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Design, Analysis and Fabrication of Hybrid Bi- cycle

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ABSTRACT: The primary objective of this project is to design a feasible E-bicycle. As the number of motor vehicles on the roads throughout the world increases rapidly each year, the need for oil-based fuel grows almost unchecked. The recent increase in the use of fossil-based fuels brings with it various environmental problems like the “greenhouse effect”, other pollutions, and the fear of depletion of fuel supply. This paper presents a study of electrical bi-cycle design. This study aims to innovate how to design a simple, cost-effective model of the hybrid bicycle (CITY BI-CYCLE) with an intelligent control system. This can be implemented by making a new bi-cycle frame and adding a DC motor with the required power along with a battery and other necessary components to travel within cities. By introducing cheaper, more efficient conversion kits, usage of electric bikes can be increased, decreasing air pollution. The noise produced by e-vehicles are considerably lower than other vehicles and the maintenance of an E-Bicycle is easier than a typical motor vehicle.

KEYWORDS: E-bicycle, Hybrid

I. INTRODUCTION

More than 36% of pollutions is made by Two Wheelers, which decreases the availability of fossil fuel and raises the temperature of Earth leading to global warming. Our main focus is on transportation, where we are designing and converting an ordinary bicycle into a hybrid electric bicycle. In these electric bikes, we use an electrical motor (BLDC motor) instead as there is less pollution, low maintenance cost and reduced noise. A promising alternative to fuel-based transport is the electric bicycle (e-bike), which has developed rapidly in recent years and exhibited huge potential for its energy-saving and environmentally friendly features. However, e-bikes have not drawn sufficient attention from academics and the Indian government as they deserve. It is urgent to understand why and how the e-bike industry has developed in other countries to further boost its development, reducing the emission of pollutants.

Nowadays the importance of electric vehicles are noticed and new vehicles, especially cars are introduced in the market but they are not affordable for all and people prefer two-wheelers as they are much more likely to go through traffic without much trouble. So, we are designing and developing a hybrid electrical bicycle that can be run either by pedaling or by an electrical motor on city roads. This will help build a cleaner environment and environment-friendly means of transport in urban and suburban areas.



Figure 1- Design of Hybrid Cycle Frame

II. FABRICATION DETAILS

Figure 1 is the start of fabrication of a product. The design setups the major ground work for any product manufacturing or idea that needs to be created. The design has to follow parameters and standards that are used in local markets and other companies for faster and easier manufacturing and stock parts. This makes it easier for the product fabricator since all the main parts will already be readily available and will be easier to modify for the future runs. With the standard frame and known parameters of the local parts, it will be easier to modify since the modifications can be fabricated according to the already standard parts that are followed by most all manufacturers.

Design Analysis of the drawing with set parameter will give additional valuable theoretical information that would help us in simulating and identifying any problems in the design itself when fabricating it in real life situations. In Figure II, a load testing has been done on the recent frame drawing to see if it can support the weight of the cyclist and also the additional modifications like the hub-motor, battery management systems and the battery itself.



Figure II - Design stress Analysis

The above Figure II shows the stress analysis test done on the drawing that was in Figure I with variable test loads of 1300N as the maximum weight that can be applied on the middle (Seating region of the frame).

The load has been tested as such that the average user will not be over 130kg since this product is rated for ages from over 15 years of age. In the upcoming literature we will see all the parts and methods that were used for the fabrication of the Hybrid Bicycle.

III. COMPONENTS USED IN HYBRID ELECTRIC BIKE

COMPONENTS

1. Frame
2. Hub Motor
3. Batteries
4. Charger
5. Battery Management System
6. Throttler
7. Brake lever for auto-cut
8. Paddle Assist Sensor
9. Speedometer
10. Disk Brake System

FRAME

The frame is the skeleton of the cycle. It is usually made of Aluminum, Steel, Carbon fiber, or Titanium. Steel frames are reasonably affordable, strong and easily available, making it a good choice for riders on a budget. We decided to go with steel frame due to its availability and strength.

We then decided to build the outer frame with a glass fiber mesh to cover all the components and the wiring.

HUB MOTOR

The hub motor (Figure III) or the wheel motor is an electric motor that sits in the hub of the wheel and drives it directly. In a hub motor, when the electromagnetic fields are supplied to the stationary windings of the motor, the outer part of the motor follows those fields, turning the attached wheel. They have few moving parts. They are stealthy in their appearance and near-silent operation.



Figure III - Hub Motor

BATTERY

The batteries supply the power required to drive the motor. The commonly used batteries are Lead-acid batteries (SLA), Nickel-Cadmium batteries (NiCd), Nickel-metal hybrid batteries (NiMh), Lithium-ion Batteries (Li-ion), and Lithium-ion polymer Batteries (Lipo). In figure IV you can see the battery we used (Li-ion) in order to run our Electric Bicycle.



Figure IV- Lithium ion Battery

SPEEDOMETER

A speedometer is a device used to check the speed of the bicycle and send the information back to the user and the battery management system. The battery management system uses that data to control the amount of power that needs to be sent to the hub motor on the move.

DISK BRAKE SYSTEM

The disk brake system is better than a normal brush type brake system due to its better-stopping force from the brush system. Also, part of the Odometer system work works on the disk brake setup. Figure V represents the disk break we used in our fabricated product.



Figure V- Disk Brake

BATTERY MANAGEMENT SYSTEM

A Battery Management System is an electronic system that manages a rechargeable battery, such as by protecting the battery from operating outside its safe operating area, monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it, and/or balancing it.

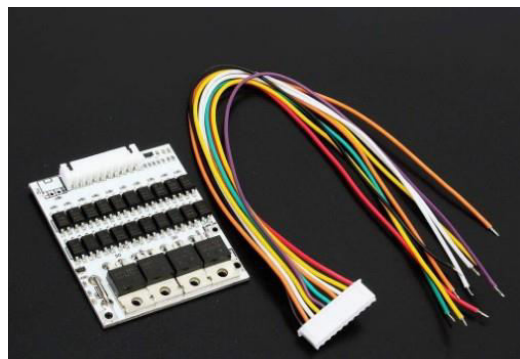


Figure VI- Battery Management system

BRAKE LEVER

A brake lever sensor is a device used to cut off the power supply to the motor during braking so that the motor and wheel can stop as a whole. This avoids the damage that may occur if the motor is still running while the brakes are applied to the wheel. in the below Figure VII, the break level system can be seen.



Figure VII- Break Lever system

THROTTLER

A throttler is a device used to accelerate or decelerate the motor by varying the power supply to the motor. Increasing the throttler works just like pressing the gas pedal in the car. It supplies more power when the throttler is raised and delivers lesser power when the throttler is lowered. In the Figure VIII, you can view the throttler that was used during fabrication.



Figure VIII- Throttler

BREAK LEVER FOR AUTO-CUT

In order to stop the vehicle, during braking, the power supply to the motor should be cut off to avoid unwanted strain. To cut off the power supply to the motor while braking, a lever is used in the brake that acts as a switch and cuts off the supply to the motor.

PADDLE ASSIST SENSOR

A paddle assist sensor is a sensor that aids in pedaling by supplying a small amount of power making it easier for the rider to drive. It detects the forward rotation of the pedal and activates the motor to power up the ride.



Figure IX- Magnetic Paddle Assist Sensor

IV. SEQUENCE OF OPERATIONS

LAYOUT

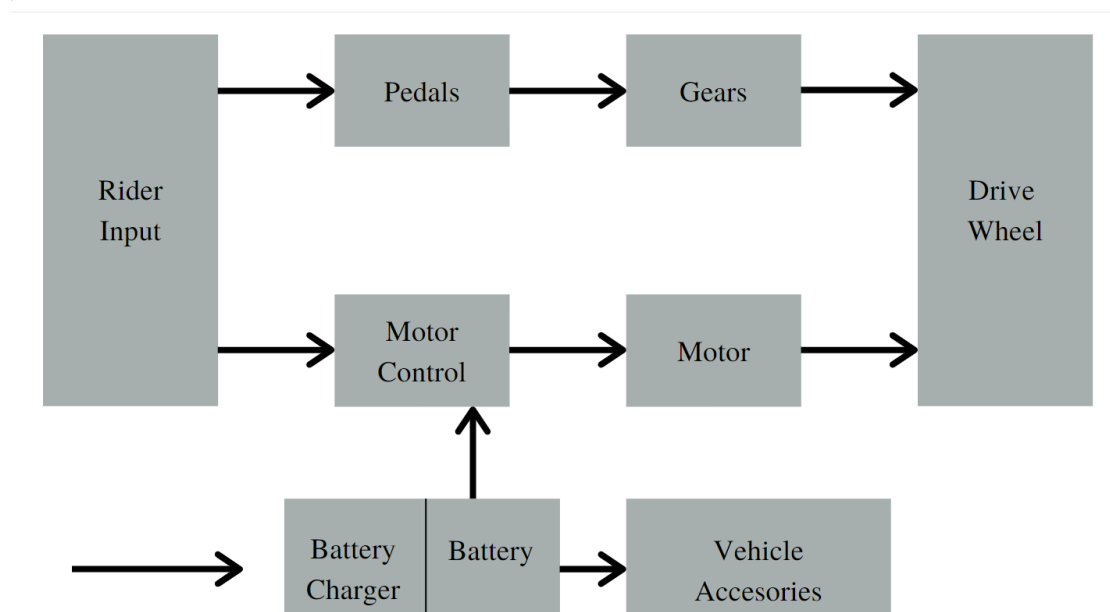


Figure X- Functioning layout of the Product

The system and the layout of the system are really simple and easy to learn. The battery is charged by an external charger which can be powered by renewable resource plants like solar panels for an environmentally friendly power supply. The battery is connected to the battery manager and the battery manager is connected to other accessories on the Electric Bicycle. The battery management system controls the speed of the Hub Motor by getting information from the throttle and it also sends feedback to the throttle on how much battery left. The battery management system controls all the necessary speed and power outputs to the motor for better handling and control. The breaks can cut the flow of power to the motor when used to protect from break damage and even an accident. This is also controlled by the battery management system.

FINAL MODEL BENCHMARK

Step 1: Power(peak)= Supplied Voltage * (peak or Stall) Current

Step 2: Power(peak)= Torque * Rotational speed(rps)*2* π

Step 3: Torque= Force(F1) * Radial distance (from the center of the motor shaft to the circumference of the object)

MOTOR BENCHMARK

Operating Voltage: 36v

Working Temperature : -20°C-45°C Rated RPM: 180-290rpm.

Continuous Power Rated & Peak : 250W/550W(peak) Torque (nm) Peak: 45NM

Efficiency : 90% Weight of motor : 3kg

Maximum Speed : 30km/hr Motor shaft size : 110mm.

BATTERY BENCHMARK

From above motor specifications, we decided to make a battery set which satisfies the above motor requirements.

Power = voltage x current $P = V \times I$

$250 = 36 \times I$ $I = 250/36$

$I = 6.94$

(i.e.) $I = 7$ Ah

Batteries required:

Battery capacity = 3.7 V, 2.7 Ah Number of series connections = 10 Number of parallel connections = 3

Total number of batteries required = no. of parallel * no of series

= 10×3

= 30

Battery Used = 36 Volts, 8.1 Ah

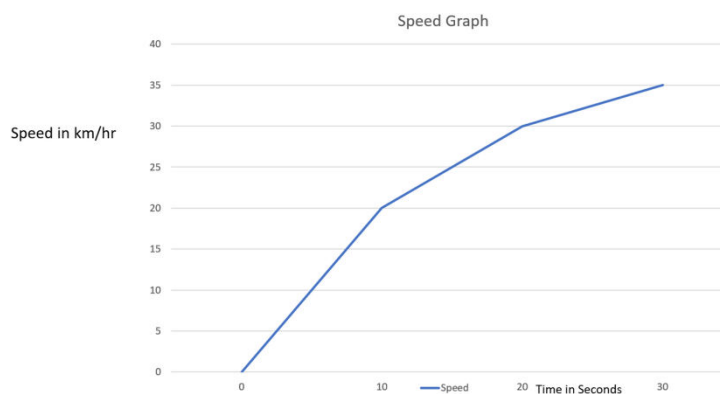
ACQUIRED RESULTS

CASE I

Load = 60 Kgs

Speed Obtained = 28 - 33 Km/HR Time = 0 - 20 sec

Braking Time = 1 - 2 sec

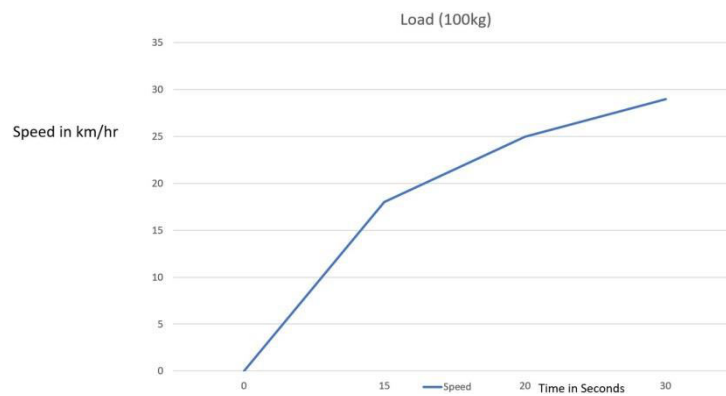


CASE II

Load = 100 Kgs

Speed Obtained = 20 - 26 Km/HR Time = 0 - 20 sec

Braking Time = 1.5 - 2 sec

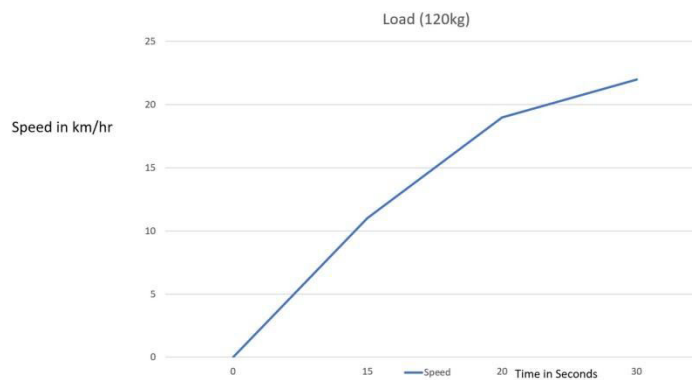


CASE III

Load = 120 Kgs

Speed Obtained = 18 - 21 Km/HR Time = 0 - 20 sec

Braking Time = 2 - 2.5 sec



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V. CONCLUSION



Maximum Load Carrying Capacity = 120 Kgs Age Limits = 15 and above
Speed Variations = 18 - 30 Km/HR Braking Time = 1 - 2.5 Seconds Charging Time = 100 Minutes Discharging Time = 60 min
Distance Covered Per Charge = 30 - 32 Km (Depending on Environmental Conditions)

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