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Design and Fabrication of Solar Electric Bicycle

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Abstract- The demand for petroleum products is at an all-time high right now due to the expanding number of cars. Because petroleum is not renewable and will eventually run out, switching to alternative energy sources is preferable. The price of crude oil has skyrocketed in recent years, and it appears there is no stopping it. The environment has recently attracted attention, and it appears that cleaner fuel options are in high demand. The hybrid bicycle is a project that can help reduce reliance on oil and promote cleaner technology. An electric bicycle is a low-cost alternative to a car. Dynamo power and solar energy are used to charge the battery. When there is no sunlight, the battery can be recharged by an electric source.

Keywords: electric bicycle, solar energy, dynamo power, battery charging.

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1. Introduction

Because of the growing number of cars, the demand for petroleum products is at its highest point right now. Since petroleum is not renewable and could eventually run out, it is preferable to switch to alternative energy sources. Over the past few years, there has been a huge rise in the price of crude oil, and it seems there is no stopping it. The environment has recently received attention, and it appears that there is a pressing need for cleaner fuel choices. The hybrid bicycle is an initiative that can support less reliance on oil and cleaner technologies.

A cheap substitute for a car is an electric bicycle. The battery is charged using dynamo power and solar energy. The battery can be recharged by an electric source when there is no sunlight.

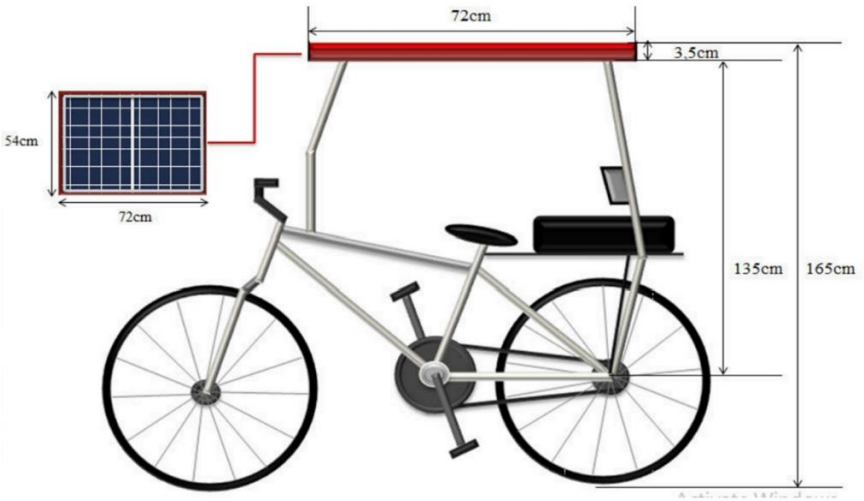

Figure 1: Layout of Bicycle

A bicycle with an electrical self-charging battery that charges the battery by converting the mechanical energy of the wheels into electrical energy. simplified to require the least amount of work. Due to its low speed, this bicycle also offers human drivers a safe means of transportation.

An electronic bicycle with a self-charging battery that charges the battery by converting the mechanical energy of the wheels into electricity. a system that cleans up the exhaust from the car. Hub motors, dynamos, controllers, batteries, and other parts are used. It is a fuel-efficient, non-polluting car that is helpful for the greenhouse impact. The user has the option of either pedalling the bicycle manually or using the hub motor to propel it entirely. When stationary, brushless DC motors produce their maximum torque. The Fleming right hand rule underpins the hub motor theory. In terms of torque, weight, and torque per watt, brushless motors have more advantages than DC motors. A dynamo serves as the electric generator in an electric bicycle system. in which mechanical energy is transformed into electrical energy. When the electric bicycle is in motion, the dynamo in the back wheel transforms rotational energy into electrical energy. A motor controller is a tool used to manage or control a device. Lead acid batteries provide a high power output, are costly, safe, and dependable, and are widely accessible. It is very affordable, has a long lifespan, and is simple to replace. Hub motor, dynamo, controller, battery, brakes, throttle, speedometer, etc. are included in it [1].

Working: As soon as paddling begins, the real wheel begins to rotate. A dynamo is then positioned; it rotates at the same speed as the wheel and transforms the mechanical energy of the wheel's revolution into electrical energy. This electrical energy is then stored in a battery for later use. The hub motor, which is mounted on the front wheel and begins rotating in accordance with the motor controller and accelerator, receives stored electrical energy from the battery. With the aid of the accelerator, which is connected to the controller and hub motor, controller controls the speed of the hub motor. The device has a speedometer as well for measuring bicycle speed. It might be analogue or digital [1].

The designed system initially consists of two distinct power sources: one is made up of batteries, and the other is a dynamo. There is an internal dynamo that powers the battery, eliminating the need for external charging. If you want to charge a battery outside, you can do it with an adaptor or eliminator. If the cost is affordable, you can also add a solar panel. Cycle is propelled by a 250W 24V DC motor. The controller, which maintains the current flow, is attached to the battery. The throttle, which is connected to the Controller, regulates the motor's speed. A 24V DC dynamo is used to charge the battery. using a flywheel to power a dynamo that rotates quickly and continuously as the bicycle is propelled. Chain drive and a freewheel are used to attach the dynamo's shaft to the cycle's back wheel. There is an internal dynamo that can charge the battery, negating the requirement for external charging [2].

The project is based on microcontroller technology and automation, and it includes elements like a controller, three-phase inverter, solar panel, hall effect sensor, variable resistor, etc. A traditional bicycle in the current system is a two-wheel vehicle that is propelled by the rider who delivers 50% muscle power through pedals that rotate one of the two wheels and 50% motor powered to rotate the wheel for riding the bicycle, lower energy cost per distance travelled for a single rider, savings in other costs like insurances, licences, registration, and parking, improvement of the traffic flow, environmental friendliness, and the health benefit for the rider. The goal of this project is to use a solar-charged battery to lessen pedal force from humans while riding bicycles. A brushed dc motor is used in the current system. As a power supply, an expensive battery was used. There is no self-energization. It is easily self-energized. The variable resistor rheostat control mechanism is used to control the vehicle's speed. A solar panel is used to charge the battery. The "Hall Effect" sensor is incorporated within the hub motor. The embedded C tool is used. This electric bicycle runs efficiently at a voltage of 37V for 20 kilometres. The battery level can be displayed on an LCD panel, which is environmentally beneficial. It contains additional amenities such as mobile charging, Bluetooth, and roof access. [3].

For charging the batteries, the bicycle employs more than one dynamo. The battery is charged using solar energy. To harness solar energy and provide power to charge the battery, two or more photovoltaic cells may be employed. The battery supplies the necessary electricity to the hub motor positioned on the front wheel to power the bicycle. This study attempts to construct and prepare a self-charging electric bicycle using a solar panel. Solar energy, which is free of charge, can be used to charge the batteries. The BLDC (Brushless DC) motor converts electrical energy into wheel rotations, while dynamos convert and store the same rotation energy into electrical energy. According to this paper, the solar smart bicycle speed is 19 km/hr on flat roads and 17 km/hr on incline roads. In the absence of dynamo, the maximum speed of the cycle on plain road reduced from 20 km/hr to 18 km/hr (10%) by increasing the weights, however on declining road the maximum speed climbed slightly from 26 km/hr to 28 km/hr (7.6%), which was more than that on plain road by 30%. The energy lost by the friction between the dynamo and the wheel contact resulted in a modest loss of maximum speed (15%) in the dynamo usage state compared to the no dynamo usage condition on the flat road, but it stayed virtually the same on the inclined road. Because of external factors such as loose pin connections, air resistance, wire resistance factor, and so on, the real time required to charge the battery by adapter 12 V 12Ah was 2hrs 15 mins, which was 12.5% longer than the theoretical time. The actual time required to charge the battery by solar panel was 9.2 hours, which was 9.5% longer than the theoretical time due to factors such as inclination angle, soil factor, solar tracking, and so on. A dynamo, BLDC motor, and a solar panel are coupled to form a fully functional regenerative self-charging bicycle [4].

A solar bicycle is a bicycle that is powered by electricity. The battery is charged using solar energy. The battery supplies the necessary electricity to the hub motor positioned on the front wheel to power the bicycle. The motor will be a permanent magnet Hub motor positioned on the front wheel. To power the dynamo, a belt and pulley arrangement will be installed on the vehicle's rear side.

Battery selection: -Because the motor chosen is 24V, the battery voltage rating should likewise be 24. As a result, we select two 12V and 7.5 Ah batteries and connect them in series to generate 24 V and 7.5 Ah. Although lead acid batteries

have a lesser energy density than lithium-ion batteries, they are very safe to use with correct safeguards. It offers numerous advantages, including low cost, frequent availability, and the absence of explosions.

Time required to charge the battery with a 12V 12Ah adaptor. Panel selection: -We utilise two 25 W panels with dimensions of 350mm*550mm. The lead acid battery is charged with voltage generated by solar energy via a photovoltaic cell. Sun cells use the photovoltaic effect to convert solar energy directly into electricity. Polycrystalline panels and microcrystalline solar panels are the two most common forms of solar panels. Polycrystalline panels have a lower efficiency than microcrystalline panels. The efficiency of microcrystalline panels is between 50 and 60%. Motor choice: -A 250 W 24V hub motor is chosen. - Controller A motor controller, sometimes known as the vehicle's brain, is a crucial component of the solar hybrid bicycle. It regulates the amount of power given to the hub motor as well as the lights and horn if necessary. The motor controller converts the direct current voltage from the battery to alternating current voltage. It primarily comprises of MOSFET transistors and a small microcontroller that performs a variety of activities ranging from detecting any faults with the motor hall sensors, the throttle, to protecting functions from excessive current and under-voltage [5].

The battery is charged using solar energy. When there is no sunshine, the battery allows for recharging using the wall charger, which plugs into standard wall outlets. The solar assisted bicycle is outfitted with a dc hub motor on the front axle of a bicycle with a power rating of 250W and a travel speed of 25-30 kmph. It comes with two 35 Ah lead acid batteries, a 20 watt photovoltaic solar panel, a 24V 10Amp voltage regulator, and a 24V 25Amp accelerator and motor controller. In the event of a weak solar supply owing to cloudy weather, there is also a provision for charging the battery using a 220-240V, AC wall outlet supply. Solar cells are joined in series and parallel to produce modules that supply the necessary power.

1.1 Controller for Solar Charge

For the solar power system, an MPPT solar charge controller is utilised. This solar charge controller converts the variable voltage from the solar panel into a safe charge for the lead-acid battery. PMDC MOTOR (Permanent magnet direct current (motor): The winding coils' ends are attached to commutator segments, which create sliding contact with the stationary brushes. Brushes are connected across motor terminals to a DC power supply.

1.2 Triple

An accelerator or throttle is required. We may drive the motor from zero to full speed using the throttle. It is mounted on the right side of the handlebar and is linked to the controller. Solar Photovoltaic (SPV) cells convert sunlight (solar radiation) into electricity. When the Hybrid electric bicycle is exposed to sunshine, the battery charges, allowing an electric motor in the front wheel to operate. The usage of a motor reduces resistance while pedalling uphill. When the battery powers the throttle using solar energy. The throttle then allows the engine to run, and the hub begins to rotate, and as the hub begins to move, the bicycle's wheel likewise begins to rotate [6].

The solar and dynamo assisted hybrid bicycle is powered by a direct current motor installed in the front axle housing and runs on electrical energy. The solar panels positioned on the carriage will charge the battery, which will then power the hub motor. When the bicycle is idle or motionless in parking, the solar panel charges the battery, and when the bicycle is running on the road, a pair of 48-volt dynamos mounted on the back wheel charges the battery. The bicycle is powered by dynamo. A pair of dynamos will be mounted on the rear wheel without the use of pedalling. The dynamos will charge the battery and produce energy, which will be stored in the battery, and the battery will send power to the hub motor of the front axle and the bicycle will operate on the road. The battery is charged using solar energy. Two photovoltaic cells can be utilised to generate voltage to charge using sun energy. This battery is linked to a direct current (DC) motor. The motor is controlled by a synchronised motor controller in this case. A throttle is also employed in this case to boost the speed of the Solar and Dynamo Bike. This accelerator is directly connected to the motor controller, which controls the motor speed [7].

The goal is to create a two-wheeled hybrid electric vehicle driven by a battery. Electric wheel hub motors, batteries, and control systems are used in hybrid electric vehicles. Because the entire power transfer in this situation is direct current, the battery is charged utilising this solar output. This battery is linked to a direct current (DC) motor. In the absence of sunlight, the battery can be charged using a wall charger. A brush-less DC motor is favoured due to its low maintenance, high efficiency, and low noise, as well as the absence of brushes, which prevents sparking in a BLDC motor. The motor is controlled by a synchronised motor controller in this case. A throttle is also employed in this case to boost the speed of the Solar and Dynamo Bike. This accelerator is directly connected to the motor controller, which controls the motor's speed. In the absence of sunlight or when the battery is depleted, the bicycle can also be powered by mechanical Pedaling.

HEV is a vehicle that runs on battery power. For high-power applications with high power requirements, a battery engine is used. Lead acid batteries are used to store solar power energy, and microcrystalline solar panels, which are more efficient than polycrystalline panels, are used to generate solar energy. Controllers are utilised to run the BLDC motor; these controllers are kept on the bicycle's handlebars. Used a high-quality brushless BLDC motor that produces no sparks while driving the automobile or bicycle shaft [8].

It is made up of a 24v 250w Geared motor that is attached near the pedal of a bicycle. The sprocket is attached to the bicycle's back wheel. A chain is used to transfer power from the motor to the rear wheel. 12v Two Lithium-ion Batteries connected in parallel deliver electric current to the motor. The controller is linked to the batteries, geared motor, and solar panel. A 24v solar panel is attached to the controller, and the controller charges the batteries. The batteries will be charged using either an electric supply or a solar panel [9].

Higher fuel prices, limited sources, and pollution all necessitate the use of alternative energy sources for transportation. Several issues arise when converting a standard electric driven bicycle to a Solar-Powered Electrical Bicycle. The photovoltaic (PV) panel specs must be sufficient to generate the electric motor, just as a traditional electric driven bicycle. The proper connection of solar cells, rechargeable battery [10], and DC electric motor with bicycle is required to ensure that this project is completed with the most efficient use of energy. The electric motor must be able to support the weight and size of the solar panel, as well as the state of the road surface [11-12].

1.3 Objective

- To investigate the operation of a solar electric bicycle.
- To charge using rechargeable lithium-ion batteries.
- To charge batteries using sustainable energy sources such as solar.
- To determine the maximum efficiency of the solar electric bicycle.
- The primary goal of the project is to use incoming solar energy to power a two-wheeled motorised bicycle.
- This project is made up of a rechargeable battery pack that powers a light-weight motor unit mounted on the wheel. The solar electric bicycle method is unique.

1.4 Scope of Problem

In the current context, a solar-powered hybrid bicycle will aid in resolving the significant issue of growing fuel prices, particularly for gasoline. Again, vehicular pollution in metropolises and metropolitan regions is steadily increasing. To address these issues, efforts are being done to investigate new sources of energy for driving the Bicycle. The Solar Electric Bicycle (Hybrid) project is primarily concerned with energy conservation.

1.5 Methodology with Flow chart

- It is made up of a 24v 250w Geared motor that is attached near the pedal of the bicycle.
- Sprocket is attached to the bicycle's back wheel.
- A chain is used to transfer power from the motor to the rear wheel.
- 12v Two Lithium-ion Batteries connected in parallel deliver electric current to the motor.
- The batteries, geared motor, and solar panel are linked to the controller.
- A 24v solar panel is linked to the controller, and the controller charges the batteries.
- The batteries will be charged using either an electric supply or a solar panel.

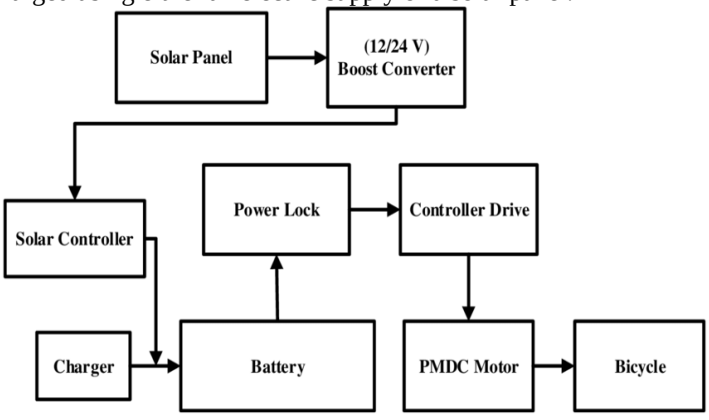

Figure 1. Flow Chart

2. Design Calculations

For the design of solar electric bicycle, following design parameters are considered for power and charging time.

C_d = Coefficient of air drag = 1
A = Total area of the rider, if seen from front = 0.5 m2
ρ = Air density
V_w = wind speed = 7km/hr (avg) = 1.94 mps
V_g = cycle speed = 30km/hr (max) = 6.94 mps
Cr = coefficient of rolling resistance
M_{tot} = Total mass of rider and bicycle
G = Road grade = sin((Δh/Δl)/100)); Δh=10m, Δl=50m
Diameter of wheel = 60cm
Weight of cycle = 22kg
Weight of rider = 65kg
Speed(v) = 30km

2.1 Power calculation

By using the equation of air drag and considering the input parameters, the power to drive the solar electric vehicle is calculated as,

Air drag, $Pw = C_d \times p \times A/2 \times [V_w + V_g] \text{ ^2} \times V_g = 167.59$ W

Total Power required = 167.59+49.30+13 = 230.7 W
Motor with power 250 W is selected.

Table 1: Input parameters

	Bicycle	**Solar Bicycle**
Maximum speed	15 Km/hr	25 Km/hr
Power required for Riding	Human Power	Solar power and Human power
Bicycle weight	18 kg	35 kg

2.2 Battery Specifications

Power = voltage × current
250 = 24×I
I = 10.41 Ah
Hence two batteries of 12 V, 7.5 Ah has been selected. We connect these batteries in series to achieve a voltage as 24 V as required by motor.

2.3 Charging

2.3.1 Electric charging: - Power supplied to battery during charging by adaptor of specification 12 V, 3 A.
P = V × I = 36 W
Therefore, time required to charge battery.
T = 180/36
Battery (Ah) = (127.5)2 = 5 hours = 180

2.3.2 Solar Panel
T = 180 25 = 7.2 hours

Table 2: Bicycle vs Solar Bicycle

Parameter	Solar e-Bicycle	Moped
Max. Speed limit (Km/hr)	25-30	55-60
Initial Cost	14000-15000	50000+
Fuel use per 100 Km	Nil	2L+
Type of energy use	Solar	Petrol

3. Conclusion

Due to the growing number of cars, the demand for petroleum products is currently at an all-time high. It is advisable to transition to alternative energy sources because petroleum is not renewable and will ultimately run out. Crude oil prices have soared in recent years, and it seems impossible to stop them. Recent environmental concerns have garnered attention, and it would seem that cleaner fuel alternatives are highly sought after. The hybrid bicycle is an initiative that can support the development of greener technology while reducing reliance on oil. A cheap substitute for an automobile is an electric bicycle. The battery is charged using solar energy and dynamo energy. The battery can be recharged by an electric source when there isn't any sunlight.

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