Design and fabrication of solar bi cycle

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ABSTRACT:

Now a day's as we all know the fuel prices especially the petrol is raising steadily day by day. Again the pollution due to vehicles in metro cities and urban areas is increasing continuously. To overcome these problems, an effort is being made to search some other alternative sources of energy for the vehicles. Again, it is also not affordable to purchase vehicles (mopeds, scooters or motor cycles) for all the class of society. Keeping this in mind, as well as to provide a solution for the environmental pollution was in progress. The solar electric bicycle developed is driven by PWM motor& operated by solar energy. The solar panels mounted on the carriage will charge the battery and which in turn drive the PWM motor. When the bicycle is idle, the solar panel will charge the battery .This arrangement will replace the petrol engine, the gear box& the fuel tank in case of a two wheeler or a chain sprocket, chain& gear shifting arrangement of a conventional bicycle being used by most common man.

Index Terms— PWM CONTROLLER,MOTOR,SOLAR PANNEL

I.INTRODUCTION

The depleting reserves of fossil fuels made the engineers and scientists to look for renewable energy sources. In addition, the environmental decay due to the combustion of fuel is alarming and justifies the design of eco-friendly system. India is spending large amount of foreign exchange to import crude oil even though we have abundant resource of solar energy. If we utilize solar power for local conveyance, a large amount of currency can be saved and we can also ensure pollution free environment and contribute to nation's economy

A solar e-bicycle is a bicycle with an integrated electric motor which can be used for propulsion. There are a great variety of e-bikes available worldwide but they to charge there batteries by ac 230V only, to overcome disadvantage our solar e-bicycles are here

Solar E-bicycle use rechargeable batteries where the solar power is used to charge the battery in ideal condition and they can travel up to 25 to 30 km/h (16 to 20 mph)for one time battery charge and depending up the ah of battery it will increase

We are mainly concentrated on the school and college students, they can easily travel to college without pedaling to a maximum distance of 30km, and after the battery of the cycle will be charged with the help of solar panels. By the evening the cycle will be ready to travel a distance of 30km again. In the absents of solar energy the battery can be charged by using 220v-240v ac supply.

Why should we go for SOLAR E-BICYCLE?

Today there is a large problem of energy resources so we need to develop the emergent technologies and to show people that those technologies are ready for use. The goal of this report is to highlight solar e-bicycle, their technology, use and cost/ benefit. The first part of the report presents the technical features of the solar e-bicycle. It then deals with the economic aspects, the cost of the solar e-bicycle, the energy created and a comparison between the electric bicycle and the solar electric bicycle

This is followed by a hypothesis of a large scale set up and then concludes with the benefits of solar e-bicycle. The foremost point of the report is the advantage of solar energy. The sun's average power is approximately 1000 W/m², which represents 10,000 times the power required for the World's population

Given our current challenges with global warming and the consequent climate change impacts, we can't emphasize strongly enough the sheer waste of not using this resource, which is so readily available but expensive.

MAIN COMPONENTS :

Basically maim components in this project as below:

- Solar panel
- Brush less dc motor
- Batteries
- Pwm controller
- Charge controller
- Throttle

II.SOLAR PANEL:

Solar panels are those devices which are used to absorb the sun's rays and convert them into electricity or heat.

A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels.

Type of solar panels as below:

The solar panels can be divided into 3 major categories:

- Monocrystalline solar panels
- Polycrystalline solar panels
- Thin-film solar panels

MONOCRYSTALLINE SOLAR PANEL:

A monocrystalline solar panel is a solar panel comprising monocrystalline solar cells. These cells are made from a cylindrical silicon ingot grown from a single crystal of silicon of high purity in the same way as a semiconductor. The cylindrical ingot is sliced into wafers forming cells.
A monocrystalline solar cell is fabricated using single crystals of silicon by a procedure named as Czochralski progress. Its efficiency of the monocrystalline lies between 15% and 20%. It is cylindrical in shape made up of silicon ingots.

Fig: 1 monocrystalline solar panel

POLYCRYSTALLINE SOLAR PANELS :

Polycrystalline or MultiCrystalline solar panels are solar panels that consist of several crystals of silicon in a single PV cell. Several fragments of silicon are melted together to form the wafers of polycrystalline solar panels.

Polysilicon, a high-purity form of silicon, is a key raw material in the solar photovoltaic (PV) supply chain. To produce solar modules, polysilicon is melted at high temperatures to form ingots, which are then sliced into wafers and processed into solar cells and solar modules.

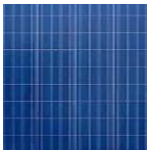


Fig: 2 poly crystalline solar panel

THIN FILM SOLAR PANEL:

Thin-Film solar panels are less efficient and have lower power capacities than mono and polycrystalline solar cell types. The efficiency of the Thin-Film system varies depending on the type of PV material used in the cells but in general they tend to have efficiencies around 7% and up to 18%

Thin-film solar panels, also called flexible solar panels, are made of one or more layers of thin-film material that absorb light and produce electricity. They're made using amorphous silicon thin film, cadmium telluride thin-film, gallium arsenide or copper indium gallium selenide. They're fast and efficient to manufacture, which often makes them a more affordable solar energy option when compared to other solar technologies.

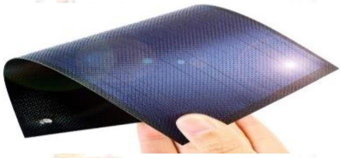


Fig: 3 thin film solar panel

III.BRUSH LESS DC MOTOR :

Some of the problems of the brushed DC motor are eliminated in the brushless design. In this motor, the mechanical "rotating switch" or commutate or brush gear assembly is replaced by an external electronic switch synchronized to the rotor's position. Brushless motors are typically 85-90% efficient, whereas DC motors with brushgear are typically 75-80% efficient.

Midway between ordinary DC motors and stepper motors lies the realm of the brushless DC motor. Built in a fashion very similar to stepper motors, these often use a permanent magnet external rotor, three phases of driving coils, one or more Hall Effect sensors to sense the position of the rotor, and the associated drive electronics

In effect, they act as three-phase synchronous motors containing their own variable-frequency drive electronics. A specialized class of brushless DC motor controllers utilize EMF feedback through the main phase connections instead of Hall effect sensors to determine position and velocity. These motors are used extensively in electric radio-controlled vehicles. When configured with the magnets on the outside, these are referred to by mode lists as out runner motors.

Fig:4 brush less dc motor

- Compared to AC fans using shaded-pole motors, they are very efficient, running much cooler than the equivalent AC motors. This cool operation leads to much-improved life of the fan's bearings.

- Without a commutator to wear out, the life of a DC brushless motor can be significantly longer compared to a DC motor using brushes and a commutator. Commutation also tends to cause a great deal of electrical and RF noise; without a commutator or brushes, a brushless motor may be used in electrically sensitive devices like audio equipment or computers.
- The same Hall Effect sensors that provide the commutation can also provide a convenient tachometer signal for closed-loop control (servo-controlled) applications. In fans, the tachometer signal can be used to derive a "fan OK" signal.
- The motor can be easily synchronized to an internal or external clock, leading to precise speed control.
- Brushless motors have no chance of sparking, unlike brushed motors, making them better suited to environments with volatile chemicals and fuels. Also, sparking generates ozone which can accumulate in poorly ventilated buildings risking harm to occupants' health.

IV.BATTERIES:

A battery is an energy source consisting of one or more electrochemical cells and terminals on both ends called an anode (-) and a cathode (+). Electrochemical cells transform chemical energy into electrical energy. Inside the battery is an electrolyte, often consisting of soluble salts or acids, it serves as a conductive medium, allowing the electric charge to travel through the battery.

When a battery is disconnected, the charge at the positive and negative ends is equal, meaning there is no electric current. When connected to an outside resistance or device, the battery experiences an imbalance in charge that pushes electrons through the device's conductive material to the positive end of the battery.

But while the electrons—or the negative charge are what moves through the circuit, the electric current is measured following the positive charge's direction, which flows from the positive to the negative end inside the battery, and vice versa outside it. Depending on its voltage and load, a single battery can power anything from a car's motor or a computer to a cellphone or a light bulb. When it comes to most electronic devices, working with the wrong voltage could result in your device not turning on or risk frying its electrical components, sometimes beyond repair.

TYPES OF BATTERIES:

Batteries are mainly classified 3 types:

- Lead Acid.
- Lithium-ion
- Sodium Nickel Chloride

LEAD ACID BATTERY:

The lead–acid battery consists of two electrodes submerged in an electrolyte of sulfuric acid. The positive electrode is made of grains of metallic lead oxide, while the negative electrode is attached to a grid of metallic lead. Lead–acid batteries are classified into two types: flooded and valve-regulated

Dependence on hazardous and restricted lead. Additionally, they have a relatively lower volumetric energy density, which makes their deployment somewhat impractical for energy management applications, and so they are primarily used for power applications.

Flooded lead–acid batteries are less expensive but require more maintenance and ventilation than the valve-regulated lead–acid batteries. Lead–acid batteries are commonly used for renewable energy systems, largely because they can be easily transported and they have relatively low costs. However, these batteries have some challenges, including low numbers of charging–discharging cycles over their lifetimes, low discharge

New lead–acid batteries utilize carbon on the negative electrode to create a super capacitor negative electrode. In these batteries, the positive electrode does not undergo any change in its chemical process, and no chemical process occurs at the negative electrode. As a result, the positive electrode is less subject to corrosion, leading to longer lifetimes and higher efficiencies than conventional lead–acid batteries.

Fig: 5 lead acid battery

LITHIUM-ION BATTERY:

Lithium ion batteries are rechargeable batteries that are characterized by very high power densities. Such batteries have become very commonplace: from everyday electronic products such as cell phones to electric vehicles. What is not commonly appreciated is that voids play a very important role in such batteries. As this example will illustrate the void structure in a material, it does not always need to be spherical. Let us first briefly describe the main features of a lithium ion battery and then point out the important role of voids in it

There are four components in a lithium ion cell: anode, cathode, separator, and the non aqueous electrolyte. Different chemistries are used; the anode is graphite, the cathode is an oxide ($LiCoO_2$), and the alternating layers of anode and cathode are separated by a porous polymer separator, which is generally made of polypropylene (PP), polyethylene (PE), or a laminate of PP and PE. In all cases a critical feature of the separator is a controlled amount and uniform size of porosity in the separator.

The electrolyte consists of an organic solvent and dissolved lithium salt, it provides the media for Li ion transport. Lithium ions move from the anode to the cathode during discharge and are intercalated into, i.e., are inserted into, open spaces in the voids in the cathode. The Li ions make the reverse journey during charging

A lithium ion battery (or battery pack) is made from one or more individual cells packaged together with their associated protection electronics.

Cells are constructed by stacking alternating layers of electrodes such as in prismatic cells or by winding long strips of electrodes into a “jelly roll” configuration typical for cylindrical cells, see Generally, cell form factors are classified as prismatic, cylindrical, and pouch cells (also known as polymer, soft-pack polymer, or lithium polymer).

Li-ion batteries are an evolving technology of interest. Small lithium-ion batteries are widely used in portable electronic devices, and a few large lithium-ion batteries have been produced to power EVs. These were prototypes, and the development process continues. These prototypes were costly, and there are technical problems to be resolved

Fig: 6 lithum –ion battery

SODIUM NICKEL CHLORIDE

Sodium–nickel chloride (Na–$NiCl_2$) batteries are another member of the 'high-temperature' family. They are currently produced by one single manufacturer under the commercial name Zebra. They operate at 270–350 °C and share two common features with NaS batteries: liquid sodium and β-Al_2O_3 ceramic

In the charged state, a Zebra cell consists of a negative liquid sodium electrode and a solid positive electrode containing NiCl and nickel. A β-Al_2O_3 ceramic tube physically separates the electrodes and ensures the transport of sodium ions. To ensure contact between the solid positive electrode and the ceramic electrolyte, the positive electrode is flooded with molten chloroaluminate ($NaAlCl_4$), which is an equimolar eutectic mixture of sodium chloride and aluminium tri chloride. During discharge, sodium is oxidized into Na^+ ions, forming sodium chloride, and NiCl is reduced to metallic Ni

There are no secondary reactions in Zebra batteries. In case of overcharge, when all the sodium chloride has been consumed, excess nickel in the positive electrode reacts with sodium chloroaluminate, which occurs at a higher potential than the cell reaction. In doing so, the current flow through the cell is stopped and this constitutes an intrinsic protection mechanism.

As for NaS batteries, the Zebra cells are connected in series/parallel to obtain the required voltage and capacity. A battery management interface (BMI) ensures thermal management, controls the main circuit breaker, supervises all electrical parameters, and controls the charger by a dedicated PWM signal.

Fig: 7 sodium nickel chloride

V.SOLAR CHARGE CONTROLLER :

CHARGE CONTROLLER:

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries it prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life

SOLAR CHARGE CONTROLLER

A solar charge controller is fundamentally a voltage or current controller to charge the battery and keep electric cells from overcharging. It directs the voltage and current hailing from the solar panels setting off to the electric cell. Generally, 12V boards/panels put out in the ballpark of 16 to 20V, so if there is no regulation the electric cells will damaged from overcharging. Generally, electric storage devices require around 14 to 14.5V to get completely charged. The solar charge controllers are available in all features, costs and sizes. The range of charge controllers are from 4.5A and up to 60 to 80A.

Fig: 7 solar charge controller

I.ACCELERATOR (OR) THROTTLE:

The implementation is controlling a BLDC motor in open loop. The motor current is measured and speed is monitored, to be able to respond to stall and overload situations. Three PWM channels are connected to the low side of the driving Half-bridges to control the speed of the motor. A BLDC motor driver stage, consisting of three half-bridges.

Fig: 8 accelerator (or) throttle

Three PWM channels, OC0A, OC0B and OC2B, control the low side of the driver bridge. This gives the possibility to control the current flow using hardware based PWMs with a minimum of timer resources in use.

This controls the speed of the motor: by varying the duty cycle of the PWM output the current flow and thereby the speed (and torque) of the motor is controlled. It is also possible to have PWM based control of the high side of the bridge, but that would require all the Atmel ATmega48 timers. Further, it would require either that shoot through protection is integrated in the driver circuit or that dead time is handled in software. If active breaking is used it can be desired to use PWM channels for both high and low side of the drivers to distribute the power dissipation more evenly over the effect transistors. However, in most applications this is not required.

II.PWM CONTROLLER :

An E-bike controller is a component that connects all electrical parts on the bike together. It connects the things like the battery, motor, throttle, display, pedal-assist, and various sensors. It is a small computer that acts as the heart of the e-bike. It can manage the overall functioning of the bike

- **Low-voltage Protection**- The controller monitors the battery voltage continuously, and it shuts down the motor whenever the voltage reaches its cut-off level. It will protect the battery against over-discharge.
- **Over-voltage Protection**- The controller also monitors the charge level of the battery voltage. It will automatically shut down when the battery voltage reaches its full charge.
- **Over-temperature Protection**- The controller monitors the temperature of the FET (Field-effective Transistors). It will shut down the motor whenever they become too hot.
- **Over-current Protection**- If the motor takes more current, the controller reduces the current flow to the motor. It protects the motor windings as well as the FET power transistors.
- **Brake Protection**- The controller provides more priority to the braking signal as compared to others. For instance, if you apply the brakes and throttle simultaneously, it will perform the brake function.

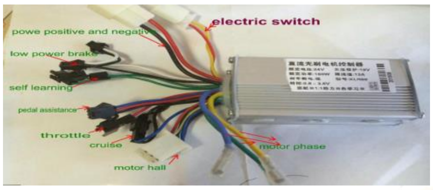


Fig: 9 pwm controller

III.DESIGN CALCULATION :

Problem statement:
Diameter Of wheel (D) = 60cm
Average Speed (v) = 19 kmph
Weight of Bicycle= 25 kg
Weight of Rider= 70 kg

Power calculations:
1) Normal reaction (N) on each tire = W/2 = 95/2 = 47.5kg = 47.5*9.81 = 465.98 N
2) Friction Force (F) acting on each tire:
For Static Friction, u = 0.03
F= u*N= 0.03*465.98= 13.98 N
For Dynamic friction u=0.004
F= u*N= 0.004*465.98= 1.86 N

Torque requirement (t)

For static Friction, T = F*R = 13.98*0.30 = 4.194 ~ 4Nm

For Dynamic Friction, T = F*R = 1.86*0.30 = 0.558 Nm

Speed calculations

w= V / R= 19000 / (0.30*3600) = 17.59 rad/sec

Power requirement (p)

A) On plain ground,

1) For Dynamic Friction, P= T* w= = 9.82 watt

2) For Static Friction, P= T* w= = 73.78 watt

Overall power requirement= 73.78*2= 147.5 watt

B) On Inclined Surface, a=2'

1) Total force required to move vehicle F = u * mg * cos (a) + Mg sin (a)

F= 60.46 N

There for power required= F * V = 251.91 W

extra power Required = 251.91 – 147.5 = 104.41 W

2) Considering dynamic friction

F= 0.004 * 95 * 9.81 * cos (2) + 95 * 9.81 * sin (2) = 36.25 N

Power (P) = F * V= 150.81 W

Battery selection:

Since motor selected is of 24V hence battery voltage rating

Should also be 24? Therefore, we select two batteries of 12V and 7 Ah in series combination of we get 24 V and 7 Ah

Charging time:

Time required to charge the battery by adapter 12 V 12Ah

P= 12* 12= 144 W T= (24*12) / 144 = 2 hrs.

By using solar panel T= (24*7) /20 = 8.4 hrs.

Panel selection:

We use two panels of 20 W each having dimension 520mm* 350 mm* 22 mm

Motor selection:

Brush less dc motor of 350 W 24V is selected

IV.RAW MATERIALS

Table : 1 various raw materials and with costs

S.no	Description	Specifications	Amount
1	Bicycle	BSA SLR	2,700/-
2	E-bike kit: - BLDC Motor, brakes, accelerator, Speed controller	BLDC Motor:- 24 DCV,2700 RPM,250W Sprocket: - Mild steel	11,500 /-
3	Batteries	2*12VDCV	2,400 /-
4	Chain	-	150 /-
5	Nut&bolt&washers.	Mild steel	150/-
6	Motor fitting work	-	200/-
7	Welding work	-	300 /-
8	Solar panels		2,600 /-
9	Green color , black color & brushes Tinner	-	300 /-
10	Grease	-	60 /-
11	Wires and cables	-	500/-
12	Solar charge controller	MPPT	500/-
13	**Total Amount**		**18,400**

V.PROPOSED DESIGN:

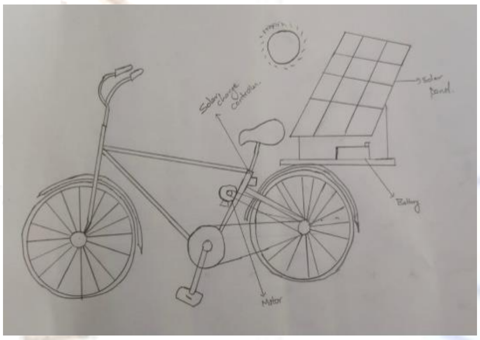


Fig: 10 proposed design

OUTPUT :

Fig: 11 output solar bicycle

DEVLOPMENT PROCESS:

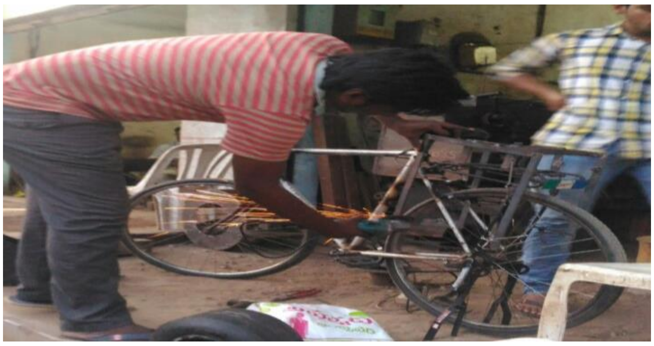


Fig:12Solar Bicycle Motor Mounting

VI.READINGS:

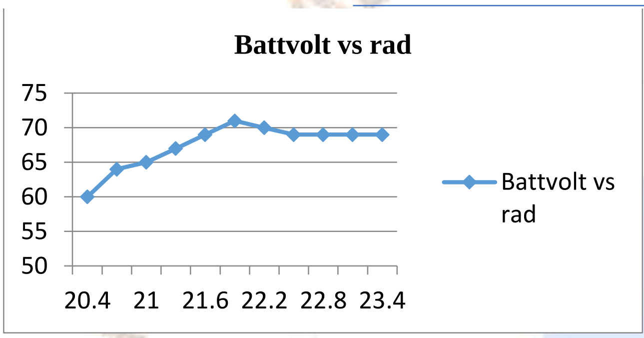
Readings are taken on Date : 27/02/2023
Weather/Season: Winter

Location: Sri Vasavi Institute Of Engineering & Technology, Nandamuru, Andhra Pradesh India

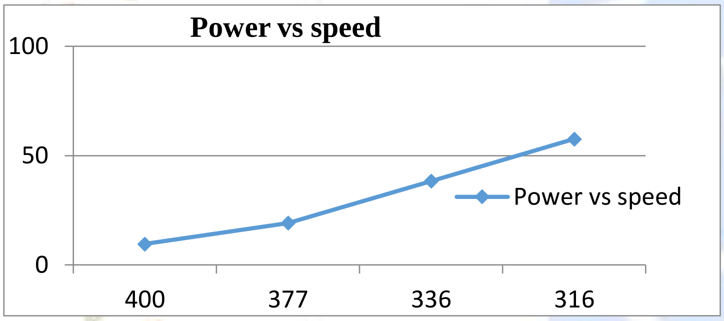
Table: 2 Motor power consumption at different loads

S.NO	Motor Power in watts	Speed in rpm	Weight or load in kgs
1.	9.6	400	-
2.	19.2	377	30
3.	38.4	336	60
4.	57.6	316	90
5.	86.4	281	120
6.	115.2	268	150

GRAPHS:



Graph 1- graph between Battery Voltage and radiation



Graph 3 - graph between power and speed

VII. CONCLUSION:

Solar assisted bicycle is modification of existing bicycle and driven by solar energy. It is suitable for both city and country roads, that are made of cement, asphalt, or mud. This bicycle is cheaper, simpler in construction & can be widely used for short distance travelling especially by school children, college students, office goers, villagers, postmen etc. It is very much suitable for young, aged, handicap people and caters the need of economically poor class of society

It can be operated throughout the year free of cost. The most important feature of this bicycle is that it does not consume valuable fossil fuels thereby saving cores of foreign currencies. It is eco-friendly & pollution free, as it does not have any emissions. Moreover it is noiseless and can be recharged with the AC adapter in case of emergency and cloudy weather. The operating cost per kilometer is minimal, around Rs.0.70/km. It can be driven by manual pedaling in case of any problem with the solar system. It has fewer components, can be easily mounted or dismounted, thus needs less maintenance.

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