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Research Article

Solar E-Bike

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Abstract: We all know that the fuel price and pollution due to general vehicles in metro cities and urban areas are increasing day by day thus there is a tremendous need to search for an alternative to conserve these natural resources. A solar e-bike is an electric vehicle that provides an alternative by harnessing solar energy to charge the battery and thus provide the required voltage to run the motor. Since India is blessed with nine months of sunny climate thus the concept of the solar e-bike is very friendly in India. Generally, the dynamo is used to gain additional supply through the moment of the e-bike. By using dynamo we didn't get efficient output. So, instead of this dynamo, we are using a solar panel to gain the additional supply which is used to charge the batteries and to run the e-bike. Thus solar e-bike becomes a very vital alternative to the fueled automobiles.

Keywords: Solar panel, solar charge controller, *PMDC* gear motor, motor controller.

1. Introduction

A solar assisted bicycle is also known as a solar e-bike. The solar panel converts light energy into electrical energy. Thus energy charges the battery. The *PMDC* motor is fitted at the back side of the cycle. The motor and freewheel connected through a chain drive. When motor terminal connected to a battery the motor drives the cycle. Generally, there are different types of batteries available in the market. The selection of battery is based on our choice or price of the battery.

Solar vehicles are not sold as practical day-to-day transportation devices at present but are primarily demonstration vehicles and engineering exercises, often sponsored by government agencies. However, indirectly solar-charged vehicles are widespread and solar boats are available commercially. At present these type of e-bike are not available in India, but in foreign few peoples can be used.

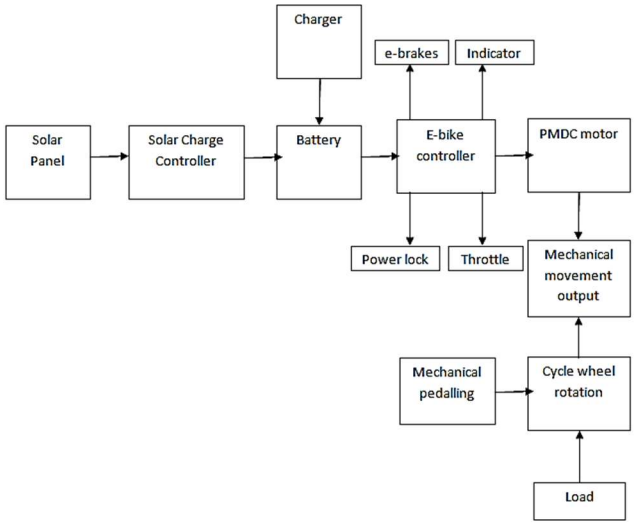

Figure 1. Block diagram of solar *E*-Bike

2. Methodology

Figure 1 shows the components used in solar *e*-bike.

2.1. PMDC Motor

The permanent magnet *DC* motor is a type of the *DC* motor that uses a permanent magnet to create the magnetic field required for the operation of *DC* motor. These types of motors are simple in construction. They are commonly used as starter motors in automobiles, windshield wiper, washers, for blowers used in heaters and air conditioners and they are extensively used in toys.

Figure 2. *PMDC* motor

2.2. Solar Panel

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Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity. A photovoltaic (*PV*) module is a packaged, connected assembly of typically *6*10* photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

Figure 3. Solar panel

2.3. Solar charge controller

A *PWM* solar charge controller stands for pulse width modulation solar charge controller. These operate by making a connection directly from the solar array to the battery bank. During bulk charging, when there is a continuous connection from the array to the battery bank, the array output voltage is 'pulled down' to the battery voltage. As the battery charges, the voltage of the battery rises, so the voltage output of the solar panel rises as well, using more of the solar power as it charges. As a result, you need to make sure you match the nominal voltage of the solar array with the voltage of the power bank.

Figure 4. Solar charge controller

2.4. *E*-Bike controller

The E-Bike controller is the heart of e-bike. It is connected to all the other electronic parts such as a battery, motor, throttle, horn, power lock, e-brakes, charger port, and indicator. It takes all the inputs from all other components and determines what should be signaled to them in return.

Figure 5. Outer and Inner view of *E*-Bike Controller

2.5. E-brakes

Now a day's, every town and city is facing more number of accident issues. To overcome those accidents brakes play a major role. Generally, brakes are used to slow down the vehicle speed or to stop the vehicle.

When building an e-bike make sure to install e-brakes why because general brakes don't cut power to the motor and it doesn't lock the throttle. For this reason, we have fixed e brakes that are used to cut-off power to the motor.

Figure 6. E-brakes

2.6. Headlight & Indicator

Headlights are essential parts of modern vehicles. Without them, not only would it be extremely difficult to see what's coming ahead of you, you would have a hard time locating other vehicles on the roads as well. There are usually multiple settings for your headlights so it is important to know the difference between your regular headlights, tail lights, and high beams. Not all vehicles will indicate that the headlights are on but they will at least tell you when the high beams are on by while illuminating a dashboard indicator light. The Indicator shows the indication of battery charge level and the motor is running or not.

Figure 7. Headlight & Indicator

2.7. Power lock

Power lock is used to on or off the power flow of e-bike controller. If it is *ON*, the power will be flow battery to some components like a horn, motor, throttle, brake light, and headlight &Indicator. If it is *OFF*, the power doesn't flow. It is used for safety purpose.

Figure 8. Power lock

2.8. Throttle

The throttle of the e-bike is similar to how a motorcycle or scooter operates. When the throttle is engaged the motor provides power and propels us and the bike forward.

Accelerator is used to increase or decrease the speed of solar. Our bicycle is designed to run at speeds ranging from *25-30km/hr*. The speed of e-bike should change while going uphill and downhill. This is possible by including the speed change that is done by the accelerator. Accelerator can be arranged in the right side of the handlebar and is connected to e-bike controller.

Figure 9. Accelerator or Throttle

2.9. Power Charger

Power charger is a charger used to charge the battery. Generally, most of the electronic devices and some of the electrical devices require a small amount of *DC* power. But in general, the available power is *AC*. So we need to convert *AC* power into required *DC* power. This can be done by the 'Power charger'.

Basically, the power charger consists of step-down transformer, a rectifier circuit, and filter circuit. When *AC* supply is given to the step down transformer, the transformer step - down the required voltage. The step-down voltage is given to the rectifier circuit, then the rectifier rectifies the *AC* power into pulsating *DC* power. The filter circuit is connected across the rectifier output, this filter removes the ripples in the output power, and then we get a pure *DC* power.

Figure 10. Power charger

2.10. Batteries

A battery is a device consisting of one or more electrochemical cell. The function of the battery is to convert chemical energy into electric energy. The batteries are classified into two types they are;

- Primary cell
- Secondary cell.

Primary cells are not rechargeable. Secondary batteries are rechargeable so as to restore power. When electrical energy is applied to the battery, the electron flow from the negative to the positive electrode that occurs during discharge is reversed and power is restored. Examples of primary cells include zinc-carbon and zinc chloride cells. Rechargeable batteries can be categorized into the following:

Lead acid batteries, nickel cadmium batteries, nickel-metal hydride batteries, lithium ion batteries etc. In this work, we have to arrange the lead-acid batteries because of its less cost and gives high potential.

Figure 11. Lead acid Batteries

3. Working of Solar *E*-Bike

The solar panel is mounted as the roof of the cycle. The solar panel generates power when sunlight falls on it. The output of the solar panel is not constant it depends on the intensity of sunlight. So, we need to use solar charge controller at its output terminals. This controller controls its output power based on the principle of pulse width modulation (*PWM*) technique. Thus controlled output power charges the battery.

Here we can also charge the batteries by using the power charger from *230v AC* supply. This charger consists of step-down transformer, a rectifier circuit, and filter circuit. When *230v AC* supply is given to the step-down transformer, this transformer step downs the required voltage. This voltage is given to rectifier circuit, this rectifier rectifies *AC* power into pulsating dc power. The filter circuit is connected across the rectifier output, the filter will remove the ripple content in the output power. Then we get a pure dc output which is suitable for charging.

The heart of *e*-bike is the controller. Which controls the overall performance of the *e*-bike by using *LM339* comparator and some other electronic components which are connected in a suitable manner. When we turn on the power lock the controller supplies power from the battery to different components of the solar *e*-bike.

When we accelerate the motor starts to rotate the cycle by chain transmission drive. In running condition, the solar panel supplies power to the motor, if that power is not sufficient to run the *e*-bike, the remaining power absorbs from the battery. This will improve the mileage of *e*-bike. The power is drawn by motor based on the load of the *e*-bike. When *e*-bike was not in use or in a rest position during the day, the battery will

charge by using solar energy. This system will make *e*-bike operates more efficiently. The special feature of the solar *e*-bike is we can ride by pedaling also, this is optional.

The function of *e*-brakes is cut-off supply flowing to the motor at the time of brakes applied. The main advantage of this type of braking is to prevent the motor from overheating of armature windings at the time of braking. Here indicator is placed at the middle of the handlebar, which displays or indicates the battery charging level.

Another advantage of solar panel is to provide shelter for the rider from sun & rain and its terminals are connected to the solar charge controller. Because the intensity of solar light is not constant this controller works on the principle of pulse width modulation (*PWM*) which controls its output power.

4. Conclusion

A solar *e*-bike is a modification of existing *e*-bike and driven by solar energy. It is suitable for both city and country road that is made of cement, asphalt or mud. This bicycle is cheaper compared to petrol operated motorcycles and simple in construction. It can be widely used for shorter distances especially for school children, college students, office persons etc. It is very much suitable for young, aged, handicapped people.

Moreover, it is eco- friendly since it doesn't produce any harmful gases and can be recharged with the *AC* adapter in case of emergency and cloudy weather. The cost per *18KM* is around *RS 0.50/-*. It can be driven by manual pedaling in case of any problem with the solar system or something else. Figure *12* shows the solar *e*-bike.

Figure 12. Solar *e*-bike

Practical Observations
Charging time: *3:30hrs*
Charging Cost: *Rs 0.50/-*
Distance travelled per charge: *18km*
Speed: *20kmph*
Weight of Solar e-bike: *45kg*

At the time of starting, due to the absence of counter *emf*. Or back *emf*, it draws current from

For 75Kg: 19.5A to 9.5A
For 68kg: 19.5A to 8.9A
For 54kg: 19.5A to 7.4A
For 48kg: 19.5A to 5.2A

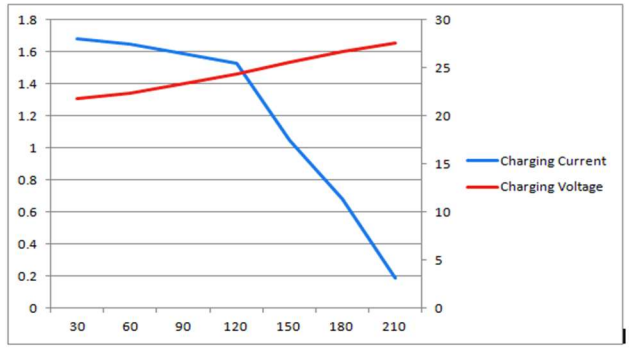

Figure 13. V-I Characteristics of Battery Charging

5. Future Work

In this project, we are using two lead - acid batteries for supplying power to the motor. This solar e-bike can be further enhanced by arranging another two lead - acid batteries for extra supply. So, we can travel for longer distances using extra battery supply to avoid pedaling for more time when compared to two batteries used solar e-bike. By the adding of additional Lead Acid Batteries, the mileage of Solar *E*-bike is also increased.

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