# ELECTRIC SMART SCOOTER

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**Abstract—** *The rapid growth in the transportation sector consumes a lot of fuel which increases pollution and global warming. The main objective of this project is to promote clean and energy-efficient vehicles. This project is intended to develop an Electric Bike which runs on the battery thereby providing voltage to the motor. The bike uses a regenerative braking mechanism to recharge the battery. The Electric bike consists of the following components: BLDC (Brush Less Direct Current) motor, Frame, Platform, Battery, Drive, etc. Electric Bike makes use of Electric energy as the primary source. This Electric Bike uses Lithium-ion rechargeable batteries whose rate of self-discharge is quite low. They have a greater energy density and will last longer than other batteries. The BLDC motor is having 1000 watt capacity with a maximum of 3000rpm. The Frame is made up of M.S. along with some additional lightweight components. The frame is built to sustain the weight of the person driving the unit, the weight of the load to be conveyed. The main aspect of building this E-bike is that it is user friendly, economical, and relatively cheap.*

***Key Words*- BLDC motor, regenerative power, BLDC controller, lithium-ion battery, Supercapacitor.**

## 1. INTRODUCTION

Electric motorcycles (e-bikes) are gaining popularity in India off late due to a steady rise in petroleum prices and environmental issues. Due to their many advantages, Electric bikes in India are given priority and many companies are coming up with the latest green technologies in the automotive sector. India is becoming a hub for e-bike manufacturing companies, with localized technologies to show their performance on Indian roads. BEVs have an electric motor in place of a combustion engine and use electricity from the grid stored in batteries. Plug-in hybrid electric vehicles (PHEV) use batteries to power an electric motor and liquid fuel such as gasoline or diesel to power an internal combustion engine or another propulsion source EVs can go beyond the above-mentioned technology-based classification and can be classified on the basis of their attributes such as charging time, driving range, and the maximum load it can carry. Of these attributes, the two most significant characteristics of an electrical vehicle of concern to the patron are:

- Driving range
- Charging time of batteries (i.e. the time required to fully charge the battery) and Charging time depends on the input power characteristics (i.e. input voltage and current), battery type and battery capacity.

E-bikes are typically driven by a brushless DC electric motor (BLDC) powered by a rechargeable battery, charger and a controller, unlike the internal combustion engines that burn liquid fuel to drive their engines. The main highlight of these vehicles is no fossil fuel is consumed to drive them. They are subjected to less maintenance since they have very few moving parts. When compared to conventional fuel bikes, these e-bikes are reliable, energy efficient and are eco-friendly too. With a speed of just 40-60 kilometers per hour, electric bikes in India are exempted from road tax and other regulations, and require no license to operate. These vehicles are pocket friendly as well, with most of them costing around INR 40K-60K. These bikes can be handled with ease by any age group. The total cost of ownership is as low as one third as compared to a regular fuel bike on Indian roads. However, we must consider their disadvantages before purchasing these vehicles. Since e-bikes in India have very less fuel capacity or range, they are not suitable for fast travel. These battery-powered vehicles find it hard to travel long distances since they lack extended battery life. Bike owners have to constantly charge the battery for at least 8 hours a day, which reduces the battery life. Replacing the battery once every two years costs more than INR 10K , which is a bit expensive. Most of the e-bikes require 3-4 hours of charge for a full battery.

## 2. LITERATURE SURVEY

**[1] Sunikshita Katoch (et al), [2019]** this paper, they are concerned about the growing demand of energy all over the world, which motivates us to switch over to renewable resources. There are many different ways by which they can save energy in different sectors. Our main focus is the automobile sector where we are converting old petroleum bikes to electric bikes. In these electric bikes they use an electric motor (BLDC motor) instead of a combustion engine as there is less pollution, low maintenance cost, and reduced noise. These bikes utilize chemical energy stored in the rechargeable battery packs. This paper deals with the design and development of electric bikes which make use of electric energy as primary source. There is a distribution for charging the battery emitting it from the main system. [1]

**[2] Farashid Naseri (et al), [2017]** this paper, a new regenerative braking system (RBS) is proposed for EVs with HESS and driven by brushless DC (BLDC) motors. During regenerative braking, the BLDC acts as a generator. Hence, by using an appropriate switching algorithm, the dc-link voltage is boosted and the energy is transferred to the super capacitor or the battery through the inverter. To provide a reliable and smooth brake, braking force distribution is realized through an artificial neural network. Simultaneously, the braking current is adjusted by a PI controller. To evaluate the performance of the proposed RBS, different simulations and experiments are carried out. The results confirm the high capability of the proposed RBS.[2]

**[3] Kumaresan.N (et al), [2019]** this paper, a regenerative braking mechanism reuses the energy created by the braking process and uses this energy to charge the battery for further use. Generally the energy lost in the conventional use is transferred to the generator of the rotating wheel and is given to the battery. This saves energy. Using regenerative braking when braking, improves the efficiency of an electric vehicle as it recovers energy that could go to waste if mechanical brakes were used. Regenerative Braking System (RBS) is an efficient system to reduce vehicle emission and fuel consumption. So our project is to develop are generative braking system on E-Bike.[3]

**[4] Pooja P. Bawangade (et al), [2017]** this paper, The market for electric bikes, scooters and bicycles is growing. There are numerous brands of E-bikes emerging locally. Almost all incorporate a rear wheel BLDC (Brushless DC) hub motor; lead acid battery pack, a lightweight chassis, and a controller. The Vehicle achieves an average speed of 30- 50km/hr, range of 70km/charge. The other drawback is the long charging time of 6-8 hrs and short lifespan of battery pack i.e. around 2 years. Considering these limitations modifications in the existing design of an electric bike we use super capacitor.[4]

## 3. PROPOSED SYSTEM

- Producing power via regenerative braking and Dynamo.
- Using 48V 40ah Lithium-Ion battery.
- Different modes - Reverse, Economy, Sport mode Normal mode.
- The bike combines a battery bank and a supercapacitor bank to achieve high-performance energy sources for electric scooters.
- The proposed system can be employed on commercial 48-V electric scooters for evaluation

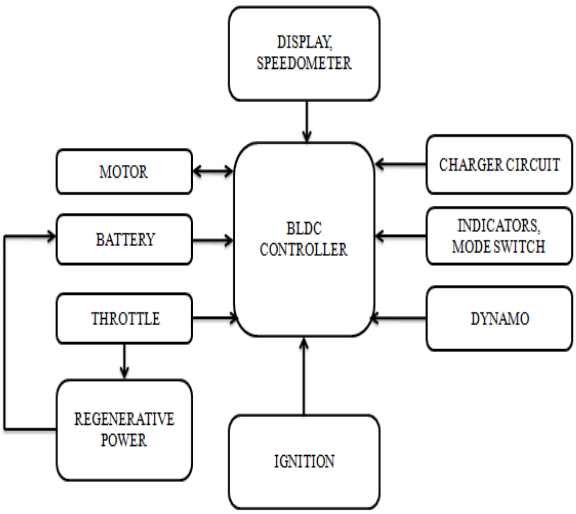
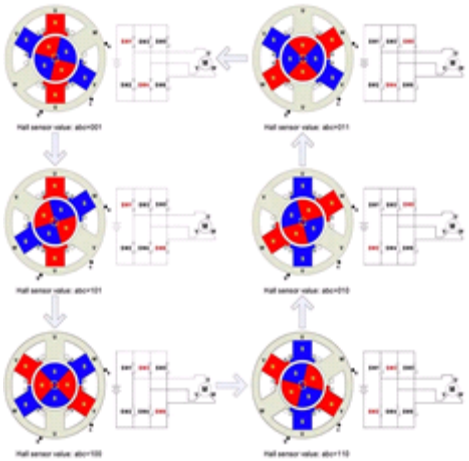



**Fig-1:** Block diagram of electric scooter

**WORKING:**

The electric Scooter works on batteries. These are rechargeable batteries made up of 48v/40ah lithium-ion type. The BLDC motor of the e-scooter is mounted on the frame. Once the Ignition is given, the battery establishes a connection with the BLDC controller then electricity that is produced in the battery is transmitted back to the motor via the controller, and motor starts to rotate. While providing throttle, depending upon the switch modes used in the controller, the motor will increase/decrease the distance traveled per hour (kmph). Then the motor will drive the belt connected with the pulley system e-scooter starts to move. In this system controller, motor, throttle, and battery play a vital role. The LCD display gives information about the battery, it displays speed, battery voltage, temperature, front light, right and left turns. This system uses Regenerative braking using dynamo.



## 4. HARDWARE DESCRIPTION

### 4.1 BLDC Motor

This brushless dc motor has a hall sensor, hall sensor transducer, and changes its output voltage with respect to the magnetic field. Hall sensor is used for speed detection, proximity switching, and current sensing. Fig.2 shows a brushless dc motor and hall sensor. BLDC motor is 3- phase motor. The armature consists of an electromagnet, when the electric is passed through the electromagnet it creates an electric field in armature which attracts and repels stator and makes the armature rotate 180 degrees. fig. 3 The internal structure of BLDC motor The BLDC motor performance is based on motor structure and control logic. By using different types of control logic, the torque ripple can be minimized

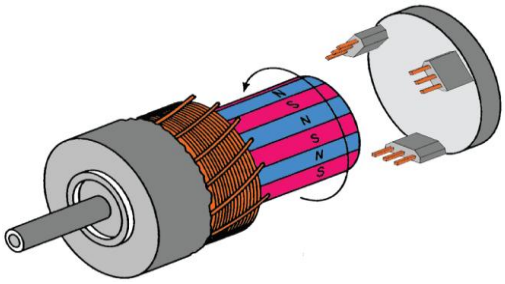


**Fig-2:** Brushless dc motor and hall sensor


**Fig -3:** Internal structure of BLDC motor

**Fig-4:** Three phase BLDC motor commutation sequence

### 4.2 BLDC Controller

A device that serves to govern in some predetermined manner of performance of an electric motor. A motor controller includes an automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, limiting or regulating the torque, and protecting against overloads and faults.

**Fig-5:** BLDC controller

The controller adopts a waterproof design, we can use it Conveniently in our daily time. Only those 8 wires(3 phase-cables & 5 hall-cables). DC brushless motors that can work with this controller, other brushless motors are not compatible. It has 4 groups of necessary cables (power cables, E-lock cables, Throttle-cables & Motor-phase cables)when hooking up these 4 groups cables, the E-bike can run normally. Besides, these controllers have other optional functions users can hook them up according to your applications. Three-speed throttle such as normal, eco, sports, and have some features such as Anti-theft, EBS, Cruise.

### 4.3 Battery

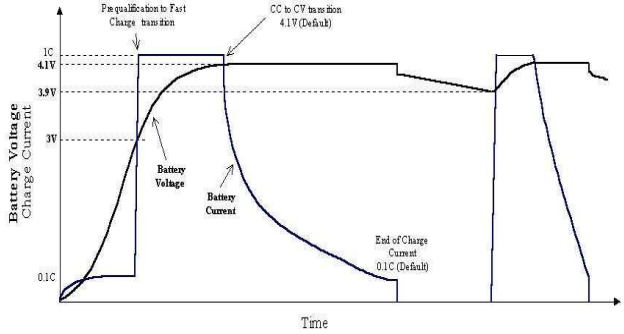
Li-ion batteries will be characterized as energy storage systems that suppose insertion reactions from each electrode wherever metal ions act because o the charge carrier. Given this broad definition, there square measure many completely

different cell chemistries that compose the Li-ion battery family. Most Li-ion batteries use a negative electrode principally made from carbon (e.g., graphite) or lithium titanate (Li4Ti5O12), with some novel materials under development, namely, Li metal and Li(Si) alloys. The electrolyte used varies based on the choice of electrode materials, but is typically composed of a mixture of lithium salts (e.g., LiPF6) and an organic solvent (e.g., diethyl carbonate) to allow for ion transfer—these components will be discussed in more detail below. A separating membrane is employed to permit metallic element ions to pass between the electrodes whereas preventing an interior tangency.

**Fig-6:** Schematic construction of Li-on battery

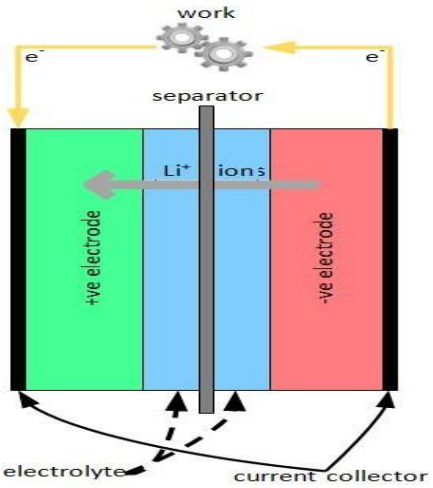
Overall Range: Eco mode @ 40Kmph: 75Km, Normal mode @ 50Kmph: 60Km, Sports mode @ 70Kmph: 40Km. The Specification of battery used in this system is 48V voltage, MEGT4840Ah Model name, Brand is Megtech, Battery Capacity is 40ah, BMS Charge Cut-off voltage is 54.6V , BMS Discharge Cut-off Voltage is 36+/-1V, Weight is 11Kg, Lithium-ion is the type of battery, charging Current 20A,Cycle life is 1000 and this battery is used in Electric Vehicle. Advantage of this battery is Environmentally Friendly, Long Cycle life, No memory effect and Low Self-Discharge

## BATTERY CALCULATION




The minimum battery required to drive the motor is 48V 20AH. With increasing the amps of the battery, the mileage can be increased.
The battery calculations of 48V 40AH Lithium Ion for different modes are as follows:

Calculation
Power required accelerating the bike from the start
F=m a =140*0.611
F=85.54N



P=F V
V=Average speed
40 V= (Vi + Vf)/2
At starting, the velocity Vi will be zero
V=Vf/2 =6.116/2 =3.055m/s
P=85.54*3.055= 261.32 watts
Power required=261.32 watts

Battery Charge Required For An Hour:
1000 WHr *1.20 =1200Whr In Ah: 1200Whr /48 V=25Ah/Hr.

Distance per Charge:
Power consumed by each cell = 1458 watt
Power consumed for 1Hr @ 45 Kmph: 1458W/ 45 Km/Hr =18.21wh/hr
In Ah: 18.21/48V=0.379 Ah/Km

### 4.4 Frame Chassis

It is the frame on which the motor, alternator assembly, and the batteries of the vehicle body is supported. It is designed such that the weight of the batteries, motor, and the alternator is properly distributed throughout the motorcycle in order to produce smooth effortless movements with minimum losses on the entire body. This is made of mild steel material. The whole parts are mounted on this frame structure with a suitable arrangement. Boring of bearing sizes and open bores did in one setting so as to align the bearings properly while assembling.

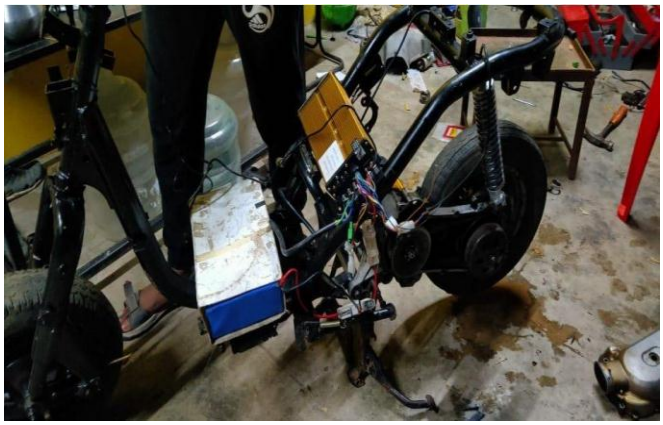


**Fig-7:** Frame chassis

Provisions are made to hide the bearings with grease**.**

### 4.5 CVT Transmission

The CVT sort of transmission's "gear ratios" automatically change within the bounds of the system, to any random setting. It's not constrained to a separate series of specific ratios such as typical motorcycle transmissions. As a result, accelerating with a CVT is an incredibly smooth uninterrupted process. You can indeed say that a CVT transmission has countless numbers of "gears" that it can run through at any time, at any engine or vehicle speed —and this makes it easy to go faster than you realize! When accelerating, the engine initially revs up to its comfortable RPM (revolutions per minute) range then remains there while acceleration continues because the ratio changes to form wheel RPM faster while engine RPM remains an equivalent .

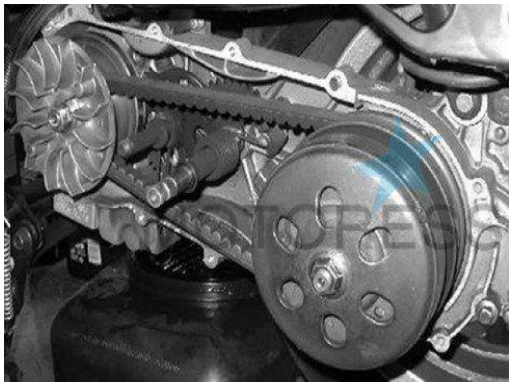


**Fig-8:** CVT transmission

The whole driving force in this system uses a belt between two pulleys—the effective radii are variable, changing according to the speed of the scooter; one radius increasing while the other decreases, accommodating its constant belt length. These belts stretch over time and as they loosen, slip and fail to transmit power to the wheel. Belt replacement is a standard maintenance task of the CVT powered motorbike[5].

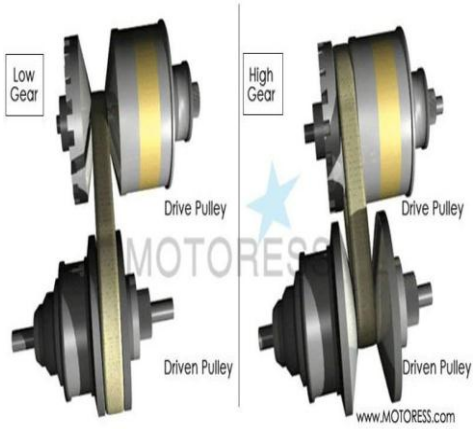



**Fig-9:** Working principle of belt CVT transmission

### 4.6 Belt Drive

A belt may be a loop of flexible material wont to mechanically link two or more rotating shafts, most frequently parallel. Belts could also be used as a source of motion, to transmit power efficiently or to trace relative movement. Belts are looped over pulleys and should have a twist between the pulleys and therefore the shafts needn't be parallel. In a two pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts) or the belt could also be crossed, so that the direction of the driven shaft is reversed (the other way to the driving force if on parallel shafts). As a source of motion, a conveyer belt is one application where the belt is tailored to continuously carry a load between two points. A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor).

### 4.7 LCD Display

An LCD Display is a device that gives information about a battery. This will usually be a visible indication of the battery's state of charge. It is particularly important within the case of a battery-electric vehicle. Some automobiles are fitted with A battery condition meter to watch the starter battery. This meter is, essentially, a voltmeter but it may also be marked with colored zones for easy visualization. Many newer cars did not offer voltmeters or ammeters; instead, these vehicles typically have a light-weight with the outline of an automotive battery thereon. This can be somewhat misleading because it could also be confused for an indicator of a nasty battery when actually it indicates a drag with the vehicle's charging system.

Fig 9 Indicator Alternatively, an ammeter may be fitted. This shows whether the battery is being charged or discharged. Both ammeters and voltmeters individually or together are often wont to assess the operating state of a car battery and charging system.


**Fig-10:** LCD display

### 4.8 Battery Charger

The charger is used for charging the battery. The 48v charger is used for charging the battery. The Specification of battery charger used in this system is Battery type is Li-ion battery, Dimensions is 170x90x50mm, Working power is 90-110Vac, 50~60Hz, Model is UY240, 48V is the Suitable battery Voltage, Output Voltage is 54.6V(For 13S Li-ion Battery), Output Current is 10A, SCP,OVP,OCP,OTP is the Battery Protection, Charging efficiency is ≥ 85%(full load), working and storage temperature is -5 ℃~ +40 ℃ and -40 ℃~ +70 ℃.


**Fig-11:** Battery charger

## 5. REGENERATIVE BRAKING

Regenerative braking has a similar energy equation to the equation for the mechanical dynamo. In this the BLDC motor act as a generator. It uses brake to charge the battery. After applying brake the vehicle stop's and still the motor rotates, the dynamo which is fixed near the belt started storing the power in the battery via a supercapacitor. Which is then used to charge the battery. Features of supercapacitor include: It is used as an energy storage system in regenerative braking. It has high power absorbing, excellent power density, and cycling properties.

## 6. RESULTS

The testing of the motorcycle is first done to check the total running range in one complete plug in charging cycle. It is done by fully charging the batteries and then driving the bike till the batteries are completely exhausted.

TABLE 1

| MODE | VOLTAGE | TOP SPEED | RANGE |
|---|---|---|---|
| ECO | 48V | 40Kmph | 90km |

| | | | |
|---|---|---|---|
| NORMAL | 48V | 60Kmph | 60Km |
| SPORTS | 48V | 70Kmph | 45Km |

**Table-1:** Performance Table

TABLE 2

| **Content** | **Petrol** | **E-bike** |
|---|---|---|
| **Source** | Ic engine | Electric |
| **Drive** | Engine | BLDC Motor |
| **Maximum Speed** | 80km | 70km |
| **Maximum Torque** | 4.5nm | 6nm |
| **Mileage** | 45-55Km | 90Km Max. |
| **Emission** | yes | no |
| **Pulling in up hills** | Good | Fair |

**Table-2:** Performance Between Petrol bike and E-bike

## 7. CONCLUSION

In conclusion, comparing our project electric Bike with the commercial electric vehicle. Our bike is efficient to run at double the distance of an ordinary electric bike. As a result, electric bikes are not only used for short-range transportation, they can also be used for long-range transportation' s too. Though our electric bike is independent of external power supply it may be used for charger free transportation's and it payees a better path towards pollution free atmosphere for our nation. In the coming future, it is forethought that all the petrol bikes need to be replaced by the E-bikes as there is a fuel energy crisis and also to save our mother earth. And also it made a low cost of transportation for the human being. This vehicle also gives safety driving for human beings because of their limited speed. The **"REGENERATIVE BRAKING"** is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. This project work has provided us a superb opportunity and knowledge, to use our limited knowledge. We gained tons of practical knowledge regarding, planning, purchasing, assembling, and machining while doing this project work.

## 8. FUTURE SCOPE

If the same work is done at higher levels with more standard processes and using standard parts, efficiency and effectiveness of the system can be improved. The regenerative braking system improves advanced technologies. As global warming is increasing day by day and the reservoir of fossil fuel tends to end, e-bikes, solar bikes, etc. will be better options. As compared to the fuel-driven vehicles, the electricity-driven vehicles are better when we talk about pollution. In the future, by using suitable arrangements in e-bikes for regeneration like motor, solar panel, alternator etc., we will increase the discharging time and therefore increase efficiency. As pollution is increasing a lot and fossil fuel is decreasing day by day, e-bike battery regeneration is a good field for research and development. There will be fewer fuel stations in the future as there will be an increment in the number of e-bikes. We regenerate the e-bike not only by applying the brakes but also by messing the light friction pulley constantly with the central hub of the wheel to get continuous voltage which is also a good field for R&D.

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