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Design and Implementation of Hybrid Powered Multifunction Bicycle

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ABSTRACT

The government of India has launched "MISSION EV" to make all the vehicles electric as soon as possible. However, the major drawback faced by the Automobile manufacturers and government is the hurdle of battery life and setting up of charging stations. This paper deals with the concept of solar powered multifunction bicycle to maximize the battery backup. The paper involves development of electric bicycle with regenerative system which charges the battery when the vehicle moves using the Generator connected to the front wheel of the electric vehicle when the rider is performing pedaling. This paper also involves development of hybrid system which will permit the rider to ride the bicycle using the pedal energy as well as the electric battery.

Keywords: *Hybrid Power, Bicycle, E-Vehicle, Design,Regenerative, Solar.*

I. INTRODUCTION

Increase in the number of travelling vehicles has increased the problems such as air pollution and to the use of petroleum. The human sensibility for the energetic and environmental problem is encouraging the research in alternative solutions for the automotive field, as multiple- fueling, hybridization and electrification. At the same time the systems are modified considering the current problems. For this the solution is the electrically assisted bicycles. The electrically assisted bikes are normally powered by rechargeable battery, and their driving performance is influenced by battery capacity, motor power, road types, operation weight, control, and, particularly, by the management of the assisted power.

Proposed system is combination electric hybrid vehicle using solar energy, pedalling action and the battery (electric charge). The system is designed specifically for multiple applications and the battery outlet can also be used for agricultural applications as well as household lighting applications. The proposed system is designed with the objective of providing a hybrid self-charging low-cost modeof transport for the rural community.

II. PROPOSED SYSTEM

The proposed system consists of the concept solar powered multifunction bicycle. The system can be consisting of development of a low-cost electric bicycle which can be powered by three sources, human energy, electric energy and the solar energy. The Innovation is done in the way the bike manages to help boost the battery backup collecting thesurplus energy from the generator embedded in the front wheel of the vehicle to charge the battery. When the person rides this bicycle from battery source or by pedaling action, the rear wheel is used

to drive the bicycle and the front wheel is used to regenerate the part of energy which will be used for charging the battery recovering some amount of the energy. The system also consists of detachable solar power source which can be used to charge the battery using solar energy. The solar power source can also be used to power other applications such as agricultural pumps as well of household lighting if desired. Further regenerative charging system will continuously charge the battery which the bicycle is in motion.

III. PROBLEM DEFINITION

The major part of rural transportation for short distance is generally through Bicycle in rural areas. Recently most of the agricultural activities have been electrified and power cuts in rural areas are common. Modifying the bicycle to help in agriculture activities like charging pesticide sprayer battery, mobile charging, lighting etc. will help the people tolarger extent.

IV. OBJECTIVES

1. To develop a Hybrid Electric Vehicle which can be powered using hybrid sources i.e., Human efforts, electric and solar energy.
2. To develop a regenerative charging system.
3. To implement solar energy-based charging system.
4. To build a multipurpose e-bicycle.

The System will be demonstrated by building a low-cost hybrid electric bicycle which can be used as low-cost daily mode of transportation mostly focused for rural community.

V. METHODOLOGY

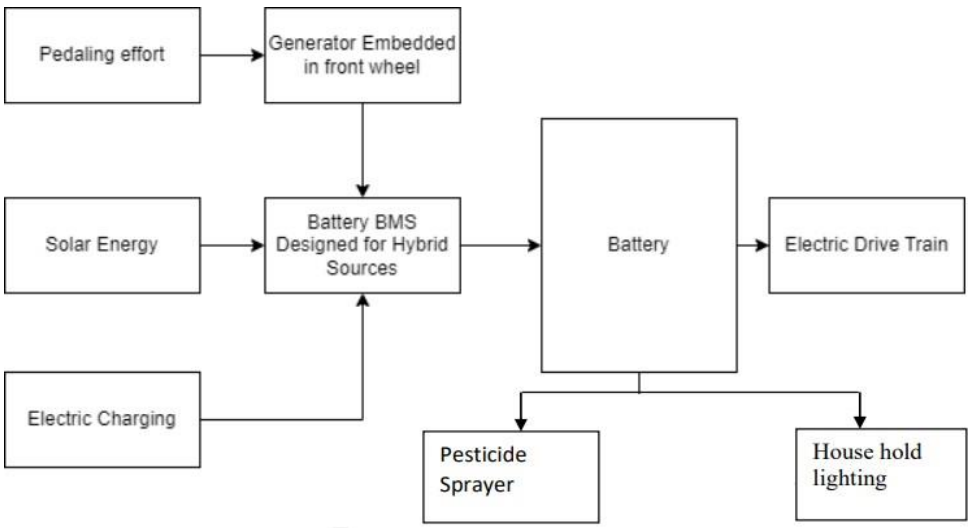

Fig. Block Diagram

As shown in the block diagram the project consists of the concept solar powered multifunction bicycle. As shown the project can be consists of development of a low-cost electric bicycle which can be powered by three sources, human energy, electric energy and the solar energy. The Innovation is done in the way the bike

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VI. HARDWARE USED

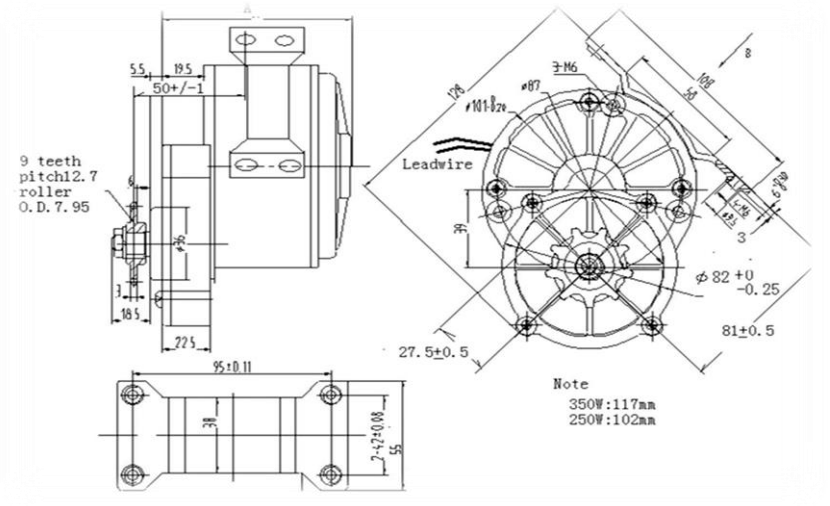

Fig. Mechanical Design of Motor and Sprocket

Specifications:

- Model: MY1016Z2

Voltage: 24 Volt DC

Output: 250 Watt

RPM (after Reduction) – 337

Full load current – 13.4A

No load Current – 2.2A

Torque Constant – 8 N.m (80 kg-cm)

- Torque stall – 40 N.m (400 kg-cm)
- Sprocket: 9Tooth only fits #410 bicycle chains
- For Chain Size: Pitch 0.5in

Roller Diameter 0.3in

Roller Width 0.16in

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MOTOR:

PMDC Motor

The motor selection was the toughest part as we needed a perfect balance of speed as well as torque. However too high-power motor may have resulted in battery drain. Therefore, the motor selected was 250-Watt PMDC motor. The motor selected with specifications is given below.

D.C motor was chosen for this project. Considering the following the 250-Watt PMDC gear motor was used inour project.

The Motor driver:

The project is high current consuming device. Since there is too much load acting on the project it is possible that too much current may burn the control system. Hence it is necessary to use the HIGH current motor driver to drive the motor of the scissor lift.

The motor driver used is 24 V 20 Amp DC motor H- bridge. The H- bridge IC is used to provide the directional control to the DC motors as well as to control the speed of the DC motors. However, in our project we will be keeping the speed of the scissor lift same and concentrating only on thedirection control of the DC motor.

The specifications of the DC motor driver are:

Input Voltage: 7V minimum to 30V maximum

Continuous Current (< 1seconds) ~ 20A

Continuous Current (< 10seconds) ~ 10A

Continuous Current (> 10seconds) ~ 5A (withoutheat sink on MOSFETS)

Absolute Maximum Peak Current ~ 50A

GND – connect to GND on controlling board

DIR – Pulled down to GND Forward by default and backward when 5V (logic high)

PWM – Pulse Width Modulation input to control speed of motor (recommended freq 20Hz to 400Hz)

BRK – breaking input to halt the motor in operations when 5V (logic high)

5V – regulated 5V output from motor driver board (maximum 50mA supply)

The specifications of the battery are as follows:

Sl. No	Parameter	Value
1	Voltage	24 V
2	Current	14A
3	Power	336W

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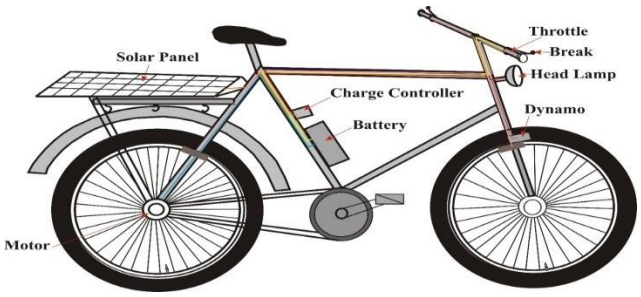
Design:



Diameter of the bicycle wheel D = 0.8m Radius r = 0.4m

Speed required s = 20km/hr

Bicycle weight Wb= 25kg

Weight of the rider (Approximately) Wr = 75 kg

Total weight Wt = 100 kg

Power calculation:

Normal reaction on each tyre Wn = Wt/2 = 50 kg

Force F = Wn * g = 50* 9.81 =490.5 N

1. Considering static friction:

friction coefficient u = 0.03

Fs = u * F = 0.03 * 490.5 = 14.71 N

Torque Ts = Fs * r = 14.71 * 0.4 = 5.88 Nm

2. Considering dynamic friction:

friction coefficient u = 0.004

Fd = u * F = 0.004 * 490.5 = 1.962N

Torque Td= Fd* r = 1.962 * 0.4 = 0.7848 Nm

3. Angular Speed: w = velocity/radius

= 20,000/ (0.4*3600) = 13.88 rad/sec

Power Requirements:

1. On plane Ground

for initial condition Ps = Ts*w = 5.88 * 13. = 81.66 W

for dynamic condition Pd = Td * w = 10.89 W

Overall power requirement = 92.55 * 2 = 185.1W

2. On inclined surface

let angle of inclination a = 2^0

total force required is

a] considering static friction

F = u * m*g * cos (a) + m*g sin (a) =63.64 N

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therefore, power required = F*V = 353.55 W

Extra power required = 353.55 – 185.1 = 168.45 W

b] considering dynamic friction

F = u * m*g * cos (a) + m*g sin (a)= 38.15 N

Power P = F*V = 211.94 W

By considering the above calculations we require 250W motor.

Calculation of charging time of battery:

Charging time of battery = Battery Ah / charging current.

Charging time for 14Ah battery = 14 Ah/ 3 A = 4.66 Hrs.

It is for ideal cases…

Practically, it has been noted that 40% losses occur in case of battery charging.

Then 14*(40/100) =5.66Ah.

Therefore, 14+5.66 = 19.6Ah (14Ah + losses)

Now, charging time of battery = 19.6Ah /3A = 6.53 Hrs.

Selection of solar panel:

If we use a panel of 40 W ,24V

Charging time of battery = Battery Ah / charging current

Charging time = 14 Ah / 1.66 A= 8.66 Hrs

Size=350x540x35 mm

Selection of battery

Two of 12V, 14Ah battery can be used

24*14=336 W

VII. SOFTWARE USED

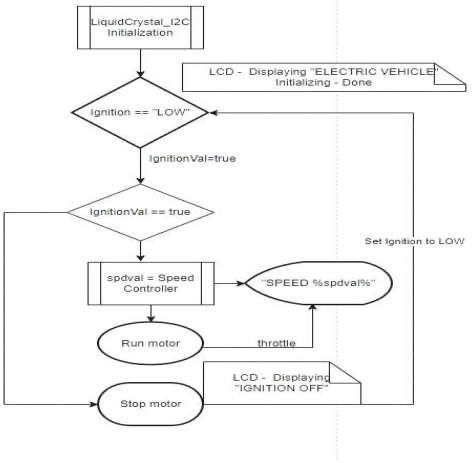

Fig. Flow Chart

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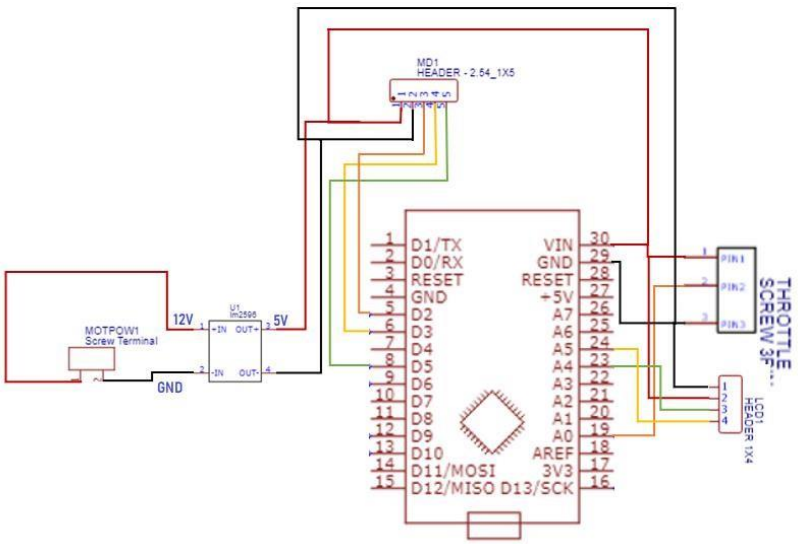
Circuit Diagram of Speed Controller of Motor



In the above circuit diagram, we have used various components like Arduino Nano, Throttle, Motor, Battery, And Converter. Arduino Nano require 5V to Operate but from battery we get 12V DC but to supply 5V to operate Arduino Nano we convert 12V to 5V by converter. There is a code to control the speed of the motor and to display the battery status and speed of the bicycle in Arduino Nano. From the throttle sensor position of the throttle will sense and sensed input is given to the Arduino Nano. From Arduino Nano signal is given to the motor and even control the batteryinput to the motor. As we change the position of the throttle the input to the motor through battery gets changed So thatwe can control over the speed of the motor.

VIII. ADVANTAGES

1. The system self-charges itself using energy regeneration when the vehicle is in motion thus recovering the surplus energy
2. The system is hybrid and hence can be powered using 3 sources, battery, solar and pedal power
3. The system is low cost and self-chargeable hence it is best suited for rural transport and by using solar energy it is eco-friendly.
4. The bicycle can also be used for powering other applications such as agricultural pumping and house hole rural lighting.
5. The proposed system can help bring an economical electric vehicle to the market
6. The proposed project can help solve the major hurdle in Electric vehicle implementation which is Battery backup and supports India's Electric Mobilitymission.

IX. DISADVANTAGES

1. Speed range is limited
2. Charging time is more

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X. APPLICATIONS

1. Can be used by the rural and village community as a mode of day-to-day commute.
2. Can be used as a source of solar power for agricultural applications and house hold lighting.

XI. RESULT

Load	Km/hr
Without load	15 km/hr
With load (one person of 67kg)	12-15 km/hr

Following table gives the reading of Solar Panel

Time	Voltage
Early Morning	16.34V
Morning	28.3V
Afternoon	31V
Evening	12.6V

Following table gives the reading of Dynamo

Speed in rpm	Voltage
2800	12.6V
1400	6.015V
700	2.89V
1800	7.89V

Here, the average battery charging time is 7hrs 35 min. The bicycle will run on road Top speed of 15 kmph. It has the average economical riding speed for max range of 12-15 kmph. It can travel up to 30km at one full charge. we have the battery peak voltage of 24V, our motor excitation voltage of 24V and Current rating of battery is 8.3Ah and voltage rating of battery is 24V.

XII. CONCLUSION

The proposed project deals with the concept of solar powered multifunction bicycle. From the proposed project it can be concluded that the project provides solution to low-cost eco-friendly transport system for specifically developed keeping the rural community in mind. The bicycle has the provision to be driven using hybrid sources including solar energy, human efforts aka pedal energy as well as the battery source. To increase the battery backup the proposed project uses energy regeneration and recovery using the generator embedded in the front wheel of thebicycle. This generates the electricity and charges the battery when the cycle is in motion. The proposed system is also expected to provide a solar mode of charging for electric bicycle which uses solar panel on the cycle to charge the battery. In addition, the solar panel can also be used to power other applications such as agricultural pumpsand household lighting in villages.

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