Modeling and Simulation of Electric Vehicle for Future Generation

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Abstract - Electric vehicle demand increase in India day by day. The Lithium-ion battery is widely used in large-scale energy storage and electric vehicle. Electric vehicles are divided into various parts like battery management systems and propulsion systems. The battery management system explains about cell balancing which can be done by two methods i.e. Active cell balancing and Inductor-based Active cell balancing. After the cell balancing process, the charging of the Lithium-ion battery is done with the help of the constant current charging method. Once charging is done battery is ready to supply electric vehicles. Electric vehicles mostly use 32-volts or 48-volts batteries. That battery voltage needs to boost for the induction motor supply at 350 volts. For that purpose, here the boost converter is simulated which boosts the battery voltage up to 400 volts to supply the induction motor. The propulsion unit consists of the inverter, motor and its control. The voltage which comes out from boost converter is DC voltage. Afterwards this DC voltage will be converted into AC voltage as it will be fed to induction motor. For this, a five-level multilevel inverter has been simulated. The induction motor needs a smooth input supply that has very low third harmonic distortion. For that purpose, a T-type five-level multilevel inverter has been simulated. To improve speed results, direct torque control method has been included. In which speed control is done by generating voltage space vector. Braking is also an important part of Electric Vehicle. Here regenerative braking, plugging and dynamic braking of induction motor has simulated and analyzed.

Key Words:
Cell Balancing, Harmonics, Inverter, Battery, Breking system

1 INTRODUCTION

1.1 Problem Statement

The developing use of fossil fuels affects developing pollution with inside the environment. Now a days electric-powered vehicles name can be very well-known in the area of the usage of fuel Consumption vehicles. Electric scooter prices can be plenty much less in evaluation to fuel or fuel-based vehicles. An electric-powered vehicle is a vehicle that is propelled thru a manner of way of 1 or greater electric-powered motors, the usage of energy stored in rechargeable batteries. The electric motor has way higher strength overall performance than an I.C. engine lots much less cooling conveys convey extra mechanical power for the same strength consumption. Speed control for the electric-powered motor is right now at the same time as IC engine tempo control is slow. Electric cars make lots much fewer noises whilst features than IC engines. Now a days battery takes place instead of the IC engine. In electric scooters, the BLDC motor is used because of their simple topologies and it has less power required (less than 3KW). for more power no any type of research till in this field. Induction motors use very high-power applications like trucks and cars etc. but are still not used in a scooter. For that, I implement an induction motor here.

1.2 Objectives

Look at batteries and their different topologies. To take a look at approximately molecular balancing methods and examine molecular balancing methods. To take a look at approximately flyback converter and evaluation that result at the same time as the usage of with inside the molecular balancing method. To take a look at charging methods and put them into effect regular nowadays charging techniques. To take a look at the higher used converter and find the results. To take a look at the inverter and put into effect the T-kind half-bridge multilevel inverter and evaluation the result

2. LITERATURE REVIEW

Lingzi Jim1 and Peter Slowik2 examine the most common foreign practices in terms of electric vehicle buyer awareness and outreach. It assesses the importance of buyer awareness and identifies best practices in the major electric vehicle markets. Based on our study, we also identified five case studies for further discussion to better comprehend the important component aspects of a successful whole buyer awareness campaign. Although the focus of this painting is on how actions to improve cognizance and know-how may affect electric powered vehicle uptake, we recognize that a wide range of vending actions is critical to growing the market. We'll wrap off with the following findings on buyer awareness of electric vehicles [1].

D. K. Bhatt1 , M. El. Darby2 examines the infusion of electrical propulsion is unavoidable for the road shipping sector due to climate and strength difficulties. BEVs havea lot of utility in the viable period. However, the fact that some stressful conditions must be overcome is illustrated by the resource of their vital role. The future landscape of road shipping can be made up of a variety of propulsion eras, each of which is a compromise between emissions and range. BEVs are likely to be the most ideal for cities' small to medium-period automobiles, while hybrid and fuel vehicles tend to be more appropriate for longer-ranged and large cars. However, to obtain key market penetration from the present very low update, stressful situations must be overcome [2]

G. N1 , G. Yadav2 , and G. CK3 explain the balancing of cells in a Lithium-ion battery are critical. The paper discusses the many molecular balancing procedures that have been used in the literature, including both active

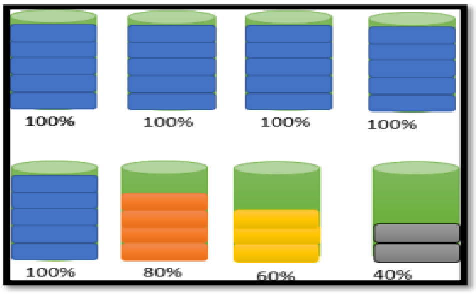
and passive techniques, as well as their benefits and drawbacks. The advantages of using an inductor-based molecular balancing technique over passive and capacitor-based active techniques are also discussed. It is non-dissipative, making it preferable to resistive molecular balancing, and it has a faster balancing time than capacitor-based lively molecular balancing. In addition, the inductor-primarily based lively molecular balancing is investigated in-depth, and it's far highlighted that with traditional inductor balancing, the strength is transferred molecular through molecular, which ends up with the inductor balancing approach that ends [3].
N. Karami1 and E. Ayoub2 explain that Lithium-ion batteries have become increasingly significant in people's daily interactions with their environment. As a result, determining the most effective charging method that provides excellent charging time, and efficiency, and does not harm the battery is critical. Following the discussion of exceptional charging strategies, the elevated charging method is positioned since the most appropriate charging method may also recharge a completely depleted battery to at least one-third of its rated cap potential in 5 minutes without hurting it [4].

S. Singh1 , A. Agnihotri2 , S. Bind3, and S. Kumar4 Due to its supremacy in immoderate voltage and immoderate power with low harmonics applications, multilevel inverter production is currently attracting a lot of attention. The use of multilevel inverter technology allows for the accumulation of extremely beautiful output voltage and current waveforms. However, as the number of layers increases, so does the number of switching elements and the amount of DC property. This issue is handled by employing hybrid technology to synthesize the inverter as a beneficial resource. The goal of this study is to construct hybrid cascaded multilevel inverters that use fewer switching elements and have better dc characteristics without using the pulse width modulation technique. A simulation using MATLAB/SIMULINK software is used to evolve the model of the hybrid cascaded multilevel inverter [5]

Thiruvonasundar Duraisamy1 and Deepa kaliyaperuma2 Different topologies EV battery Managment Service Active cell balancing take more time**[6]**
Sandhya P1 Nisha G.K2 explaintion About Charging Different Methods Research Gap cc is batter than cv**[7]**

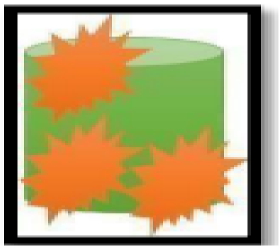
3.Methodology

3.1Cell balancing process



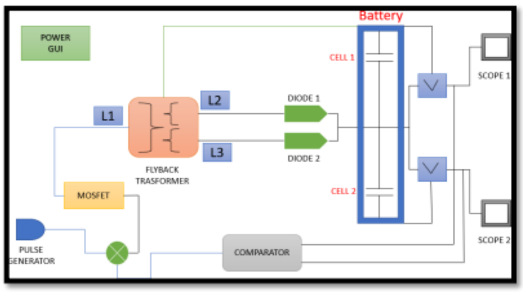
Here as shown in fig .there are 2 conditions first is the ideal condition and the second is practical. In Ideal conditions, all batteries have the same states of charge and voltage levels but it is not possible practically. In practically all batteries different states of charge and voltage level so, to make all batteries same level and provide working we use the cell balancing process

a. Need of Cell balancing



Suppose I take 2 batteries and 1 battery soc 30% and other battery soc 70%. When I put both on charging so, there are chances to overflow in 70% soc battery and chance to burn the cell for that we need to cell balancing.

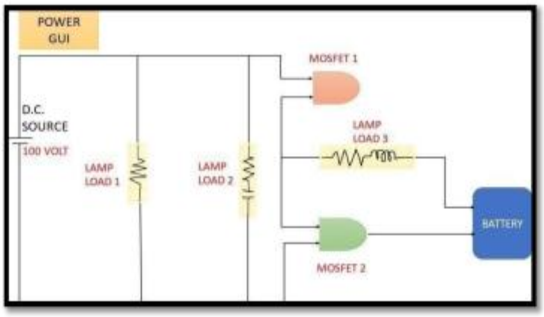
b. Types of Cell balancing
   i. Active cell balancing



As shown in fig here explained active cell balancing where 2 cells are series connected whose initial voltage cell 1 is 3 volts and cell 2 is 4 volts. The comparator compares both cell voltage so here cell unbalance condition observes pulse generator generates a pulse to trigger the gate and MOSFET turned on so, both cell voltage gives to the primary coil. Here diode work as 2-way reverse bias and forward bias. If cell voltage is greater compared to secondary coil voltage so, the diode reverses bias. If cell voltage is lesser compare to secondary coil voltage so, diode forward bias. So, at a time one cell's energy is transferred to another cell.

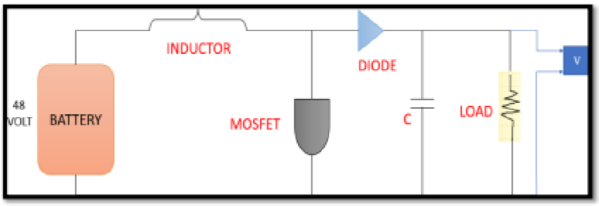
c. Charging method for lithium-ion battery

3.2 Constant current charging method



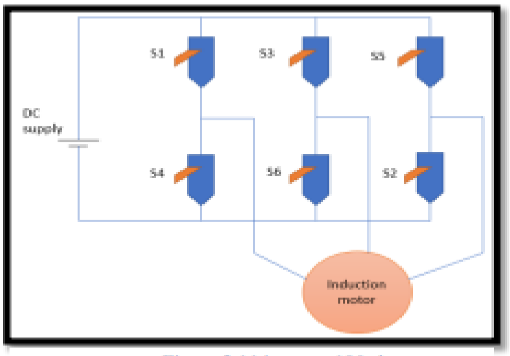
Here we have 2 conditions, the first one is ideal voltage source value is very high, and the second is our battery capacity is low compared to ideal voltage sources like 6volt, 12volt, 24volt, etc. Figure 3.8 lamp load for constant current Now assume we required 2 amperes constant current for charging and overall lamp load has 1-ampere capacity. So, at that time 2 lamp switches turned on and we get 2-ampere constant current. As shown in figure 1.9 here takes a 100-volt D.C. supply and three lamp loads that are series connected to the load (lithium-ion battery). Initially battery SOC 48% and all lamp capacity 1 ampere. After running the simulation observe that battery SOC increase with a constant current.

d. Boost Converter



As shown in figure here taking a 48-volt battery that needs to boost voltage at 400- volt as per induction motor required input. for that here take 0.88 duty ratio of MOSFET. During Ton time inductor stores the energy. At that time diode reverse bias. During Toff time inductor energy and battery energy are both added and given to the resistive load at that time diode forward bias. Here capacitor work as a filter that is used to eliminate distortion.

3.3 Inverter



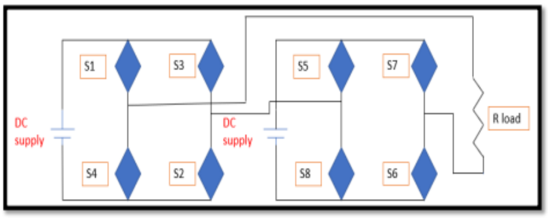
The inverter is a device that converts DC supply to AC supply. The inverter operates in 180-degree and 120-degree conduction modes. Three-phase induction motor work on AC supply for that required convert DC boost voltage to AC supply. The induction motor operates on 180-degree conduction mode inverter.

Multilevel inverter

Five-level multilevel inverter

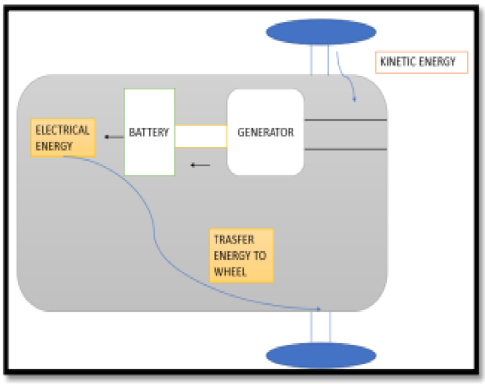
➢ Inverter: it is a device that converts DC to AC. Conventional power electronic converters are mostly 2-level converters +V and -V. but in multilevel inverters by increasing the levels of output try to make the waveform nearer to the sinusoidal waveform.

➢ Multilevel inverter: multilevel inverter has 3 types 1) Diode connected 2) Capacitor connected 3) Cascaded H-bridge



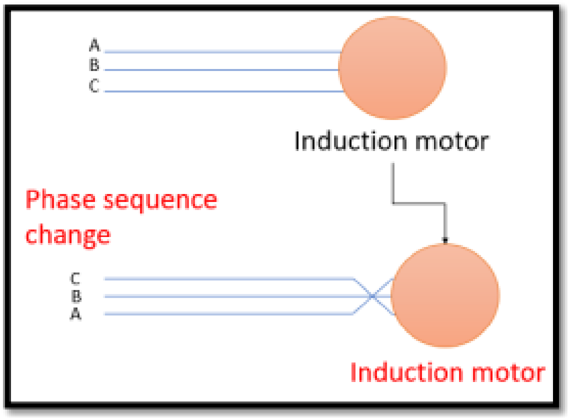
3.4 Regenerative braking: -

in induction motor Nr < Ns and in induction generator Nr > Ns. Here we need to reach Nr = 0. But Nr is not our control so if we reduce Ns compared to Nr that results in motor work as a generator. Ns can also be reduced using the variable frequency method in which frequency can be reduced keeping voltage/frequency constant. The below diagram shows regenerative braking. Here kinetic energy of the wheel transfer to the generator. The generator converts mechanical energy into electrical energy. That energy is transferred to the wheel using the battery. Here lithium-ion battery is used due to its less cost and lightweight.



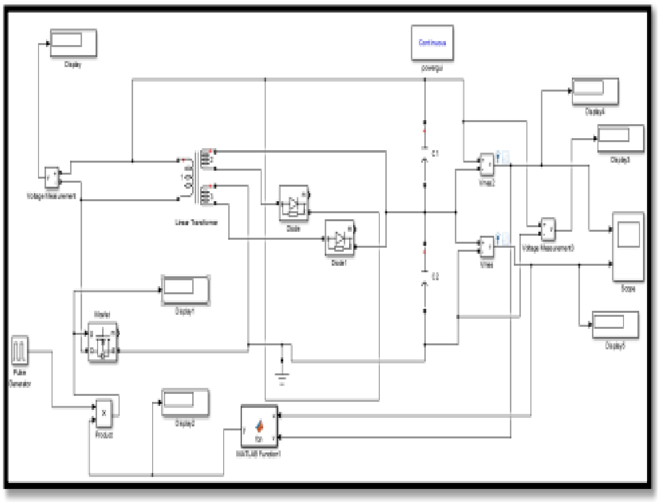
3.6 plugging

in this method reverse the phase sequence of the supply voltage connected to the stator. Reversing the sequence direction of the rotating magnetic field also reverses. So, it applies torque on the rotor in the reverse direction. Such the torque opposes the rotation of the rotor

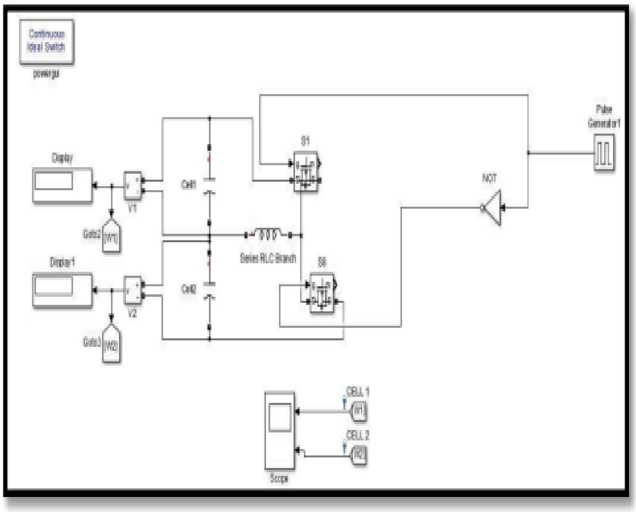


4 Simulation

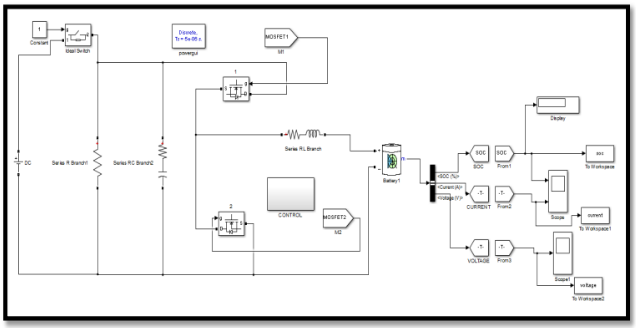
4.1 Active Cell balancing

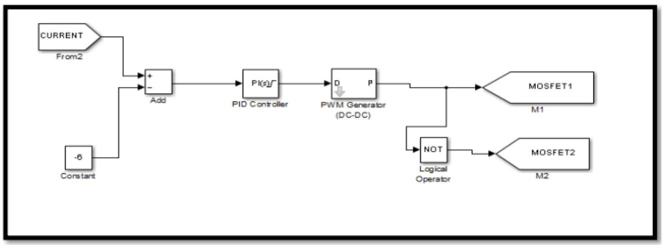


4.2 Inductor Based Active Cell balancing

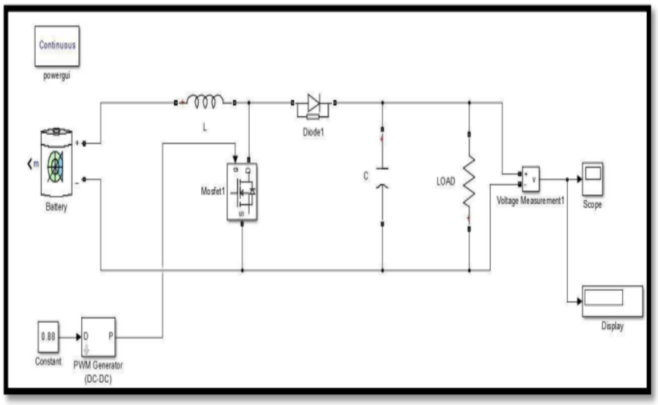


4.3 Constant current charging method

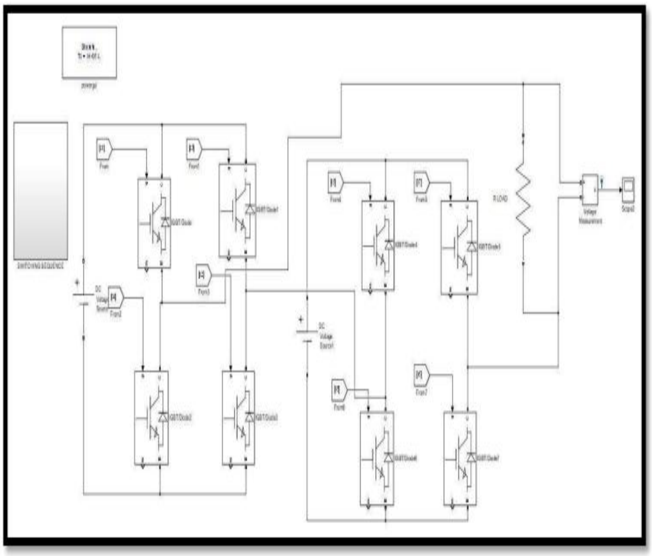




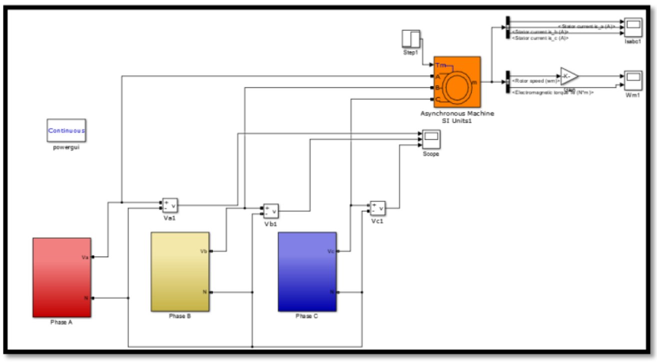
4.4 Boost Converter



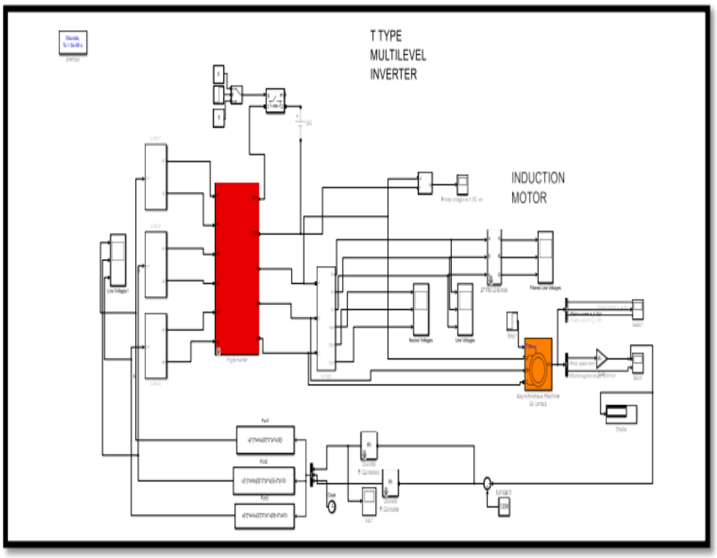
4.5 Five-level multilevel inverter



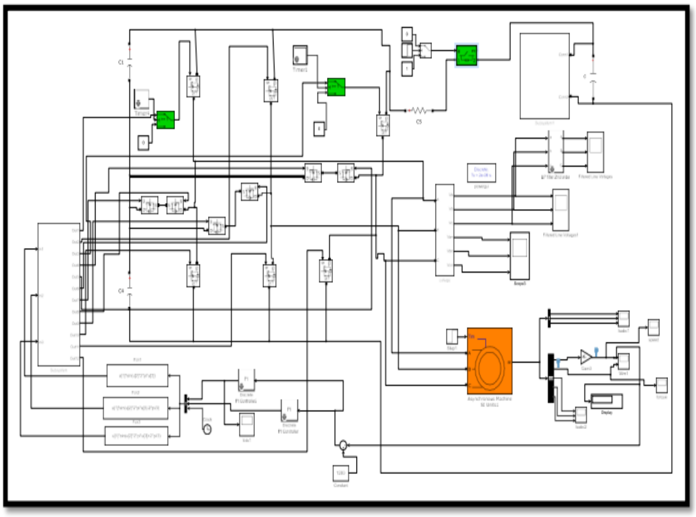
4.6 Five-level multilevel inverter with induction motor load



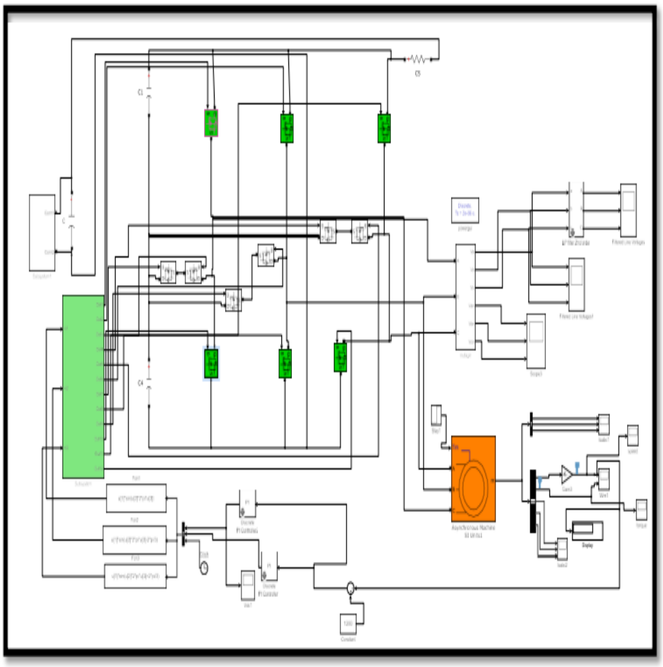
4.7 T Type multilevel inverter with induction motor load



4.8 Regenerative braking of induction motor

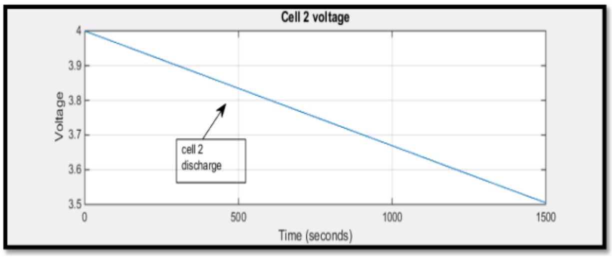


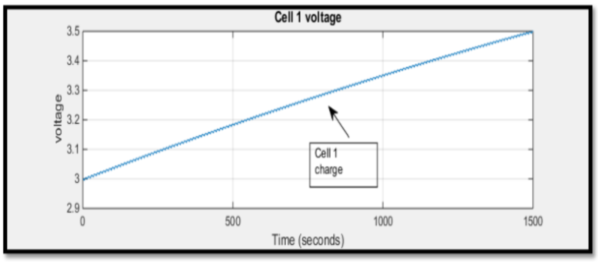
4.9 Pluging of induction motor



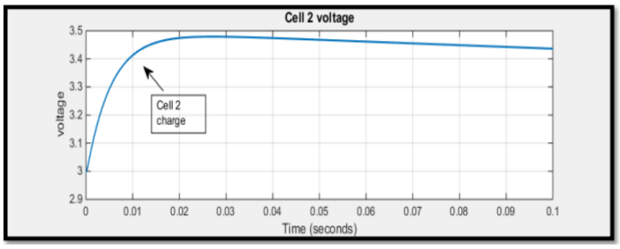
5 Results

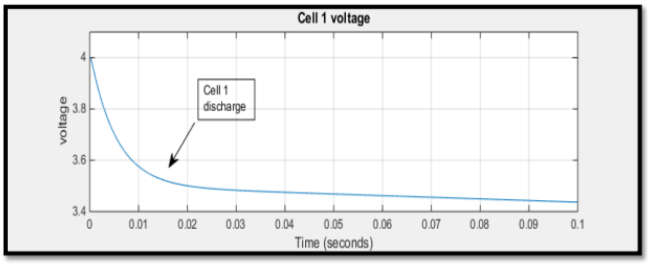
5.1 Active Cell balancing



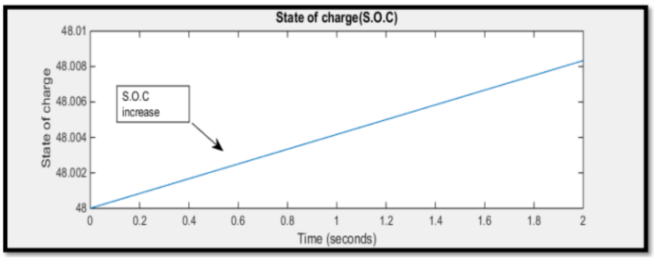


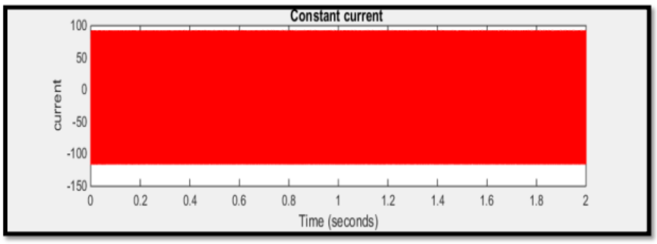
5.2 Inductor-based active cell balancing



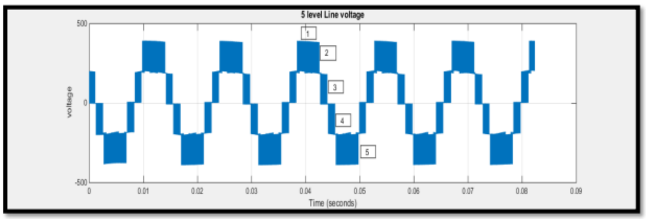


5.3 Constant charging method

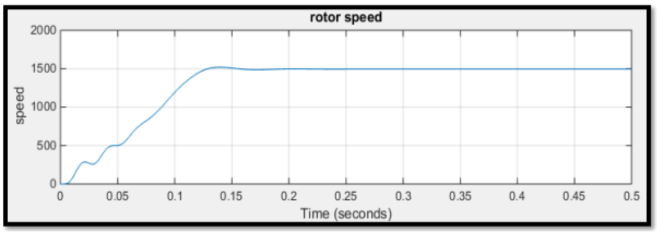


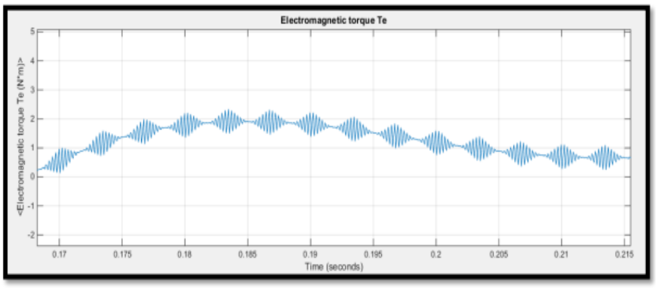


5.4 5 Level multilevel inverter

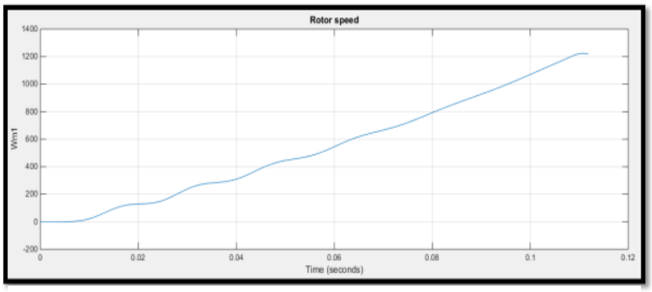


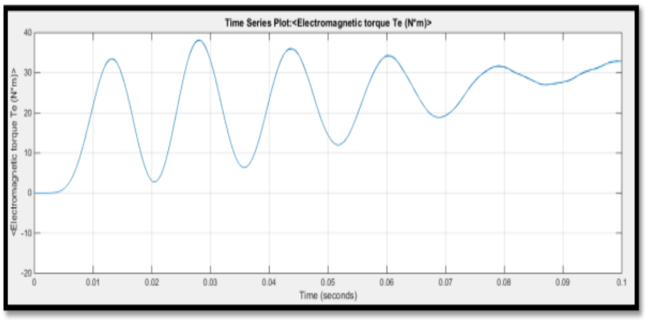
5.5 Five Level multilevel inverter with induction motor load

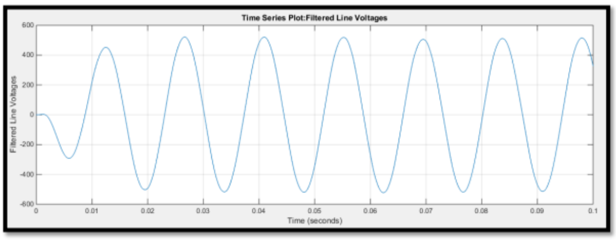




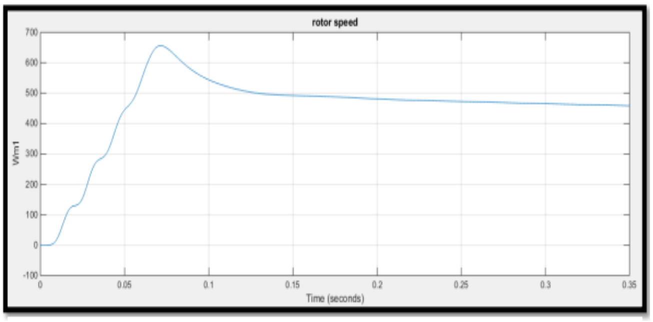
5.6 T-type multilevel inverter

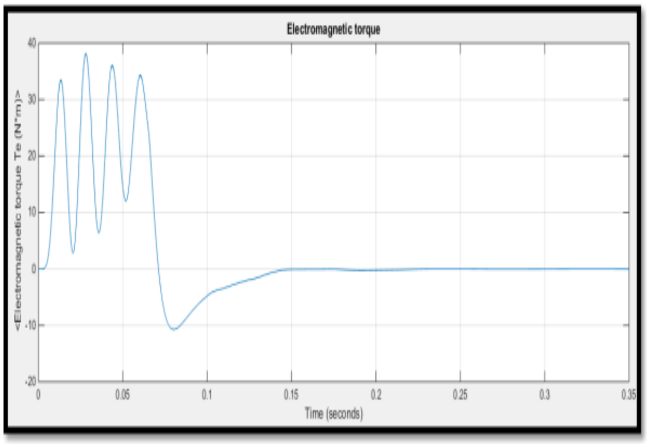




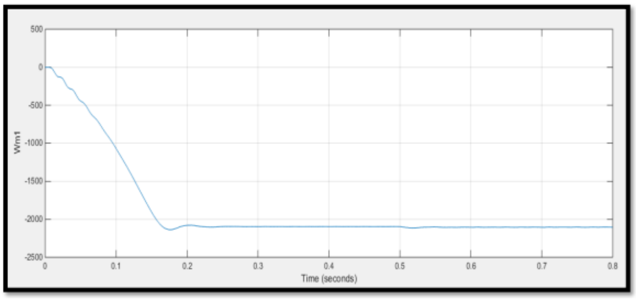


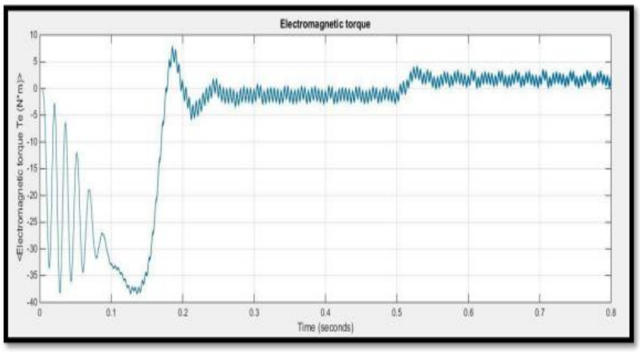
5.7 Regenerative braking





5.8 Plugging





3. CONCLUSIONS

The cell balancing process is quite important for the long life of the battery. For that here simulated active cell balancing and inductor based active cell balancing and here observe that inactive cell balancing both cells are getting balanced at 1100 seconds with the values of 3.362 Volts and 3.412 Volts which is very much time consume compare to inductor based active cell balancing. In inductor-based active cell balancing both cells are getting balanced at 0.3 seconds with the values of 3.483 volts. After the cell balancing process is done focus on the charging of the battery. For that here simulated constant current charging method. After running the simulation observe that lithium-ion battery SOC increased from 48 in which current constant at -5 to 5 ampere and voltage slightly increase. After the charging process is done need to put the battery on the field. Electric scooters mostly used 32 Volts or 48 Volts battery. By simulating a boost converter battery voltage getsto step up from 48 volts to 400 volts. Boost converter output voltage DC and that need to convert AC for Three-phase induction motor supply. For that simulated T-type 5 level multilevel inverter. After running the simulation observe that getting level AC voltage output and they are 400 – 200 – 0 – (- 200) – (-400). Here observe that the filter line voltage waveform is purely sinusoidal and here speed reaches its reference speed 1200 rpm. To reduce the actual speed error of the induction motor, need to close the loop system. For that here direct torque control method is simulated. Using this method generates voltage space vector whose control rotor speed by switching operation of T-type 5 level multilevel inverter. Braking is important for every vehicle topology. For that here regenerative braking, dynamic braking, and plugging are simulated. After simulating regenerative braking for electric vehicles observe that by Ns < Nr so, the motor start working as a generator. After simulating dynamic braking for an electric vehicle observe that by changing the power supply from AC to DC of the induction motor during running motor start work as a generator. After simulating plugging for electric vehicles observe that by changing the phase sequence for the supply voltage induction motor

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