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DESIGN OF EV BIKE

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ABSTRACT

The increasing demand for sustainable and eco-friendly transportation has led to the rapid development of Electric Vehicles (EVs), with electric bikes emerging as a popular and practical solution for short to medium-range travel. This project focuses on the design, development, and implementation of an *Electric Bike (E-Bike)* ***that combines energy efficiency, cost-effectiveness, and environmental consciousness. The EV bike operates using a rechargeable battery-powered electric motor, eliminating the need for fossil fuels and significantly reducing carbon emissions.. The project also explores smart features such as GPS tracking, battery management systems (BMS), and IoT integration for real-time monitoring. The EV bike offers a promising alternative to traditional gasoline-powered two-wheelers, aiming to address urban transportation challenges while promoting green mobility and sustainability.***
Keyword: a brushless DC motor, lithium-ion battery, motor controller, throttle, and regenerative braking system

1. Introduction

With growing concerns over environmental pollution, fossil fuel depletion, and rising fuel costs, electric vehicles (EVs) have emerged as a sustainable alternative to conventional internal combustion engine vehicles. Among these, Electric Bikes (E-Bikes) have gained significant popularity due to their efficiency, affordability, and suitability for urban and semi-urban transportation. An EV bike is a two-wheeled vehicle powered by an electric motor and a rechargeable battery, offering a clean and quiet mode of transportation. E-bikes not only help reduce greenhouse gas emissions but also require lower maintenance and operating costs compared to petrol-powered bikes. The integration of modern technologies such as Battery Management Systems (BMS), regenerative braking, and IoT-based monitoring enhances their performance, safety, and user experience. Furthermore, their lightweight design and ease of use make them accessible to a broad range of users. This project/report aims to explore the design, working, and benefits of EV bikes, highlighting their role in promoting sustainable mobility and addressing the challenges of traditional transportation systems.

1.1 Scope of Work

For a successful project, an engineering solution for the following needs statement must be developed. There is a need for a vehicle that is cheap, easy to maintain and operate. The vehicle should have less pollutants released into the environment either solid, liquids or gases during its idle and operation time. The vehicle should be safe to the user and to the people around it. It should also be easy to use and finally it should be both appealing to the user and satisfactory to their needs''. We therefore, used our knowledge in engineering to provide some of solutions to the above needs.

1.2 Project Background

A method of upgrades a conventional electric powered bicycle over to Solar-Powered Electrical Bicycle that is powered by an electric motor which gets its supply from photovoltaic (PV) panels. The PV panels must be mounted and installed at the bicycle without compromising riding comfort ability. The method employs a small electric motor that are easily connected and separated for ease of transport. A solar collector is connected to the rechargeable batteries for collecting solar energy and converting such energy to electrical power that is delivered to the rechargeable batteries for recharging thereof. A rechargeable battery is operable connected to DC motor for providing electrical power to drive the motor.

1.3 Problem Statement

There are several problems that occur during upgrades a conventional electric powered bicycle to Solar-Powered Electrical Bicycle. The specifications of photovoltaic (PV) panels must be sufficient to generate the electric motor same as a conventional electric powered bicycle. The suitable connection of solar cells, rechargeable battery and DC electric motor with bicycle needed to make sure this project accomplish with more optimum energy use. The electric motor must to support the weight and size of the bicycle, size of solar panel and condition of the road surface.

1.4 Objectives

The objectives of this study project are as indicated below:

i) To design a handmade multipurpose Electric Vehicle (EV) using locally available subassemblies.
ii) To determine the cost affordability of the designed EV.

1.5 Design Requirement

The design requirements were;

i) A vehicle capable of vehicles carrying one person as well as some load as min
   Purpose of our project is to made industrial load vehicles carrier.
ii) Average Speed up to 45 kmph
iii) On road Vehicle which would move around the industry.
iv) The cost of design and fabrication should be kept at a minimum.
v) The vehicle's operation should be easy and the design should ensure that all parts
   are easily accessible for repair and servicing.

2. Components of EV Bike

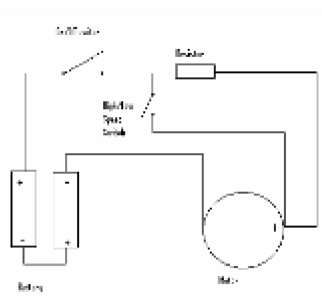
2.1 Dry Cell Batteries

A dry cell is a type of chemical cell, commonly used today, in the form of batteries, for many electrical appliances. It was developed in 1886 by the German scientist carl Gassner. A dry cell uses a paste electrolyte, with only enough moisture to allow current to flow. Unlike awed cell, a dry cell can operate in any orientation without spilling, as it contains no free liquid, making it suitable for portable equipment. As system requirement is 48 volt 18 amp supply accordingly we have used dry cell batteries each of 12 v 26 amp , dry cell battery that can be obtained locally. It is a deep cycle battery that has been used in A.T.M .machines

Dry Cell Battery

2.2 Motor Control

Electric bike already do exist with different control systems. The purpose of The control systems is to act as an On/Off switch and as a speed controller. Our system Consists of a 48 VDC (4 X 12VDC) battery and a 48V brushless DC motor.



Motor Control

In some limited testing, the design was shown to be effective. Our main problem With it was that there wasn't enough initial torque at slow speed. With this we, decided We would have to decrease our resistance, initially 1.7 ohms. When trying to decide on what resistance we should go for, we thought it would Be useful to come up with a way to make a resistor from local materials that are readily Available in Malegaon. So we decided to go for thin stainless steel metal. Since stainless steel is widely used and has relatively high resistivity, it seemed Appropriate to pursue making a resistor. The major factors involved in resistor design are the electrical resistivity of the Stainless steel, the length, and the area of the cross section.

2.3 Controller

Efficiency, simplicity in lever design, and reduced cost are gained by choosing the PWM Controller. The main reason in choosing the resistive control option would be to gain Reliability, and we can't be sure that it will indeed be gained. Both options are about Equal in appropriateness. The question of reliability will have to be tested to be Answered. We chose the PWM controller option because it is being used the way it is Designed to be used, possibly offering greater reliability, while the switches will be Seeing use for which they were not designed. The Currie Technologies motor controller that we selected for our final design has A 0-5V throttle input that could be achieved through the use of either a Hall effect throttle Or a 5k potentiometer. It is a 48V controller with a 18amp current limit and 45v cutout, Meaning that if battery voltage drops to 45 the controller will no longer provide power. This helps prevent battery damage from over discharge. See picture of controller:

Electronic Controller

A charge controller, charge regulator or battery regulator limits the rate at which electric currents 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.

2.4 Throttle

When the user is running on the electric motor, the acceleration will be in the form of squeezing and releasing a hand throttle which will allow the user to speed up or coast. This hand pedal will be located on the steering wheel column for easy reach and safety.

Thottle/Accelarater

Your electric bicycle's throttle is the physical connection between your electric bike Through just a few square centimeters of surface area, a magical bond is formed between man and machine that allows the two to feel each other and respond to each other's thoughts and desires. Ok, perhaps I'm romanticizing it just a bit, but the type of throttle on an bike really does affect the entire riding experience.

2.5 Steering Handle Bar

Among the considerations made during the design of the steering system were

- Steering must be lightweight and have few mechanical parts
- Driver's hand must not leave handle while accelerating and breaking
- Driver must be able to maintain control while turning
- Steering must allow wheels to be turned at a 45 degree angle.
- The camber must be adjustable.
- The steering system must have minimal wind resistance.

In an effort to current cycle design, we designed and made a simple type steering bar that allows two handed steering operation while leaving the other hand free for throttle and brake application. In testing the steering initially seemed backward, but it proved to work remarkably well after only a few minutes of familiarization. See steering bar picture:

Steering Handlebar

Motorcycle handlebar is a tubular component of motorcycle's steering mechanism. Handlebars provide a mounting place for controls such as brake, throttle, clutch, horn, light switch and rear view mirrors; and they may support part of the rider's weight. Even when a handlebar is a single piece it is usually referred to in the plural as handlebars.

2.6 Wheels

The design consideration made in the choice of the wheels for the vehicle was the desired clearance of the vehicle from the ground. Too high a clearance causes the vehicle to roll over since it raises the center of gravity of the vehicle. The maximum allowable clearance for small road vehicles is 165mm. The factors affecting clearance are;

- Approach angle - Maximum angle a vehicle can approach an obstacle without any part of the wheel approaching the obstacle.
- Departure angle - Maximum angle a vehicle can leave an obstacle.
- Break over angle - maximum angle a vehicle can ride over an obstacle without striking the obstacle between its axles.
- Roll over angle - Angle at which a vehicle will roll when traversing a slope. The allowable angle is 400

Wheel

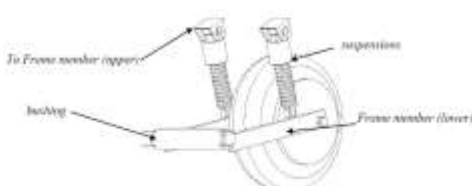
2.7 The Suspension System

2.7.1. Rear Suspension

The suspension system is made of a

- **Damper And A Spring**

This is a component of hero sprint scooty. Its length is 304.8mm from the lower axis to the upper axis for anchorage. We chose this model because of its simplicity in design, availability and the mass that we require to support. It ends are made of cylindrical tubes of inside diameter 6.647mm and the outer of 25mm. the length of the cylinder comes in different sizes and the choice of a 25mm was a good decision as it provides a rigid connection to the frame. It is connected to the frame using bolt and nut to provide a semi rigid connection for ease of articulation.



Rear Wheel And Suspension

2.8. Axle

An axle is a non-rotating member that carries no torque and is used to support rotating wheels, Pulleys, and the like (shingle's mechanical engineering design, eighth). Unlike a rotating axle, a non-rotating is designed and analyses as a static beam. To ensure that The axle used is of correct strength and not an overdesigned component that is beyond the Economic constraints allocated, various theoretical tests are carried to get a picture of what the Final design will be like geometrically and the component's mechanical properties. Simulation of This component can also be done using software that are used for these analysis.

2.8.1 Front And Raer Axle

It has a shaft of diameter 30 cm and length 98mm this shaft carries another shaft on its side which is 13mm diameter and the length is 34.43mm.The smaller shaft of 13mm carries the front wheel . The wheel is connected to the shaft through a roller bearing (ISO 15 – 838 - 30 X 33) inside and fixed to the same shaft by a helix nut

Rear Axle

Front Stud Axle

3. Performance Calculation:

3.1 Motor Power Determination:

P = F*v

P = (22 lb) (7mi/h)(5280ft/mi)(1h/3600s)
P = 257 ft-lb/s = 0.47 hp = 351 Watts
Where, **P:** Motor power
F: Rolling resistance force = μr*N;
μ_r : is coefficient of rolling resistance;
N: is weight of Tricycle and rider with batteries.

3.2 Motor Torque Determination:

Testing done on a 10% (5.7º) grade using torque wrench on hand crank axle:
Front axle torque = 26 lb-ft = 212 lb-in = 25.5 N-m

Rear axle torque = 24 lb-ft = 406 lb-in = 46.2 N-m
Required gear ratio > rear axle torque / motor stall torque
Motor stall torque = 4*P/_; P is motor power, _ is motor free speed in rad/s
Motor stall torque = 78 lb-in

6.3 Speed Reduction Determination:

For 7 mph top speed, rear wheel rpm should be about 91 rpm.
Therefore, speed reduction = motor speed (rpm) / 91 rpm
With Currie 350 W motor, free speed = 2600 rpm,
necessary gear reduction is 2600/91 = 28.
We used a 26:1 reduction as this was the largest reduction that Could be achieved using hub moter In testing, this setup has achieved but not Exceeded our objective of a 7 mi/h top speed.

3.4 Battery Capacity Determination :

Start current is 25 amps (tested)
Current at top speed is 8.3 amps (tested)
Estimating average current from testing in typical start/stop use to be 15 amps
Assume average speed of 4 mi/hr
Objective requires 8 mile range
Capacity = average current * run time
Capacity = 18 amps * (8 mi / 4 mi/hr)

3.5 Rear Axle Force And Diameter Calculation :

Our shaft is 1m long from the point in which the wheels are attached. The sprocket and a disc Brake are held between two bearings that act as the loading point of the shaft and as the Connection between the shaft and the frame. The bearings being the only point having a real Contact with the frame, have the following forces $B1$ and $B3$ acting on the shaft. These bearing Points are located 0.251m from each end of the shaft.

Force acting on $B1$and $B3$ are given as
$B1 = 125 \times 9.81 = 1226.35N$
$B3 = 125 \times 9.81 = 1226.35N$

This is because the two points are placed at the same distance from the ends of the shaft. The Mass being supported is also assumed to be equally distributed. The bearing and the reaction forces are not the only forces acting on the shaft, there are other Loads on the shaft.

3.6 Motor Drive System :

To choose the motor for the car, the following torque and power calculations were done The total tractive force required for the vehicle;

Total tractive force = rolling resistance + force required to climb a grade + force required to Accelerate to maximum velocity

3.7 Rolling Resistance :

Rolling resistance = gross vehicle weight * surface friction value

= 13\20 x 0.22(surface friction value for asphalt)

=26.4 kilograms

= 26.4 x9.81 = 258.98n

3.8 Grade Resistance :

Maximum angle the vehicle will be expected to climb in normal operation;

Grade resistance = gross vehicle weight * maximum incline angle (degrees)

= 200 x sin 17

= 25.0871kgs

= 760.444n

3.9 Acceleration Force :

Acceleration force is the force necessary to accelerate from a stop to maximum speed

Acceleration force = vehicle mass* (maximum speed / time required *gravity)

= 120 x (35/13)

= 323.07

Hence total tractive force = 247.46 + 323.07 + 327.07

= 893.60

3.10 Wheel Motor Torque :

Wheel torque = total tractive force* radius of the wheel * resistance factor

Resistance factor accounts for the frictional losses between the wheels and the axis. Typical Values range from 1.13 to 1.15

Wheel motor torque = (893.60 * 0.30*1.13)/ 9.81 = 30.87 n.m

Hence the power required;

P = τω = 35.104 *10.38 = 350watts

From evaluation of the local market, dc motors are not available. The most viable option is to Order from eBay. We found the motor to suit our torque requirements which was a manta teak Permanent magnet dc motor from Briggs and Stratton. The permanent magnet motor is compact And creates its torque by pushing two magnetic fields against each other. One magnetic field is Produced by mineral permanent magnets while the other magnetic field is from the batteries. This provides for a very powerful and yet very small motor.

4. Implantation

4.1 Construction

We encountered a few difficulties while constructing our prototype. Something That was important for us to keep in mind while designing our drive system was that we Use only locally available materials and construction methods. Welding was one of those Processes that we had to keep in mind since those in the area where our design will be Implemented are only able to stick weld. Designs requiring milling or turning operations For construction were not options. Stick welding became a problem because of the amount of heat that was Dissipated through the parts. This became a problem when our weld was close to threads Of our sprocket and slightly changed the exact opening. Again we encountered this Problem when welding the motor sprocket to the female end of the motor axle. Some Minor design changes that we made were more in the procedure then in the actual Changing of the design. We learned a lot about being sensitive to a culture that doesn't have the Abundance of materials and opportunities as we have. We had to keep in mind what was Available and still make a very simple and robust system that would be able to withstand Substantial environmental abuse. Even though our design was of the more simple nature, We think it was more difficult since we had to reverse engineer things to make them more User friendly and appropriate. A complicated design solution is often much easier than a Simple one.

4.2 Working Operation

Testing was a huge part in our overall project. Since we were designing for a Very real client, it was important that our system be tested to be reliable. Maintenance Needs had to be at a minimum since we could not count on it being pampered in its use. As the chart below shows, operation of the Electric Tricycle met or exceeded 4 out of 5 Of our objectives. Grade climb testing showed that we could start from a stop on a Maximum of a 16% grade. We measured a 7 mph top speed on level ground, and we Calculated that its range would exceed our 8 mile goal by monitoring motor current and Knowing the battery capacity of the implemented design. We made a subjective Evaluation of the design's appropriateness, and we decided that only the necessary items Of motor and controller are not locally available.

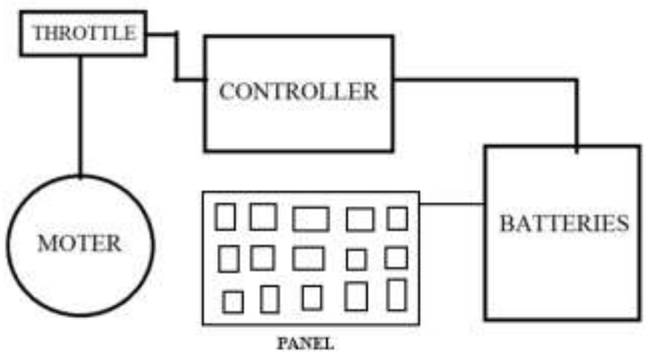


Fig.7.2 Working Principle of Electric Vehicle

As simply shown in fig. batteries supply requires electric energy to controller is a monitoring device that controls the electric supply to be given to motor and other accessories throttle works as a accelerator of our motorbikes, it regulated the speed of vehicle as per our need. the electric supply from throttle is given to motor so a to achieve actual motion. motor rotates acting as an energy developing element and motor power is given to wheel by suitable means of transmission.

5. CONCLUSIONS

The development and adoption of **Electric Bikes (EV Bikes)** represent a significant step toward cleaner, more sustainable transportation. By utilizing electric motors powered by rechargeable batteries, EV bikes reduce dependence on fossil fuels and minimize harmful emissions, making them an environmentally friendly alternative to traditional gasoline-powered vehicles. They also offer economic advantages through lower operating and maintenance costs, while incorporating modern features like regenerative braking and IoT-based monitoring enhances their functionality and user experience.As technology continues to advance and environmental awareness grows, EV bikes are poised to play a crucial role in the future of urban mobility. This project demonstrates not only the technical feasibility of EV bikes but also their potential to contribute meaningfully to greener and smarter transportation solutions.

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