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Development Of Solar E-Bike

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Abstract —Solar e-bike is a hybrid vehicle which allows the user to choose the mode of its energy. There are two ways a rider can opt to drive Solar E-Bike-electrically operated system, and manual pedal system. The batteries in the electrically operated system can be charged by either Solar panels or wall charge plugin. The P.V. panels must be mounted and installed at the electric bicycle without compromising riding comfort ability. The concept of the solar energy is that a high torque motor will be put on the bicycle which will be generated by the solar energy. The solar energy will be absorbed by the portable solar panel to generate the power. The power that had been absorbed by the panel can be used directly by the motor if the power matches the power requirement. If not, the motor will use the power from a battery. When the bicycle was not in use during the day, the solar panel will charge the battery. The system will make bicycle operate more efficiently.

Keywords: Solar e-bike, E-vehicle, hybrid bicycle.

I. INTRODUCTION

Parts used in Solar E-bike are Solar panels, Voltage regulator, Brush-less DC Motor, Throttle Accelerator, Battery, Chain Drive, Frame and other common bicycle parts. There are two parts of Solar e-bike as per their functions and working: Power on Demand and Manual Pedal Assist. The BLDC motor is activated by a throttle with power-on-demand, customarily handlebar-mounted as well as on general scooters or motorcycles. The pedal-assist augments the efforts of the rider when they are pedalling. Disabling the motor is the brake sensing action. Systems with E-bikes could open up their use to a broader audience. The potential for modal shift from fossil fuel powered transport modes would thus increase. Furthermore, a roof may be placed on top of the E-bike station that could serve as combined weather protection and provider of electric energy by installing solar panels on the roof. If the available solar energy is sufficient, it could for example keep the system off-grid which means that stations can be placed temporarily where needed, e.g. close to festival areas or sports events. Placing solar panels on station roofs would introduce solar energy in places that otherwise would not have been considered. An E-bike charged with electricity from the sun may be one of the most efficient means of transport there is. The main reason is because its mass is lower than a car's or a scooter's and thus less energy is required for propulsion. The second reason is that bio-fuels or regular cycling requires conversion of solar energy to chemical energy which is characterized by low energy conversion efficiencies relative a solar panel.

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II. LITERATURE REVIEW

Georgia Apostolou , Angele Reinders and Karst Geurs [1], They acknowledge us about the current scenario of e-bikes, more specially, with the solar-powered e-bikes. Also, this review paper explores existing literature findings for the use of solar energy in transportation, and more specifically in e-bikes.

S Adisuwignjo, I Siradjuddin, M Rifa, R I Putri [2], They study about the development of solar-powered electric bicycle controlled using fuzzy logic controller that can keep the battery charging in order to solar e-bicycle to remain stable.

G.Srinivasa Rao, K. Harinadha Reddy, Raghu Thumu,Ch Amarendra [3], In this scenario , They have proposed electric propulsion system using B.L.D.C. motor with sensory speed control along with smooth running operation is shown.

H.S.Upare, P.S.Pandure [4], studied the present scenario a Solar Hybrid Bicycle system will help to solve the major problems of fuel and pollution. India is blessed with nine months of sunny climate thus concept of solar bicycle will be very useful 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. The bicycle has the most feasible solar/electric power generation system mounted on the vehicle to charge the battery during all durations. This multi charging vehicle can charge itself from both solar and mechanical power. Solar panels can be mounted on the backside of bicycle to capture the sun rays. When there is no presence of sun, mechanical work act as an auxiliary energy source. For controlling speed of the motor, an accelerator is given which controls the supply. This type of technique is to reduce the running cost and increasing the running efficiency of the vehicle.

C.Sivapragash, C.Shankar , M.Nageena , B.Reetha Devi , K.Kiruthiga [5], The project is based on the microcontroller with automation technology, it consisting of components such as ATMEGA328 and PIC30F2010 as a controller, three phase inverter, solar panel, hall effect sensor, variable resistor etc., In the existing system, a traditional bicycle is a two-wheel vehicle that is propelled by the rider who delivers 50 percent muscle power through pedals that rotate one of the two wheels and 50 percent motor powered to rotate the wheel for riding the bicycle, the motor used in the existing system is brushed dc motor, it has less efficiency.

Kartik S Mishra, Shubham V Gadhawe, Dhiraj C Chaudhari, Bhupendra Varma and S. B. Barve [6], Solar bicycle 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 poly-crystalline panels and micro-crystalline solar panels. The poly-crystalline panels are having less efficiency as compared to micro-crystalline panels. Poly-crystalline panels have efficiency of approximately 15-20 percent while micro-crystalline panels have efficiency of 50 -60 percent. There are different types of batteries used in electric vehicles like lead acid batteries, lithium-ion ,Nickel cadmium batteries, etc.

Fabian Fogleberg [7], studied that the recommended system design is to have a grid-connected system as an off-grid solution would not utilize the solar irradiation fully. Coupling the grid-connected system with a battery was shown to increase the share of time the system is independent of energy from the grid from about 40 to 80 at 2 m2solar panels per E-bike. The main benefit of introducing a buyer battery is that it enables origin marking of the electricity when the grid has not

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been used and that the system efficiency increases as less energy from the solar panel is converted to AC. Such origin marking can be used to inform the user that their E-bike now is powered 100 by solar energy.

Mr.Prashant Kadi, Mr.Shrirang Kulkarni [8], have presented the hybrid bicycle project that can promote both cleaner technology as well as a lesser dependence on oil. It will run on clean electric power with the ability to recharge the battery 3 separate ways: through the 230 V AC wall source, by solar cell generative power and by dynamo which is attached to bicycle wheel.

III. WORKING PRINCIPLE OF SOLAR E-BIKE

The solar electrical bicycle consists of main components that is solar panel, battery, DC motor, chain drive, wheel. This project consists of bicycle, solar panels, dc motor, battery, sprocket, chain. In this project, solar panel firstly absorb the sun rays and produce the energy, this energy will go to battery. And this energy will use for start to motor**.**

Figure 1: Solar e-bike

Parts of Solar E-bicycle model:

a) **Solar panels**:
Two solar panels of 40 W capacities were selected due to space constraint. To charge the battery completely, it needs 300/ 40 = 7.5 hours are required. The DC voltage booster keeps the voltage optimum for the battery to get charged even while the voltage falls below threshold in diffused sunlight.

Figure 2: Solar panel

b) Lead Acid battery:

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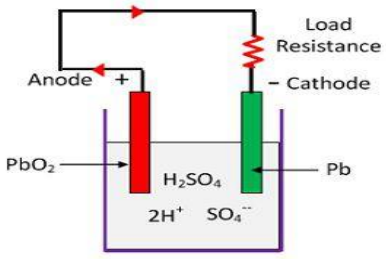

Figure 3: Working of Lead Acid battery.

Specifications of Lead Acid battery:

• BM Part #:	○ SLA-12V7-F1
• Voltage:	○ 12 Volt
• Capacity:	○ 7 Ah
• Type:	○ Sealed Lead Acid Battery

c) BLDC motor Specifications:

Figure 4: BLDC Motor

- Output Power: 350W.
- Supply Voltage: 24/36V DC.
- Speed: 2750 RPM.
- No load speed: 3300RPM.
- Full load Current: ≤19.20A.
- No load Current: ≤2.5A.
- Weight: 2.56 Kg.
- Rated Torque: 1.11 N.m (11.1 kg.cm).
- Stall Torque: 5.55 N.m (55.11 kg.cm).
- Efficiency: ≥78%.

d) Arduino Board Technical Specifications:

• Microcontroller	ATmega328
• Operating Voltage	5V

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• Input Voltage (recommended)	7-9V
• Input Voltage (limits)	6-20V

e) Chain drive:

Chain drive is a way of transmitting mechanical power from one motor to system.

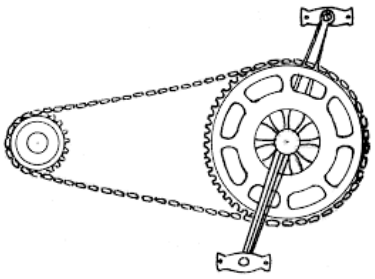

Figure 5: Chain Drive

f) Bicycle Wheel:

Bicycle wheels are typically designed to fit into the frame and fork via dropouts, and hold bicycle tires.

Figure 6: Wheel

IV. DESGIN CALCULATIONS

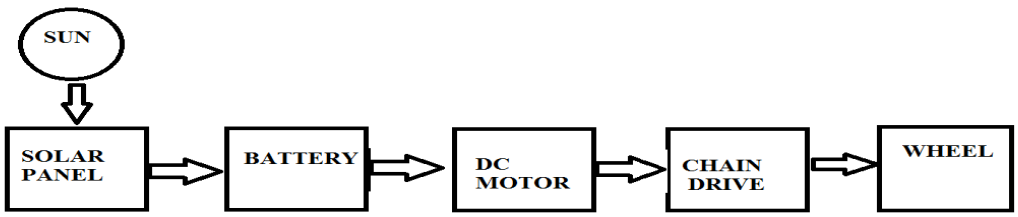

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Figure 7: Working mechanism Solar e-bike.

Notations:

- d = diameter of the cycle rim in meters.
- r = radius of cycle rim in meters.
- ω = Angular velocity of cycle shaft.
- N = Speed of cycle wheel in RPM
- v = Linear velocity of the cycle in kmph
- N_1=Normal reaction of the road on each tire in Newtons.
- μ=Coefficient of friction = 0.3 F=Frictional force between tire and road in Newtons.
- T=Torque developed on the shaft due to frictional force in Newton-meters.
- P=Power required to ride the cycle in Watts.
- t=time required to charge the battery by A- C Supply in hours

Bicycle data available:

- Cycle Rim Diameter d = 66.04 cm = 0.66 m
- Required Cycle Speed v = 20 kmph
- Cycle Weight + Rider Weight (w)=100 kg.
- Electric - Bicycle is eco- friendly and comfortable but costly. It is infeasible as there is no enough provision for charging in rural India. Hence a bicycle which can be peddled as well as run on solar powered battery seems to be suitable option to solve the issues discussed above.

Design:

- The design involves the calculation of power required to run a e-bike at a known speed (say 20 km/h) and to develop a solar powered system to produce the required power.
- Since additional attachments are to be mounted on the cycle, a light weight cycle with geared system and suspension was selected. A Cycle was purchased.

Motor calculations

- Since the total cycle weight is equal to **100 kg**, the Normal reaction acting on each tire is equal to **(50 x 9.81) Newton** each.

Friction force acting on the tire

- F = μ N1
- F = 0.3 x 490.5
- F = 147.15 N

Speed calculations:

- **ω = v ÷ r**,
- **ω = (20 x 1000) ÷ (0.33 x 3600)**
- **ω = 16.83 rad/sec**
- **ω = (2 π N) ÷ 60**
- **N = (60 x ω) ÷ (2π)**
- N = (60 x 16.83) ÷ (2π)
- N = 161 rpm

Power calculations:

- **P = (2 π N T) ÷ 60**
- P = (2 π x 161 x 21) ÷ 60
- P = 353.878 W
- The solar power is used as a supplementary energy to ride the bicycle. A motor with power of 350 W with peak wattage 388W is selected.

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Battery specification:

- Power = Voltage x Current
- P = V.I
- 350 = 24 x I
- I = 14.58Ah
- Hence according to the above calculations, to drive a motor of **350 W**, **24 V** capacity; we select 2 batteries of **12V**, **12.5Ah**. We connect these batteries in series to achieve a voltage of **24V** as required by the motor.

Electrical charging:

- Time required to fully charging the battery is calculated.
- Power Supplied to Battery during AC Charging:
  AC Adapter Specification: 12V, 3 A
- P = V.I
- P = 12 x 3
- P = 36 W
- Therefore, the time required to charge the battery completely is: t = 300 ÷ 36 = 8.5 hours
- Hence, it is found that, the time required to charge the batteries completely is **8.5 hours**.

V. CONCLUSION

After studying various research papers and conducting research on current scenario of Solar e-bike, the following conclusions were proposed.

- Our solar e-bike can carry a total weight of 120 kg including the weight of battery, motor and solar panel. When battery is fully charged the Hybrid Powered maximum travelling distance at plain road is 35km. Hybrid bicycle can attain a maximum speed of 30 km/hour. Compared to already existing E bikes travelling distance and maximum speed is small but considering the cost our hybrid bicycle is around 20000 Rupees and E-bikes cost more than 55000 Rupees.
- The present work deals with the design of solar E-bike. It makes use of the fuzzy logic controller that helps the battery to remain charged using the solar energy through solar panels. We are going to make use of this fuzzy logic controller in our solar e-bike. And also the researchers used brush-less D.C. motor for smooth and silent functioning of vehicle. We are going to use the Brush-less D.C. motor in our model for smooth running and for reducing the heat and friction losses.
- Analysis of environmental conditions was done. This analysis and result were used for the further development of solar E-bike. For example-The use of plug charge system was made in case of absence of solar energy. Also, from previous research papers we have pointed out some defects that lead to decrease in efficiency of their model. In our model, we tried to eliminate those defects for better performance of our solar e-bike.
- In ideal cases, all solar energy available would be collected by the solar panels but in a city environment this is not always the case since buildings will shadow the irradiation. A method of estimating these losses needs to be developed. When the sunlight hits the solar panels, a number of different losses will occur during the conversion to electric power. These will be dependent on a number of factors such as type of solar cell technology used, outdoor temperature etc.

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