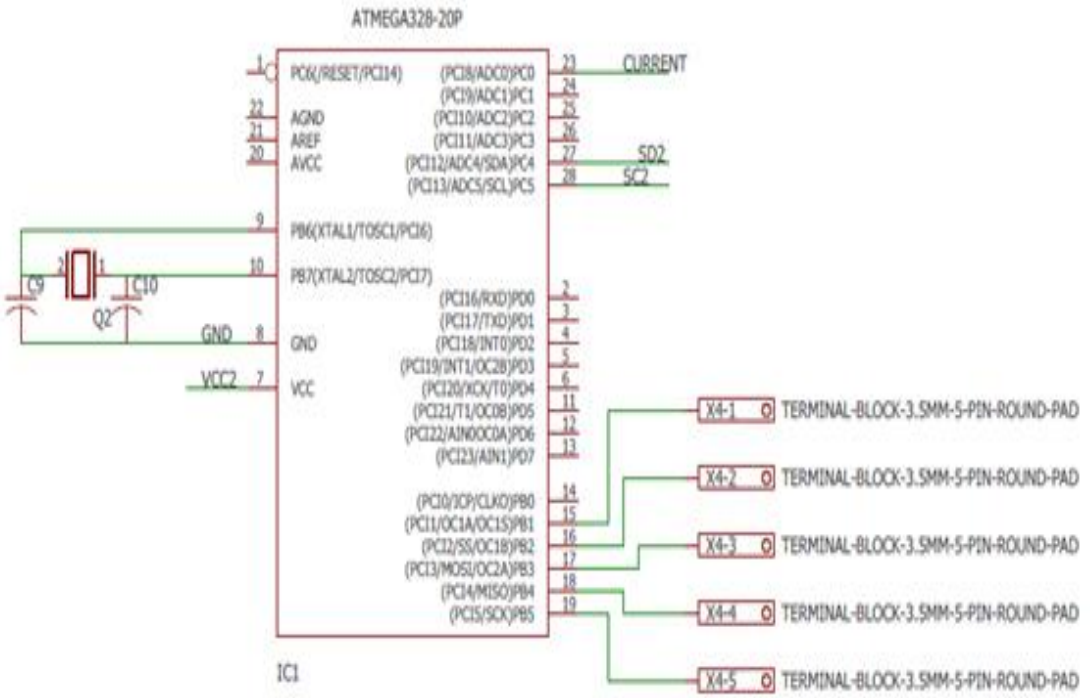

fig 8.Alternator status circuit

The circuit in PCB was designed by using Eagle software. Eagle is a scriptable electronic design automation application with schematic capture, printed circuit board layout, auto-router and computer aided manufacturing features.

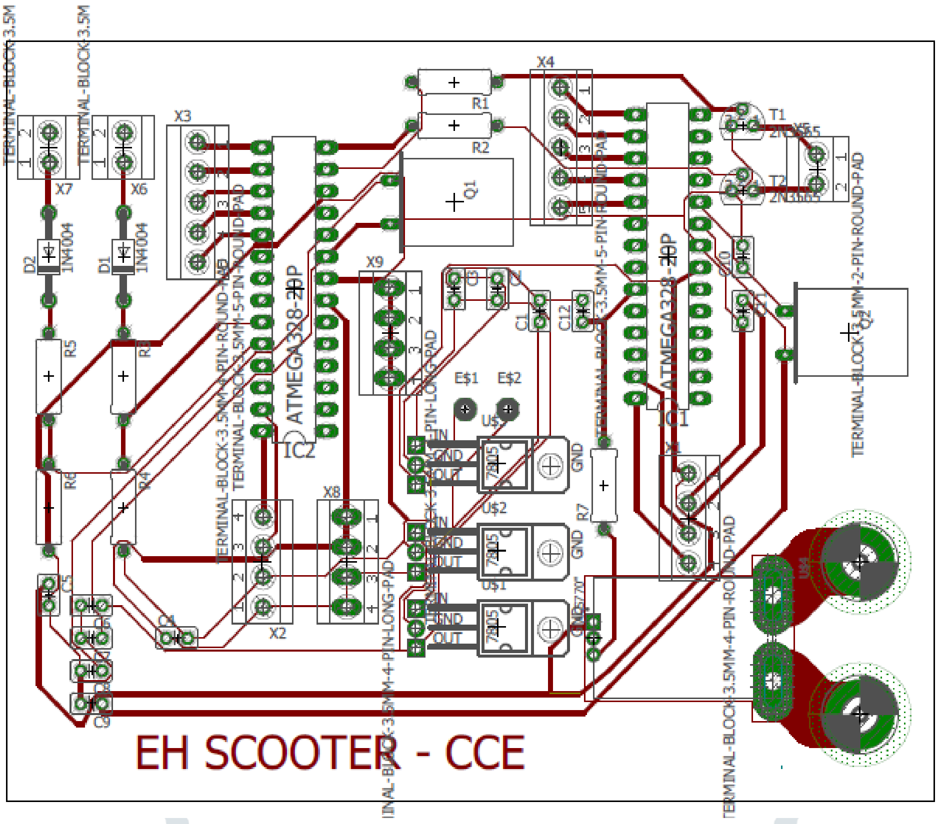

fig 9.PCB design

VI. SIMULATION

The simulation was done in matlab/simulink software. To conduct the simulation in matlab we have to keep any parameter as constant. In this set up we keep torque as the constant parameter and various characteristics like armature current, field current and speed performance of the motor are obtained. Here we provide inputs as:-

t=0sec,T=0Nm.
t=3sec, T=7.3Nm.
t=6sec, T=1.9Nm.

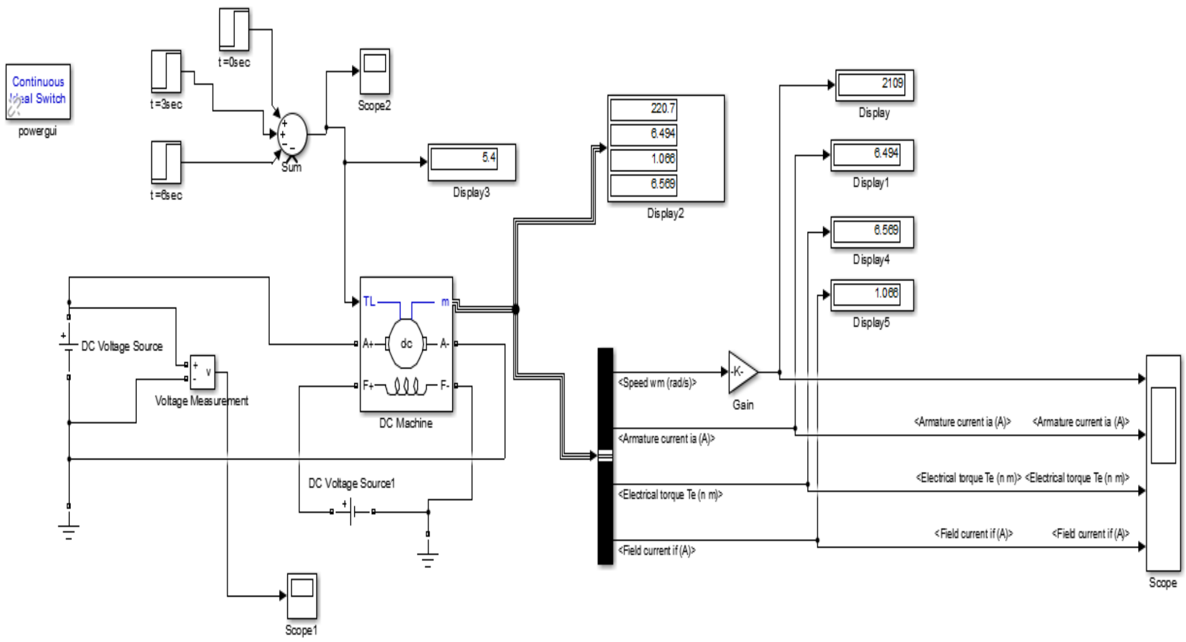

fig 10.Simulation of motor in matlab

6.1 Result Analysis

The result of simulation is obtained as in the form of graphs sow in the figures.

6.1.1 Armature current analysis for various torque is shown in the below graph. Here x-axis represents the time period and y-axis represents current in ampere.

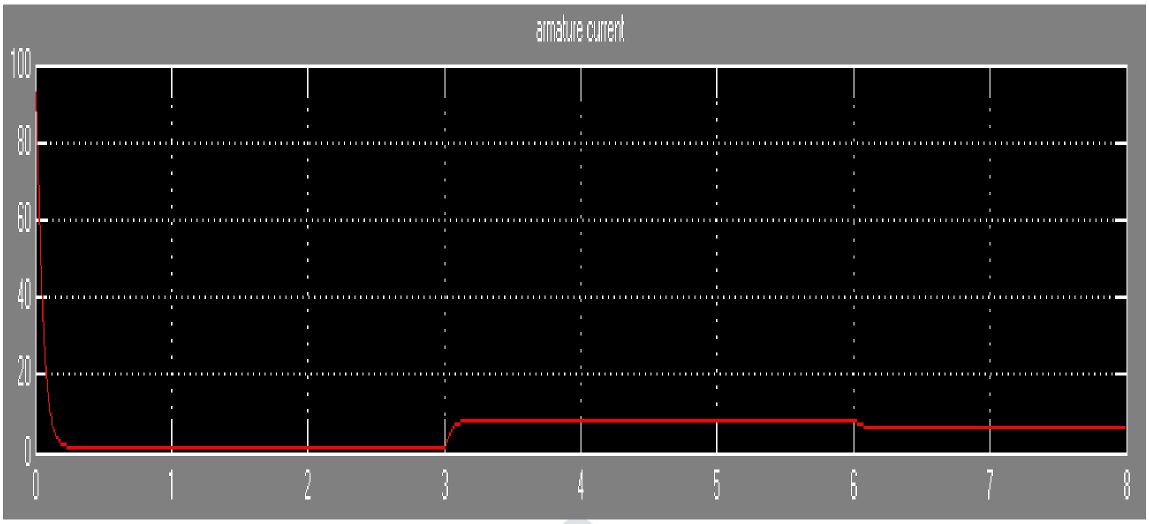

fig 11.Armature current vs time period graph

6.1.2 Speed analysis of various torque is shown in the graph below. Here x-axis represents the time period and y-axis represents speed in rpm.

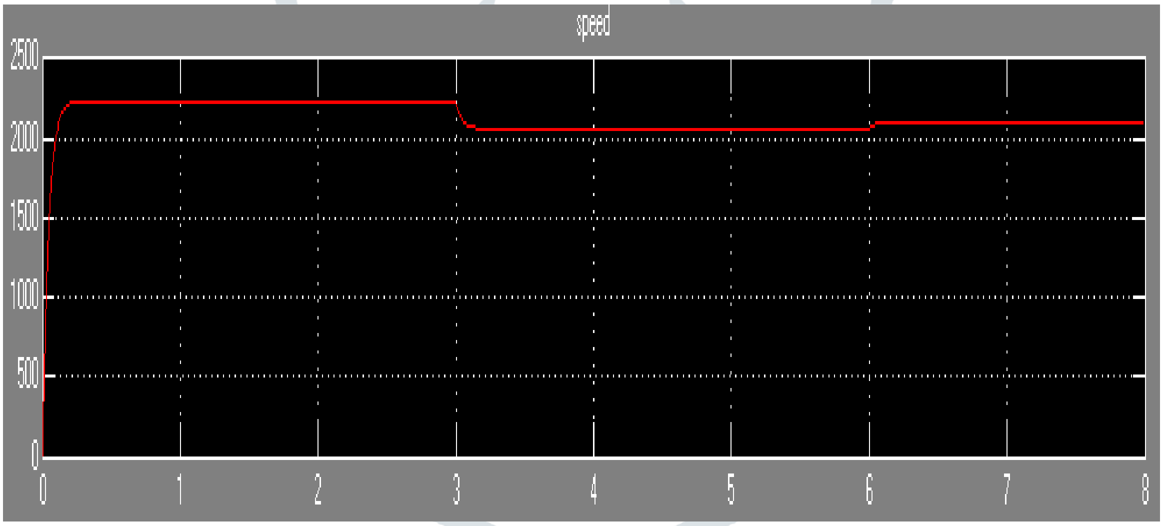

fig 12.Speed vs time period graph

6.1.3 Variation in torque with respect to different time periods is shown in the graph below. The x-axis represents time period and y-axis represents torque in Nm.

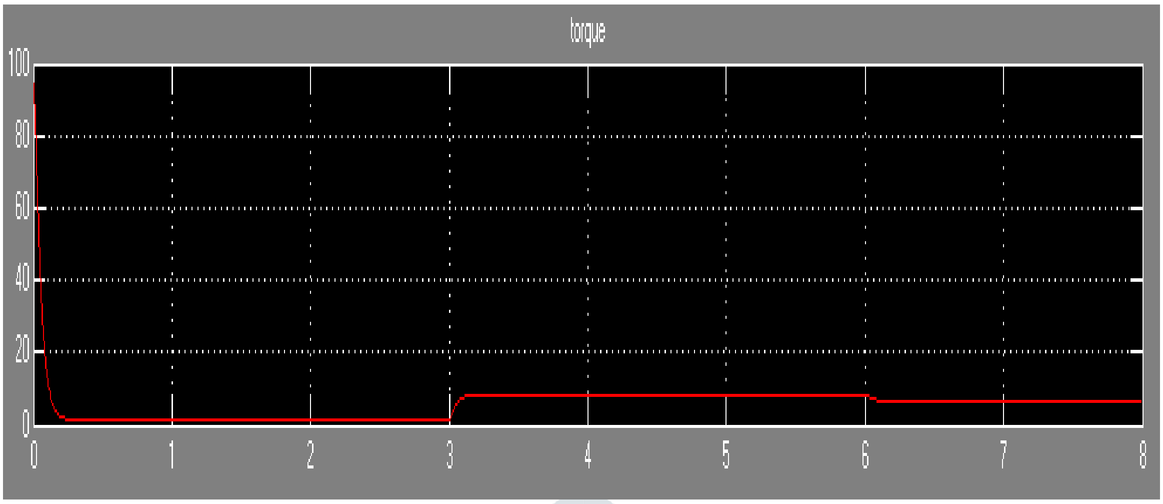

fig 13.Torque vs time period graph

6.1.4 Field current of the motor with respect to time period is shown in the graph below. The x-axis represents time period and y-axis represents field current in ampere.

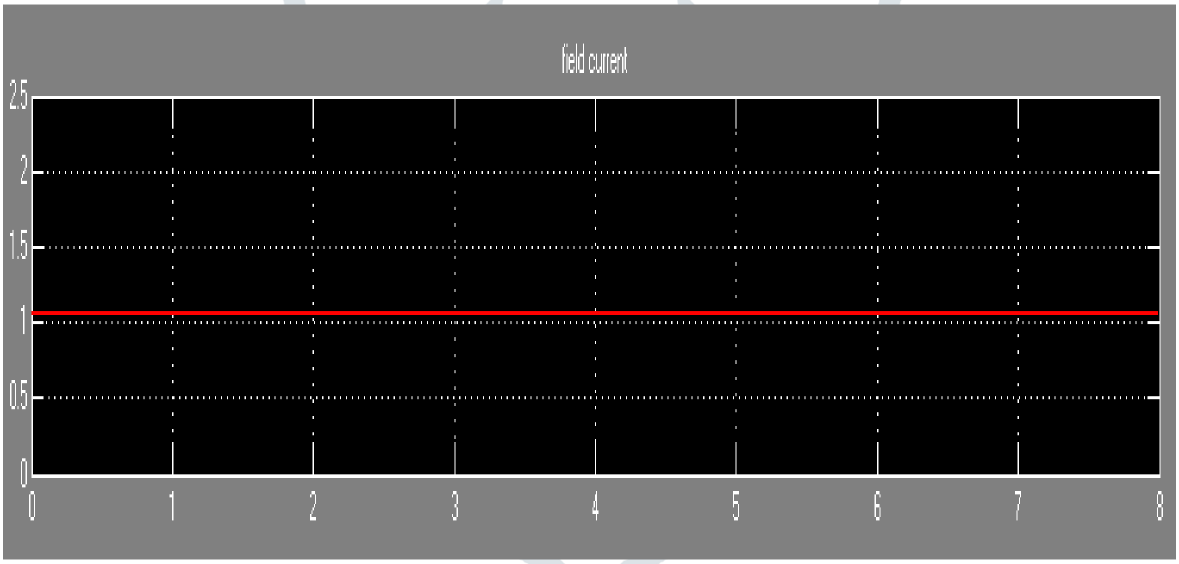

fig 14.Field current vs time period graph

VII. DISCUSSION AND RESULT

7.1 Result

Table 1.Specifications of hybrid electric scooter design

SL NO	Vehicle characteristic	Value
1.	Motor power	500W
2.	Number of motors	1
3.	Motor Torque	7.09 N-m @2750rpm
4.	Vehicle max Speed	30km/hr
5.	Brake	Drum Brake
6.	Motor type	PMDC Motor
7.	Battery capacity	(12 V, 26 Ah) x 4
8.	Charging time	1 hours
9.	Engine power	3.5bhp @ 5000rpm
10.	Engine torque	5Nm @ 3750rpm
9.	Carrying capacity	1 adult
10.	On board Charging	Yes
11.	Range	75.095 km

Table 2.Comparison between proposed and current electric scooter

SL No	Characteristics	Proposed model	Current electric scooter
1.	Regenerative braking	No	Yes
2.	Plug-in recharge	Yes	Yes
3.	On board recharging	Yes	No
4.	Method	Discharge of charge+onboard recharge	Discharge of charge
5.	Technology	Extended Range	Ordinary Range
6.	No. of Motors	1	1
7.	Hybrid system	Yes	No
8.	Range	75.095 km	50 km
9.	Petrol	Yes	No
10.	Range extender	Yes	No

7.2 Cost Analysis

The table below shows the comparison between petrol, battery and hybrid vehicles under same condition. From the table it is clear that cost of hybrid system is less than the IC engine. Also the range of hybrid system is more when compared with the other systems.

Table 3.Cost analysis

SL NO	Mode	Person Weight (Kg)	Price (Rupee)	Distance (KM)	Price per unit Distance (rupee)
1.	Petrol	67	70	45	1.6
2.	Battery	67	4	46	0.086
3.	Hybrid bike	67	74	75.12	.98

7.3 Tested Route

In order to obtain the performance data of the vehicle the test was conducted by riding the vehicle under real conditions. The test ride was conducted through the routes of Irinjalakuda city, India. The test route chosen is shown in the figure below.

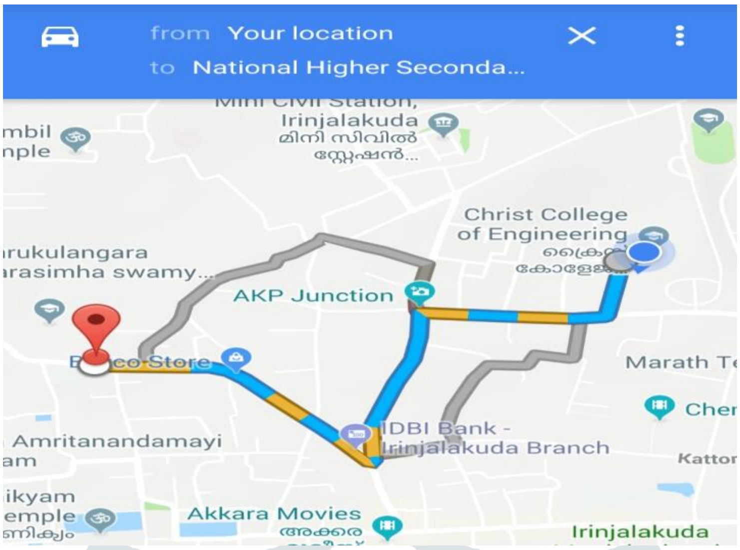

fig 15.Tested route

Table 4.Routes tested

Route	Speed (km/h)	Distance (km)
Route-1	30	2
Route-2	25	2.5
Route-3	30	2

VIII. DESIGN CALCULATIONS

Theoretical Calculations of Model:-

i) Time taken by the battery to discharge completely by the load :

(Ampere rating of battery in Ah/ Ampere rating of motor)*efficiency factor

= (26Ah/27A)*0.8

= .77hrs

For two battery packs discharge time is:

= .77hrs*2

= 1.5407hrs

ii) If the vehicle moves at an average speed of 30km/hr the distance travelled will be:-

Distance = velocity/time

= 30km/hr * 1.5407hrs

= 46.22km

iii) Time required to charge a single battery pack:

Ampere rating of battery/Ampere supplied to battery to charge

= 26Ah/26A

= 1hr

iv) For 1l petrol one battery pack can be fully charged and the other battery pack can be charged to 25%.

A fully charged battery can run the vehicle through 23.1km and 25% charged battery can run the vehicle for about 5.8km.

v) Entire travel distance covered by hybrid vehicle is:

= 46.22km+23.1km+5.8km

= 75.12km.

IX. CONCLUSION

The world interest towards the hybrid technologies are increasing. Therefore the series hybrid project is implemented along to satisfy the need for keeping up with this approach. The series hybrid project is complicated integrated systems which represents a good challenge for project. The most important challenge in hybrids way is the battery its volume weight, efficiency and the amount of energy stored in it. The AC form of the generator is converted to DC by a bridge rectifier. Thus makes the DC motor to run and drive the wheels, which in turn reduces the emission. Thus we expect to gain maximum mileage for scooter by implementing this system.

This hybrid scooters will be a new innovation in automotive era, it is more eco-friendly because it cause less pollution. The hybrid scooter is a better solution for hiking fuel cost day to day.

Series Hybrid-electric vehicles combine the benefits of gasoline engines and electric motors and can be configured to obtain different objectives, such as

1. Improved fuel economy.
2. An engine less than 100 cc can be used.
3. Compact battery can be used along with 36 V hub motor which requires only 3 batteries.
4. Chain pulley can placed on the bike.
5. Efficiency can be increased.

X. REFERENCES

i) N.Hattori, S.Aoyama, S.Kitada, I.Matsuo, and K.Hamai, “Configuration and Operation of a newly developed parallel hybrid propulsion system”, in Proc. Global Power train Congr. Detroit.

ii) H.Kono, “Fuzzy control for hybrid electric vehicles”, Master’s thesis, Department of Electrical Engineering, The Ohio University.

iii) H. Yap, N. Schofield, C. Bingham, "Hybrid energy/power sources for electric vehicle traction systems", *Proc. IEEE Conf. PEMD*, vol. 1, pp. 61-66, 2004-Mar./Apr.

iv) C. C. Chan, K. T. Chau, Modern Electric Vehicle Technology, New York:Oxford Univ. Press, 2001.

v) https://www.sciencedirect.com/science/article/pii/S0306261915001774?via%3Dihub

vi) T. J. Miller, “Lithium-ion battery automotive applications and requirements,” in Proc. Seventeenth Annu. Battery Conf. Applications and Advances, 2002, pp. 113–118.

vii) Montreal City, Electrifying Montreal Transport Electrification Strategy 20162020, 2016.

viii) Build your own electric vehicle, Seth Leitman and Bob Brant, second edition, McGrawHill, 2009

ix) "History of Hybrid Vehicles". HybridCars.com. 2006-03-27. Archived from the original on 2009-02-08. Retrieved 2010-03-21.

x) Matt Lake (2001-11-08). "How it works; A Tale of 2 Engines: How Hybrid Cars Tame Emissions". The New York Times. Retrieved 2010-03-22.

xi) Elizabeth Lowery (2007-07-01). "Energy diversity as a business imperative". The Futurist. Retrieved 2010-03-21.

xii) Maclean, H. L.; Lave, L. B. Life cycle assessment of automobile/fuel options Environ. Sci. Technol. 2003, 37 (23) 5445–5452.