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Solar Powered Electric Scooter

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ABSTRACT - In the present era, petrol engines are widely utilized in vehicles as they rely on petrol for fuel, enabling the operation of the vehicle. However, with the limited availability of crude oil nowadays, it is crucial to explore alternative methods. One significant innovation is the electric bike, which offers a highly beneficial solution. Electric vehicles, including electric bikes, provide a clean and environmentally friendly means of transportation, devoid of pollution. To ensure zero emissions, the latest electric vehicles require daily recharging based on usage. Therefore, efforts are being made to find renewable sources for charging these scooters. Considering the need for sustainability, we have considered harnessing universally available solar energy to charge the scooter. This approach not only benefits the environment but also contributes to social well-being. Electric scooters are two-wheeled vehicles that operate using rechargeable batteries, which are replenished by connecting them to an external electricity source. The electricity, generated by solar panels, assists in accelerating the scooter. The energy generated is then stored in a battery, which powers one or more electric motors for movement. The motor employed in this system is a BLDC motor and connected to a brushless motor control unit. The battery is also linked to this control unit. Importantly, the scooter does not require a continuous supply of solar energy to gain the capacity to operate. Instead, it draws energy from the stored power in the batteries. This approach proves to be an effective means of road transport as it produces no pollution, making it eco-friendly and cost-effective

Key Words: Electric scooter, Solar energy

I. INTRODUCTION

The world is experiencing an increasing need for clean energy, and the transportation sector is a major contributor to carbon emissions. Therefore, it is necessary to explore environmentally friendly, cost-effective, and sustainable alternatives for transportation. Currently, global warming and air pollution, particularly in urban areas, pose significant challenges worldwide. These issues affect decisions regarding transportation systems. Urban environments have poorer air quality compared to rural areas, largely due to vehicle emissions. In response, we propose a project to develop an electric scooter that utilizes solar energy as its power source. The solar power obtained is stored in the scooter's batteries. The world is currently striving to eliminate pollution and one of the biggest engineering challenges is to provide clean energy to meet this goal. Solar energy conservation is one of the most extensively studied fields in generating electricity today. Increasing the number of electric scooter users, while addressing safety and comfort concerns, offers a great opportunity to make significant strides in reducing environmental pollution. The high cost of electric vehicles has been a major deterrent for consumers. In our project, we aim to develop a cost-effective electric scooter, taking into account both the electrical and mechanical aspects' motor will be controlled by a brushless motor control system powered by a battery charged with solar energy. The primary focus of the project is to develop a solar-powered electric scooter with regenerative capabilities. By achieving this goal, we aim to contribute to the development of affordable electric vehicles that offer consumers added value while reducing greenhouse gas emissions and combating global warming. Currently, most vehicles rely on non-renewable energy sources like petroleum and diesel, which cause environmental pollution. Internal combustion engines emit CO2, CO, NO2, and hydrocarbons, which have negative effects on human well-being. With the limited availability of crude oil, electricity is the most promising alternative fuel. Electric vehicles provide pollution-free transportation, and our project harnesses universally

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accessible solar energy to generate the electricity needed to operate an electric scooter.

II. PROPOSED SYSTEM

In the proposed system we are using a brush less dc motor which is connected to a brush less dc motor control for the purpose of controlling the speed, and the controller then connects to the throttle of the scooter which can be used by the driver to control the speed of the scooter while driving.

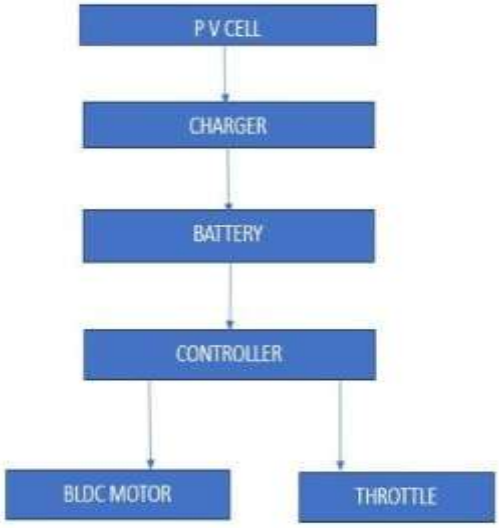

Figure1. Block diagram of proposed system

Fig.1 shows the block diagram representation of the proposed system. The sensor less brush less motor control is powered by the battery which we can charge using either PV cell that is using solar energy or using the conventional method present.

2.1. Basic information about electric scooter

Electric motorcycles and scooters are plug in electric vehicles with two or three wheels. The electricity is stored on board in a rechargeable battery, which drives one or more electric motors the key points are :

• Power source: lithium iron batteries, Solar energy.
• Charging: Recharge using sunlight.
• Range: Have a fixed distance running on single charge.
• Maintenance: No.of frictional component are less, wear-tear is lesser.
• Fuel cost: Electricity and solar is enormously cheap than fuel.

2.2. Selection of components

To produce a complete model of scooter be required number of different components. So our proposed methodology includes the information about the following components. Major components of the electric scooter are:

• solar panels
• BLDC motor
• Batteries
• Wheels
• Brake
• Speedometer
• Accelerator etc.

2.3. Batteries

Sealed lead acid batteries are used here for our project. Lead acid are one of the oldest forms of batteries and it is also the cheapest batteries. Sealed lead acid batteries are commonly found in the large motor vehicles such as trucks and also there are found in many electric machines for an example golf carts. Since the lead acid batteries are the firstly build batteries they can be seen commonly in the kids toys and many other electronic devices since they are the batteries available then. The most common drawback of lead acid batteries is the bulkiness in the size of it and it make it inconvenient to use. Regardless of the bulkiness in their size they are mostly known to produce a high immediate and also they store a lot of power in it. Therefore we can still find them in many vehicles such as some bulky scooters and heavy cars. The another drawback of the sealed lead acid batteries are that their longevity or lifespan depends upon the temperature of their surrounding as well as they also depend upon their size and quality.Fig2 represents the internal diagram of the lithium-ion battery.

That is when selecting a battery for the electric scooter these all things to be considered and also it is really important to ensure that the battery is compatible for the designed electric scooter and also make sure the charging of the battery is proper. Battery should be maintained according to its respective procedures to maintain optimal performance and longevity of the battery. Commonly lead acid batteries that are used because they are comparatively inexpensive and also they provide with a good balance between power and weight. Sealed lead acid batteries are maintenance free that is they don't require regular topping up with distilled water like traditional lead acid batteries. In terms of specifications, the lead acid batteries used in electric scooter usually have a voltage range of 12 V and its capacity rating ranges from 7Ah to 20 Ah, this ranging of the battery will determine how much energy it will store and how far the scooter can travel in a single charge.

Hall effect can be explained as "when a magnetic field is applied at right angles to the current

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flow in a thin film where an electric field is generated, which is mutually perpendicular to the current and the magnetic field and which is directly proportional to the product of current density and the magnetic induction."

Analogy: A hall effect linear sensor also known as a linear is a Analog device that varies its output voltage proportional to the magnetic field it is sensing. when there is no magnetic field the device will produce an output voltage which is equal to the half of the power supply voltage that is VQ.

Purpose: The hall effect sensors can be used to measure the density of the current carriers present and their freedom of movement also known as mobility as well as we can say that the hall effect is used to detect the presence of the current carriers in a magnetic field present.

2.4. Brush less dc motor

A Brushless DC (BLDC) motor, also known as a electronically commutated motor (ECM) or synchronous DC motor, is a type of motor that operates using direct current (DC) and employs electronic commutation to control the motor's speed and direction. Unlike brushed DC motors, BLDC motors do not have brushes and commutators, which simplifies their construction and improves reliability. BLDC motors consist of a rotor with permanent magnets and a stator with windings. The stator windings are typically arranged in a three-phase configuration, creating a rotating magnetic field. The rotor's permanent magnets interact with this rotating magnetic field, resulting in the generation of torque, causing the rotor to rotate. To control the speed and direction of a BLDC motor, electronic commutation is used. This involves sensing the rotor position and applying appropriate currents to the stator windings to create a rotating magnetic field that interacts with the permanent magnets on the rotor. The rotor position can be detected using various methods, such as Hall effect sensors, encoders, or back electromotive force (EMF) sensing.

BLDC motors offer several advantages over brushed DC motors, including higher efficiency, longer lifespan, improved reliability, and better speed control. Since there are no brushes and commutators that can wear out, BLDC motors have reduced maintenance requirements. Additionally, they can provide precise control of motor speed and torque, making them suitable for applications that require high-performance and variable speed operation.

2.5. Brush less dc motor control

A BLDC (Brushless DC) controller is an electronic device used to control the speed, direction, and other parameters of a brushless DC motor. BLDC motors are commonly used in a wide range of applications, including robotics, electric vehicles, industrial machinery, and consumer electronics. The primary function of a BLDC controller is to energize the motor windings in a specific sequence to create a rotating magnetic field that drives the motor shaft. It typically uses Hall effect sensors or back EMF (Electromotive Force) sensing to determine the rotor position and commutate the motor coils accordingly. BLDC controllers often incorporate a microcontroller or a dedicated digital signal processor (DSP) to execute complex algorithms for motor control. They receive input signals, such as speed and direction commands, and apply appropriate voltage and current to the motor windings to achieve the desired performance. Key features of a BLDC controller may include:

- Commutation: The controller determines when and which motor windings to energize to maintain smooth rotation and efficient operation.
- Speed control: The controller regulates the motor speed by adjusting the timing and duration of the applied voltage pulses.
- Direction control: The controller controls the direction of rotation by changing the sequence of energized motor windings.
- Current sensing and limiting: BLDC controllers monitor the motor current to prevent overloading and protect the motor and controller from damage.
- Protection features: They may include over-temperature protection, short-circuitprotection, under-voltage protection, and other safeguards to ensure safe and reliable operation.
- Communication interfaces: Some BLDC controllers provide communication interfaces like UART, SPI, or I2C to allow external devices to communicate with the controller for monitoring and control purposes.
- Regenerative braking: Advanced BLDC controllers can support regenerative braking, which allows the motor to act as a generator, converting kinetic energy back into electrical energy to recharge batteries or dissipate excess energy.

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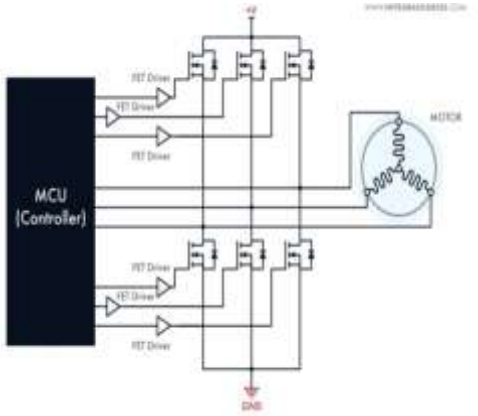

Figure2. Typical BLDC motor drive

2.6. Solar energy

Here we are using solar energy for charging our electric scooter. For charging our scooter we need a solar panel and a solar controller. As we know that the solar panel will capture the energy from the sun and it converted into electrical energy which is then can be stored in the batteries. The solar charge controller will help to regulate the flow of the electricity produced between the solar panel and the battery present in our system and this will make us ensure about the battery is charged safely and efficiently with causing any trouble for the battery. And when the battery is completed the charging it will power our scooter. The amount of the time taken to charge the battery of our electric scooter depend upon the the solar panel we use, the size of the solar panel used, the capacity of the battery used and last but not the least the main factor the amount of the sunlight present at that time. To charge an electric scooter using solar energy we have to find a solar panel with voltage output and current output that is compatible with the batteries we selected for our electric scooter. And also the main part is that the solar panel should be able produce enough amount of energy to charge the battery of our scooter and it should be done within a reasonable time period. Some factors must be care as well when selecting a solar panel for the electric scooter.

Figure3. Typical solar panel

III. WORKING

We all know that the electric scooter is a vehicle that uses an electric motor to power its movement other than the mechanical systems present. And the motor is usually powered by a rechargeable battery pack and is always controlled by an electronic controller according to the motor used in the electric scooter.

3.1. Working of electric scooter

The working of an electric scooter can be explained through various steps as follows;

• Step 1: At first the driver should power on the electric scooter by using the starting option provided. Once the electric scooter in turned on it will send a signal to the controller we used.

• Step 2: The controller then checks the battery for the level of battery is good enough for riding and it will communicate it with the throttle. Throttle is the part handle which allow user accelerate and decelerate while driving. Throttle is controlled by the driver of the vehicle.

• Step 3: Now the throttle is twisted by the driver which will in turn sends a signal from the controller to the electric motor used in the scooter and it will make the motor start turning.

• Step 4: The motor which started to turn will now produce a rotational force that will make the electric scooter wheel to turn.

• Step 5: Then the electric scooter speed is determined by the amount of power that is send from the battery to the converted motor that we used here. Then the controllerhelps to regulate the power to maintain the consistent speed or the speed of the drivers choice.

• Step 6: If the rider wants to either slow down or stop the scooter the rider just need to release the throttle or or apply the brakes of the scooter this will produce a signal to the controller to reduce the power that is supplied to the motor.

• Step 7: The battery pack that is used in the scooter gives power to the motor to run. And it is also rechargeable and can be recharged by plugging it into the solar energy we provide or any other electrical outlet.

So that is basic working of how an electric scooter work.

3.2. Working of solar powered electric scooter

A solar-powered electric scooter utilizes solar energy to charge its batteries and power its electric motor. Here's how it typically works:

- Solar Panels: The scooter is equipped with solar panels that are usually integrated into its body or attached as an accessory. These solar panels

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consist of photovoltaic cells that convert sunlight into electrical energy.

- Charging the Batteries: When the scooter is exposed to sunlight, the solar panels collect solar energy and convert it into electricity. This electricity is then used to charge the scooter's batteries. The batteries store the energy for later use, allowing the scooter to operate even when sunlight is not available.
- Electric Motor: The scooter is powered by an electric motor, which is connected to the batteries. When the rider activates the scooter, the stored energy from the batteries is transferred to the motor, generating the necessary power to propel the scooter forward.
- Regenerative Braking: Some solar-powered scooters incorporate regenerative braking technology. When the rider applies the brakes, the scooter's motor acts as a generator and converts the kinetic energy of the moving scooter back into electrical energy. This energy is then sent back to the batteries, helping to recharge them and increase the overall efficiency of the scooter.
- Charging Efficiency and Range: The charging efficiency of solar panels can vary depending on factors such as the size and quality of the panels, the amount of sunlight available, and the angle at which the panels are positioned. The range of a solarpowered electric scooter will also depend on the capacity of its batteries and the energy consumption of its motor.

TORQUE CALCULATIONS

Angular Velocity = (2*3.14*N)/60rad/sec
N = Max. speed of motor in rpm

Power = Torque * Angular Velocity
= (2*3.14*450)/60
= 47.12 rad/sec

Power = Torque * Angular Velocity
1000 = T * 47.12
T = 1000/47.12
= 21.22 Nm

IV. CONCLUSIONS

Solar powered electric scooters are a relatively new innovation that combines the benefits of the solar power and electric mobility. These scooters are equipped with solar panels that allow them to be charged directly by the sun, making them environmentally friendly and cost effective. One of the key advantages of the solar powered electric scooters is their low operating cost. Since they do not rely on the fossil fuels they can be operated at a significantly lower cost than traditional gasoline powered scooters. Additionally their use of solar power can reduce the overall carbon footprint of the transportation sector. Another advantage of solar powered electric scooters is their versatility. They can be used for variety of purposes including commuting, running errands, and leisure activities. They are also light weight and easy to maintain, making them an ideal choice for urban environments. Here we are making an electric scooter which is concentrated on the cost which is a main problem of the electric scooters available at the market.

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