International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 9 Issue 8 ǁ 2021 ǁ PP. 01-05

Solar Powered Electric Bicycle

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ABSTRACT:
Since the fuel prices throughout the world are increasing day by day thus there is a tremendous need to search for an alternative to conserve these natural resources. Thus, a solar bicycle is an electric vehicle that provides that alternative by harnessing solar energy to charge the battery and thus provide required voltage to run the motor. Since India is blessed with nine months of sunny climate thus concept of solar bicycle is very friendly in India. Hybrid bicycle combines the use of solar energy as well as the dynamo that runs through pedal to charge the battery to run the bicycle. Thus, solar hybrid bicycle can become a very vital alternative to the fuelled automobile thus its manufacturing is essential.

Date of Submission: 12-08-2021 Date of acceptance: 27-08-2021

I. INTRODUCTION:

The increasing mobility has directly led to deteriorating traffic conditions, extra fuel consumption, increasing automobile exhaust emissions, air pollution and lowering quality of life. Apart from being clean, cheap and equitable mode of transport for short distance journeys, cycling can potentially offer solutions to the problem of urban mobility. Urban mobility is a prevalent problem in many cities around the world. Issues on the urban mobility affects the quality of life and environmental sustainability are gaining importance in the world.
The world population has been progressively concentrating in the cities [1]. Cities around the world are undergoing rapid urbanization. Mobility in urban areas is one of the challenge that must be addressed and improved to get a better quality of life for the community [2]. The increasing mobility has strong correlation to the traffic conditions, extra fuel consumption, automobile exhaust emissions, air pollution, and quality of life. Urban mobility is a prevalent problem in many cities around the world. Issues on the urban mobility affects the quality of life and environmental sustainability are gaining importance in the world.

Cycling can be considered as one of the solutions for urban mobility problems especially for short distance trips. Cycling offers many benefits to the problem of urban mobility

A solar bicycle is a bicycle which runs using the electrical energy of battery to run the hub motor which ultimately runs the bicycle. Solar energy is used to charge the battery. Battery gives the required voltage to the hub motor mounted on the front wheel to run the bicycle

PROBLEM STATEMENT:
The above literature survey reveals several problems associated with solar powered electric bicycle, listed as follows:

- Use of external BLDC motor [3]'- affects the designing and makes the system complicated. BLDC motors can be brutal on the drive system. It also causes jerky or awkward motor timing during hill climbing and around obstacles.
- Solar energy is not stable with weather changes. [1]'- along with the weather changing, the electricity always varies with the light intensity. The clouds, seasons, day and night and extreme weather can affect the power from solar cells.
- The maximum speed of bicycle when external BLDC motor used is only about 30-35km/hr. [2]'- BLDC motor is connected externally through chain arrangements; losses occur due to friction. They cannot be used in regenerative situations and hence reduces the speed.

OBJECTIVES OF PROJECT:

- To use hub motor to simplify the design.
- Harnessing energy from multiple sources using dynamo, regenerative braking techniques and solar panels.
- Improving the speed of bicycle.

Using Hub motor, harnessing energy from various sources and improving the speed of the bicycle, an eco-friendly and efficient vehicle can be realized.

SOLAR POWERED ELECTRIC VEHICLE:

A solar bicycle is a bicycle which runs using the electrical energy of battery to run the hub motor which ultimately runs the bicycle. Solar energy is used to charge the battery. Two or more Photovoltaic cells may be used to harness solar energy to generate voltage to charge the battery. Battery gives the required voltage to the hub motor mounted on the front wheel to run the bicycle.

Solar powered electric bicycles use photovoltaic cells that convert solar energy into required voltage to charge the battery. There are two types of solar panels that are generally used that is polycrystalline panels and microcrystalline solar panels. The polycrystalline panels are having less efficiency as compared to microcrystalline panels. Polycrystalline panels have efficiency of approximately 15 – 20% while microcrystalline panels have efficiency of 50 -60%.

There are different types of batteries used in electric vehicles like lead acid batteries, lithium ion batteries, Nickel cadmium batteries, etc. Different batteries they have their different advantages for different applications. As far as solar bicycles are concerned lead acid and lithium ion batteries are most commonly in use.

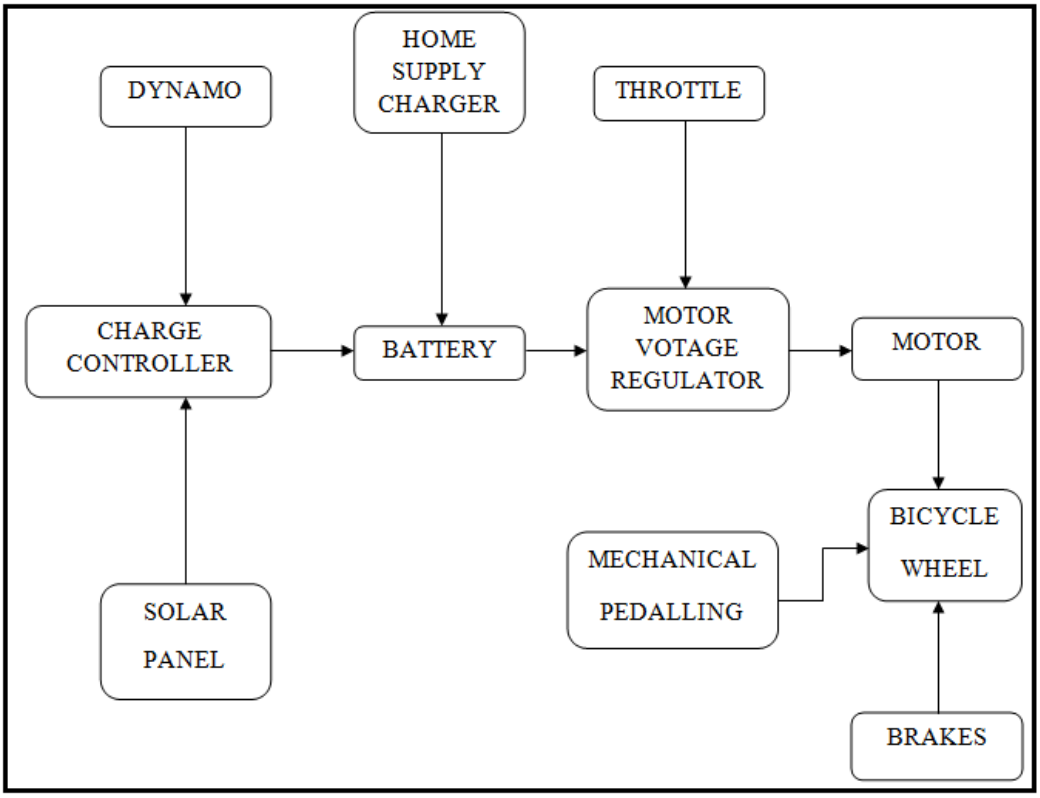
Lead acid batteries have lower cost, higher current carrying capacity but have smaller life and are heavier. While lithium ion batteries have lower weight but higher cost and there are chances of explosion.

Solar bicycles have gathered attention from all over the world and there have been many projects being done on this topic. The motor used is a permanent magnet Hub motor which will be mounted on the front wheel. While a belt and pulley mechanism will be provided on the rear side of the vehicle to run the dynamo.

COMPONENTS REQUIRED:

- Hub motor
- Solar panel
- Lead acid battery
- Motor voltage controller
- Accelerator
- Bicycle
- Dynamo
- Charge Controller

BLOCK DIAGRAM:



The block diagram of electric bicycle driven by DC motor fitted on middle shaft of bicycle & operated by battery energy shown in figure. The solar panel mounted on carriage. Solar panel generates 12V power when sun light falls on it and its terminals are connected to charge controller.

Dynamo is mounted on side shaft of bicycle, supports in such a manner that dynamo shaft is touching the back-wheel tyre. As wheel rotates dynamo shaft rotates and generates 12V power. Its terminals are also connected to charge controller. When the bicycle is idle in day time, the solar panel will charge the battery. Due to non-uniform sunlight and varying in wheel speed, output voltage from both solar panel and dynamo is varying in nature. Charge controller adjusts the constant voltage of 12 volt and charges the battery. The power flow acts in parallel with the power delivered by the rider via the pedalling. The rider of a solar bicycle can opt the motor completely or pedalling (as in conventional bicycle).

1. BRUSHLESS PMDC MOTOR:

In this project 24v, 350W brushless type permanent magnet dc motor is used

2. SOLAR PANEL:

Solar power is the generation of electricity from sunlight. Solar power is the conversion of sunlight to electricity. Sunlight can be converted directly into electricity using photo voltaic (PV) panel

3. CHARGE CONTROLLER:

It is essential to regulate the voltage output from the solar panel before it is supplied to the battery. A charge controller is a power converter with an output DC voltage greater than the input DC voltage. This is used to regulate an input voltage to a higher regulated voltage

4. DYNAMO:

Dynamo is used to generate electric power. A dynamo is an electrical generator that produces power with use of a commutator. Dynamo is placed on rear wheel of the bicycle and dynamo commutator is connected with rear wheel of bicycle.

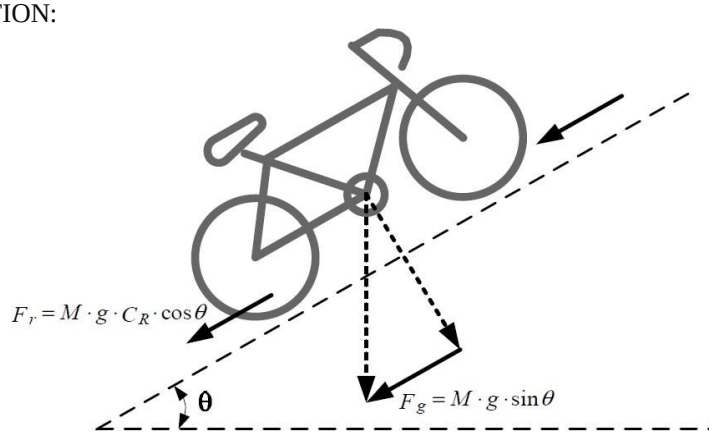
5. MOTOR VOLTAGE REGULATOR:

Voltage regulator controls the voltage level as per requirement. The voltage regulator used in this project acts as a tapping switch. In our project two voltage levels are used.as per required voltage levels regulator can be adjusted The world population has been progressively concentrating in the cities [1]. Cities around the world are undergoing rapid urbanization. Mobility in urban areas is one of the challenge that must be addressed and improved to get a better quality of life for the community [2]. The increasing mobility has strong correlation to the traffic conditions, extra fuel consumption, automobile exhaust emissions, air pollution, and quality of life. Urban mobility is a prevalent problem in many cities around the world. Issues on the urban mobility affects the quality of life and environmental sustainability are gaining importance in the world.

6. ACCELERATOR / THROTTLE:

This solar electric bicycle thumb throttle is easy to use and great for those that want to keep their original handlebar grip. Typically, the thumb throttle is used on bikes that have a twist gear changing system. Thumb throttle that said it comes down to personal choice as the thumb throttle can also be used on a bike that has a thumb gear changing system. A “Thumb Throttle” refers to a method of controlling the speed of an engine or motor.

DESIGN CALCULATION:



Diameter of the bicycle wheel D = 0.66m Radius r = 0.33m
Speed required s = 30km/hr Bicycle weight Wb= 20kg
Weight of the rider (Approximately) Wr = 70 kg Total weight Wt = 90 kg
Power calculation:
Normal reaction on each tyre Wn = Wt/2 = 45 kg
Force F = Wn * g = 45* 9.81 =441.45 N

1. Considering static friction:
static friction coefficient u = 0.03

Fs = u * F = 0.03 * 441.45 = 13.24 N

Torque Ts = Fs * r = 13.24 * 0.33 = 4.37 Nm

2. Considering dynamic friction:
static friction coefficient u = 0.004

F_d = u * F = 0.004 * 441.45 = 1.765N

Torque T_d= F_d* r = 1.765 * 0.33 = 0.5827 Nm

1. Angular Speed:

w = velocity/radius = 30,000/ (0.33*3600) = 25.25 rad/sec

Power Requirements:

1. On plane Ground

for static condition Ps = Ts*w = 4.37 * 25.25 = 110.34 W for dynamic condition P_d = T_d * w = 14.71 W
overall power requirement = 110.34 * 2 = 220.68W

2. On inclined surface

let angle of inclination a = 2'
total force required is
a] considering static friction

F = u * m*g * cos (a) + m*g sin (a) =57.28 N
therefore, power required = F*V = 477.33 W extra power required = 477.33 – 220.68 = 256 W
b] considering dynamic friction
F = u * m*g * cos (a) + m*g sin (a)= 34.34 N
Power P = F*V = 286 W
By considering the above calculations we require 350W hub motor.

Charging adapter selection:

Charging current should be 10% of the Ah rating of the battery.
Therefore,
Charging current of adapter = battery Ah * (10/100) = 1.5 A

Due to some losses, we may take 1.5- 3.5 Amperes for battery charging purpose instead of 1.5 Amp.

We select 24V 3A charging adapter.

Calculation of charging time of battery:
Charging time of battery by adapter = Battery Ah / charging current. Charging time for 15Ah battery = 15 Ah/ 3 A = 5 Hrs.
It is for ideal cases…

Practically, it has been noted that 40% losses
occur in case of battery charging. Then 15*(40/100) =6Ah.
Therefore, 15+6 = 21Ah (15Ah + losses)

Now, charging time of battery = 21 Ah /3A = 7 Hrs.

Selection of solar panel:
we use two panels of 50 W ,12V each having dimension 350mm* 550 mm connected in series to provide 24V output.
Charging time of battery when charged by solar panels:

Charging time of battery by adapter = Battery Ah / charging current. Charging time = 15 Ah / 2.5 A= 6 Hrs.
The calculation provides the required rating of the devices that are to be used in the project. These rated components are assembled in a proper manner to develop our project. The outcomes of all these are analyzed and discussed in the next chapter.

Maximum power (Pmax)	50W
Maximum power voltage	19.95V
Maximum power current	2.51A
Short circuit current	2.63A
Open circuit voltage	22.26V
Maximum system voltage	600V

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