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Design and Fabrication of Solar Powered E-Bicycle

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Abstract: ***In today's world efficient, eco-friendly and economical ways of transportation is very essential for improved living standards of the human beings. This paper focuses on the design and fabrication of electric bicycle which makes use of solar power charged electric battery as the primary source energy. The electric power generated is used to run the bicycle which in turn can give better fuel economy, better performance and less pollution compared to conventional motorized vehicle.***
Keywords: Throttle mechanism, Chain drive, BLDC motor, Solar PV cell, e- bicycle

I. INTRODUCTION

All conventional motor vehicles that are in the market cause pollution and the fuel cost is also increasing day by day. An effective remedy is to work on the alternate fuels like solar power and production of electrical transport vehicles (e-bikes). Due to ignition of the hydrocarbon fuels, in the Vehicle, sometime difficulties such as wear and tear may be high and more attention is needed for proper maintenance. E- Bicycle is easy to handle and has no fuel cost like in the other petrol fueled vehicles.

A. Design Of E -Bicycle

The major components used in the design of the E-bicycle are Brush less DC motor (BLDC), Battery and Battery charger, Solar panel, Microcontroller, Throttle or accelerator, normal bicycle.

1) *BLDC Motor:* In order to make operation more reliable more efficient and less noisy the latest trend is to use BLDC (Brushless DC) motors. They are lighter when compared to brushed motors with the same output.

Fig 1: BLDC motor

Specification	Ratings
Rated voltage	24 V
No load rpm	330 rpm
Rated load rpm	300 rpm
Rated current	250 w

Table 1: DC motor ratings

2) *Battery:* The lead acid batteries are being used currently in most of the electric vehicles and are also potentially used in hybrid applications. Lead acid batteries are designed to be of high power, inexpensive, safe and reliable. Rated voltage of each battery is up to 12v.

Fig 2: Lead acid battery

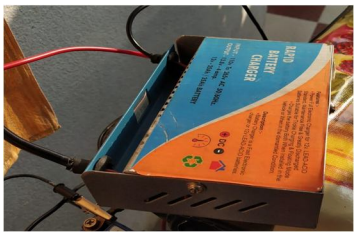

Fig 3: Battery Charger

Specifications	Ratings
Rated voltage	12 V
Input voltage	110 to 265 v
Output voltage	13.8 V
Type	Fast charging

Table 2: Battery Charger Ratings

3) *Battery Charger:* The battery charger or recharger is a device used to put energy into secondary source or rechargeable battery by forcing an electric current through it.

Fig 4: Solar Panel Fig 5: Micro Controller Fig 6: Throttle

4) *Solar Panel:* The solar panel is designed for absorbing the sun rays as a source of energy for generating electricity or heat.

Specifications	Ratings
Rated peak power	15.0 W
Rated voltage	12.0 v
Rated current	0.84 A
Module weight	1.5 kg

Table 3: Solar Panel ratings

Specifications	Ratings
Voltage	24 V
Current	6 Amp
Best use for	Up to 70 W solar panel
Max voltage	24 V

Table 4: Charge Controller Ratings

5) *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 current and voltage hailing from the solar panels setting off the electric cell. The solar charge controller are available in all features at different costs and sizes. The range of charge controller is about 4.5A to 80A.

Specifications	Ratings
Rated power	24 V
Rated voltage	250 W
Type	DC
Max current ratings	19 – 21 A
Max voltage ratings	19.5 – 20.5 W

Table 5: Micro Controller ratings

COMPONENTS	Mass in kg
Bi cycle and Assembly	19
Battery and Mounting	9
Sprocket	2
Cyclist	80
Total	110

Table 6: Mass of various components in e-bicycle

6) *Micro Controller:* Micro controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor may include automatic or manual means for starting or stopping the motor, selecting the forward or reverse rotation, selecting and regulating the speed or limiting the Torque.

7) *Throttle:* Throttle or accelerator is a device controlling the flow of fuel or power to an engine. The Pwm channel is connected to low side of driving half bridge to control the speed of motor

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B. Calculations

1) Power Required To Accelerate The Bicycle From Start

F = m*sinα x g =110*sin (2.5 *9.8) =47.02N

Required power for accelerating the bicycle

P = F * v = 47.02*20*5/18 =261.22W

2) Battery Power Calculation

Batteries are connected in series. There are two 12V batteries connected in series with 6amp power =24*6=144wh. We have 250W motor

Backup time = (144/250) = 0.576hrs = 0.576*60 = 34.56 min ~ 35 min

3) Battery Charging

a) Through Solar panel

Solar charger is of 12v 15 W panel by pwm charge controller

Actual charge time =15/12 =1.25 A

Power back = 6/1.25 = 4.8hrs

It takes 4.8 hrs to full charge due to pwm

with 70% efficiency =4.8+(70/100) = 8.16 Hrs to full Charge

b) Through charger

By boost charger it takes = 3 hrs

24v* 4A = 48 W

24v*6Ah = 144Ah

Charging time = 144/48 = 3hrs

4) Current Required To Drive Motor

P= V*I

I= 261.22/24= 10.84 amp

5) Gear Teeth Reduction

Teeth on motor sprocket z1= 9

Teeth on wheel sprocket z2 = 24

Gear Ratio, G =Z2/Z1 = 24/9 = 2.66

6) Calculation Of Torque

Torque is a force that tends to cause rotation

Where power $P = \frac{2\pi NT}{60}$

$T = \frac{261*60.}{2\pi*300} =$. 7.95 N-m

N = 300 rpm

7) Speed of E – bicycle

Motor of unloaded rpm = 300 rpm

Wheel of loaded rpm. = 300 rpm

Gear ratio = Z2/Z1 = 2.66

Wheel rpm = 300/2.66 = 11.25 rpm

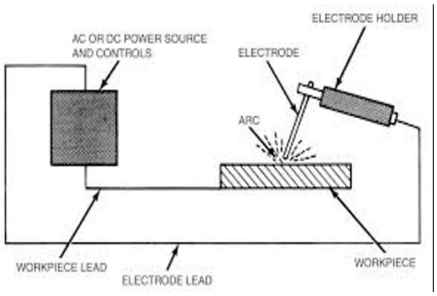
V = rw = 2πN/60000. = 300*2π*11.25/60000 = 3.53m/sec

= 3.53*180/5 = 12.07 ~ 13kmph

C. Fabrication Of E –Bicycle

It works on the principle that electromotive force of AC motor which receives electric energy stored in the DC battery which is converted by the help of DC to AC converter.

1) *Shield Metal Arc Welding:* It is the welding process known to even a layman and can be considered a road side welding process in this country. It is a manual arc welding process that uses a consumable electrode covered with a flux to lay the weld. In this project we have used. Arc welding at many places such as motor clamps, solar panel clamps etc.



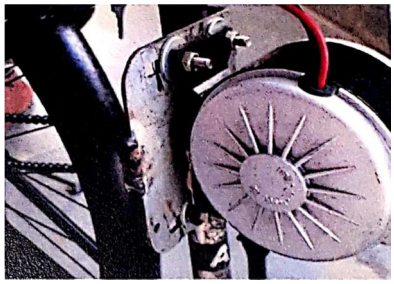


Fig 8: Shield Metal Arc Welding set up Fig 9: DC Motor Fig 10: Battery Box Arrangement

2) *DC Motor:* The DC motor is mounted on the plate with the help of studs. The mounting plate is fixed at bottom of the seat at a certain height and parallel to sprocket of the rear wheel axle by arc welding therefore the motor can't get any jerks while E-BICYCLE. Is moving.
3) *Battery Box:* The 24 v lead acid batteries are placed in a box and it is place above the carriage of bicycle such that can be in stable position.
4) *Solar Panel and Controller:* Solar panel is fixed at the front portion of bicycle such that it receives the solar power directly while riding the bicycle.
5) *Micro Controller:* Microcontroller is placed under the seat of E- bicycle there by it doesn't receive jerks while driving.
6) *Chain Drive:* Sprocket is arranged on the opposite side of the rear wheel. Chain drive a way of transmitting mechanical power from one place to another place. It is often used to convey power to the vehicles. It is also used for machines besides vehicles.

Fig 11: Solar panel & controller fixation Fig 12: Chain Drive

D. *Fabricated Model*

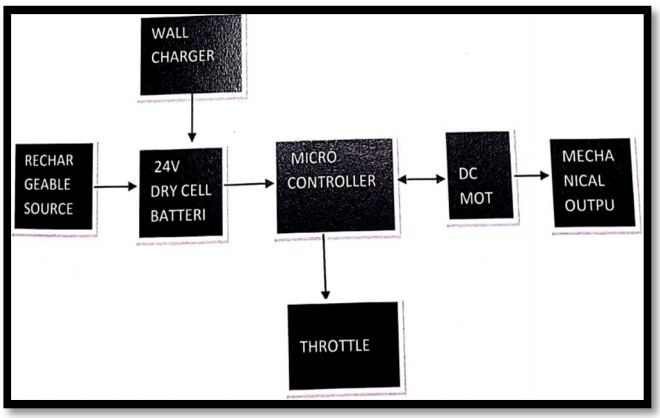


Fig 13: Fabricated model of E- bicycle Fig 14: Block diagram of fabrication procedure

E. Advantages

1) *Speed:* Electric bikes generally have a higher top speed (30-40 kmph) than a normal bicycle with the same rider. However the rider can pedal to make it go even faster.
2) *Great for Commuting:* An electric bicycle can require little to no effort to ride. Just twist the throttle and steer the bike where you want to go.
3) *Easy on the Body:* An electric powered bicycle allows riders who are physically less able.
4) *Economy:* Cost of this e- bicycle is incredibly low and affordable at about Rs.10000. The operating cost per Kilometer is minimal, around Rs.0.70/km.

F. Future Scope

In future everyone should move towards clean and renewable energy to save the conventional fossil fuels i.e. petrol, diesel etc. It reduces traffic and pollution problems. Fast charging Lithium-ion batteries can make the e-bikes a more attractive option for transportation.

II. CONCLUSION

It can be clearly seen that e-bicycle is economical and the right solution for energy crisis. Solar powered e-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. The most important feature of this bicycle is that it does not consume valuable fossil fuels thereby saving crores 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. 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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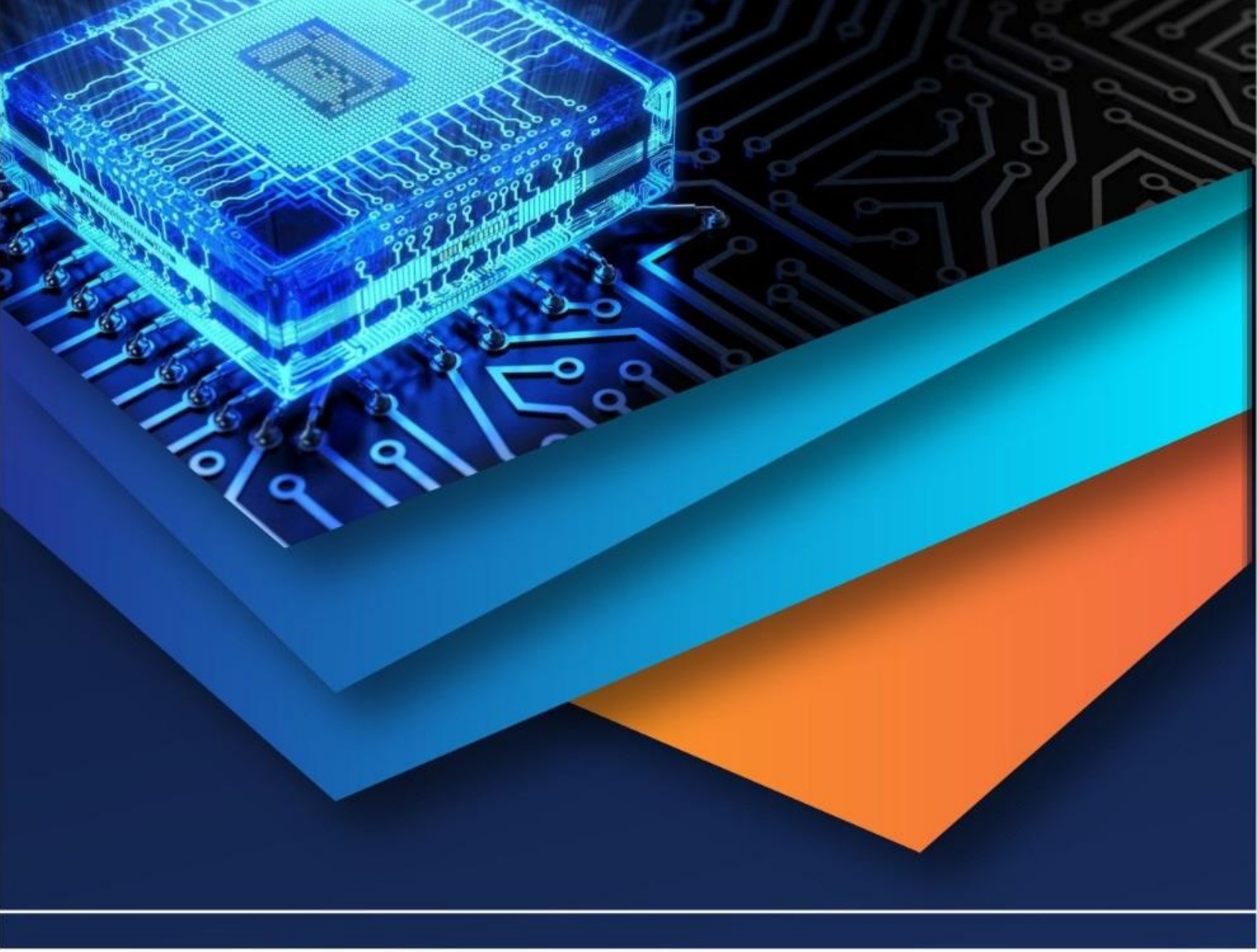

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