

Modification of Standard Bicycle into E-bicycle (Electric Bicycle)

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ABSTRACT

As the worldwide population is growing day by day and there is increasing demand for product from manufacturing industry a simple, reliable, eco-friendly, safety and less costly product. One of them is electric vehicle. One type of electric vehicle is the ELECTRIC CYCLE (E-CYCLE). Increase in fuel price of Petrol bike along with the consideration of the environmental factors uses a bicycle over a motor vehicle for short distance traveling. E-cycle typically incorporates a battery which can be charged at an ordinary domestic power socket link to an electric motor in bicycle transmission system

The rider has power to control the output power from motor i.e. speed using a handlebar mounted throttle and controller.

This project based on combination of standard bicycle with an electric power motor the system is modified in such way that the rider can make choice of mode he prefers i.e. he can either choose the bicycle to driven completely with electric motor or he can choose it to be driven manually by himself.

The hope is that this design can become very efficient, cost-effective, and one day massproduced, especially in developing countries where automotive transportation is an impossibility.

INTRODUCTION

When thinking of possible senior projects, we all decided that we wanted to do something that would somehow be beneficial to the planet. We decided that the electric bicycle would be the best fit. As worldwide population is growing day by day and there is increase in manufacturing and using of fuel powered. This vehicle requires fossil fuel to run and it is a limited source of energy which will be over after some period and to cope up with this need, the revolution for the eco-friendly cycles are the most depended modes of transportation, along with this the consideration of the increase in fuel price and the environmental factors we must admit that it is far more better to use a cycle over a motor vehicle for short distance travelling. Imagine how useful would the cycle be if even the small effort applied by man for riding on rough terrain.

An **electric bicycle**, also known as an **e-bike or e bike**, is a bicycle with an integrated electric motor used to assist propulsion. Many kinds of e-bikes are available worldwide, but they generally fall into two broad categories: bikes that assist the rider's pedalpower (i.e. pedelecs) and bikes that add a throttle, integrating moped-style functionality. Both retain the ability to be pedalled by the rider and are therefore not electric motorcycles. The electric bicycle offers a cleaner alternative to travel short-to-moderate distances rather than driving a gasoline-powered car. In recent years, the United States has increasingly encouraged a cleaner environment and less dependence on foreign oil. The price of crude oil has increased significantly over the past few years and there seems to be no turning back. The environment has also been more of a focus throughout the world in the past few years, and it seems that cleaner alternatives have been steadily on the rise with no end in sight. The electric bicycle is a project that can promote both cleaner technology as well as a lesser dependence on oil. It will run on clean electric power with the ability to recharge the battery separate ways: through by generating power through the pedals of the bicycle with the help of alternator.

An extra benefit to building the electric bicycle is that it can also show the general public how much cheaper it would be to convert their regular bicycle into an electric bicycle rather than driving solely in their gas powered vehicles. The greater importance of the environment in the world leads to an opportunity for students in our position. With the economy trying to get out of one of the worst depressions of the century, there are numerous opportunities for us to help\out. This is our opportunity to contribute a greener and more efficient planet.

LITERATURE REVIEW

Abhishek Doiphode et al. [2019] researchers' project is based on combination of the standard geared cycle with an electric power motor. The system is modified in such a way that the rider can make choice of

which mode he prefers i.e. he can either choose the cycle to be driven completely with the electric motor or he can choose it to be driven manually by himself. The idea of mounting the motor and its support assembly onto a geared cycle was to reduce the effort to-be applied for extra little weight that the rider will have to take along with the cycle. The unit has been designed in such a way that people of any age group can depend on it. The idea of implementation of the project was mainly biased towards providing inter college transportation. E- Bikes are difficult to compare directly across different types. Normally in every electric Bicycles there are two common parts which is consider while making it i.e. motor and manually operated paddle. The Bicycle consists of 6 gear speed, through which any person can drive this Bicycle manually with the help of this gears easily without any fatigue. At a same time there is another arrangements is made in which battery powered motor is use to drive the Bicycle. For power transmission from motor shaft to the sprocket chain drive is use. This chain is connected is such a way that it can be fixed according to vary in chain cause due to environmental or mechanical problems which creates tension in chain. Apart from all motor & battery arrangement three is an indicators, tail light, gearing arrangement, horn & front light.

Ranjan Kumar et al. [2018] researcher present the idea of harnessing the various energy and use it in today's existence of human life .Now-a-days there are so many vehicles on road, which consumes more fuel and also hazards our environment. It is our responsibility to reduce the consumption of fuel and its hazardous emission products. Taking this into consideration it is a small step towards reducing the use of more fuel consuming vehicles and attract the eye of people towards its alternatives i.e. Electric bicycle. So author intend to design a cycle which would run on an alternative source and also reducing human efforts called as Battery Operated Cycle. In this paper author design an alternative mode of transport for betterment of social and environment. The project is designed to improve the normal bicycle and make it extra efficient. The electric bicycle is a hybrid and so it can run electrically and can also be pedalled thereby still retaining the exercise people drive from riding bicycle.

Deep R Prajapati et al. [2017] The main gist of this paper is to give the exact view by bridling the various sources of energy available to mankind. In today's modernized world travelling is very essential for human beings in order to protract in this world. And to do so his travelling should be done in minimum possible way and in jiffy. This paper gives the details about the Electric Bike which runs on the battery thereby providing voltage to the motor. This paper compromises with design and fabrication of Electric Bike which makes use of Electric energy as the primary source and solar energy if possible, by attaching solar panels. It also highlights on the design aspects of the bike. There is a provision for a charging the

battery by ejecting it from the main system. The electrical power generated which is used to run the bike can give better fuel economy compared to conventional vehicle, better performance and also causes less pollution.

A Karthi et al. [2020] The main aim of this project is to give the exact view by bridling the various sources of energy available to mankind. In today's modernized world travelling is very essential for human beings in order to protract in this world. And to do so his travelling should be done in minimum possible way. This project details about the Electric Bike which runs on the battery thereby providing voltage to the motor. This project compromises with design and fabrication of Electric Bike which makes use of Electric energy as the primary source. The electrical power generated which is used to run the bike can give better fuel economy compared to conventional vehicle, better performance and also causes less pollution. To reduce the air pollution and the noise pollution. It provides an eco-friendly vehicle and reduces the usage of fuels. Thus, here transmission is also used as to control the speed of the vehicle as by increasing and decreasing. The speed can be varied as like gas powered motorcycle.

Vladimir Dimitrov [2018] This paper reviews possible approaches to the design of an electric bicycle with an emphasis on three different domains – electrical, mechanical and system level design. It reviews the available solutions to a wide range of issues in each of the abovementioned domains. After grouping the solutions presented and classifying them on a domain basis the paper presents a classification on the ways to design an electric bike, so that a designer can easily obtain the required information in order to start their project.

Matteo Corno et al. [] The researcher presents the idea to recover energy from the cyclist when he is most efficient and return it during low-efficiency pedaling. A control-oriented analysis of the cyclist's metabolic efficiency is carried out to guide the design of the control algorithm. Three features are employed for this purpose: an ad hoc-defined equivalent cycling efficiency based on oxygen consumption, a dynamic model for the state of fatigue (SoF), and heart rate (HR) measurements. The analysis of the equivalent cycling efficiency and SoF dynamics guide the design of a charge-sustaining assistance algorithm. The algorithm is designed and tuned through simulations. The proposed system is tested on subjects, and it is shown that it is capable of maintaining the battery charge. The tests indicate that improvements up to 25% in equivalent cycling efficiency and reduction in peak HR and SoF can be achieved for urban cycling.

PROBLEM STATEMENT

The modification of electric bicycle by adding power assisted and carrying load 130kg & achieve speed up to 20km/h have to go. To find out the power required to propel the bicycle calculations are done using bicycle dynamics.

OBJECTIVE

1. To modify standard bicycle into E-bicycle
2. To increase the product that may be simple, reliable, eco- friendly safety and less costly e-bicycle
3. To develop the e-bicycle that will save the costly fuel energy and protect the atmosphere from global warming and environmental pollution
4. To develop the model of e-bicycle that may be user friendly and save excessive physical exertion.

METHODOLOGY

The following components will be assembled together on a regular ordinary bicycle and the electric bicycle will be made ready.

Components of the Electric Bicycle:

1. Bicycle
2. Battery
3. D.C. Electric motor with Mounting plate
4. A speed controller or motor controller
5. Head light and Horn
6. Thumb Throttle
7. Battery Charger
8. Chain
9. Freewheel

1. DCMOTOR

A DC motor is one of a class of rotary electrical machines that converts direct current electrical power into mechanical power. Maximum power according to federal:750W at 20mi/h speed. This is much more power than is normally required with electric bicycles.

The most mutual types rely on the forces created by magnetic fields. electric bicycles in the Current market generally do not exceed 400w. The universal motor can operate on direct current but is a lightweight motor used for convenient power tools and appliances. Bigger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The arrival of power electronics has made replacement of DC motors with AC motors possible in many applications

Working Principle Of motor: -

A motor is an electrical machine which translates electrical energy into mechanical energy.

The principle of working of a DC motor is that "whenever a current carrying conductor is placed in a magnetic field, it practices a mechanical force".

WORKING:

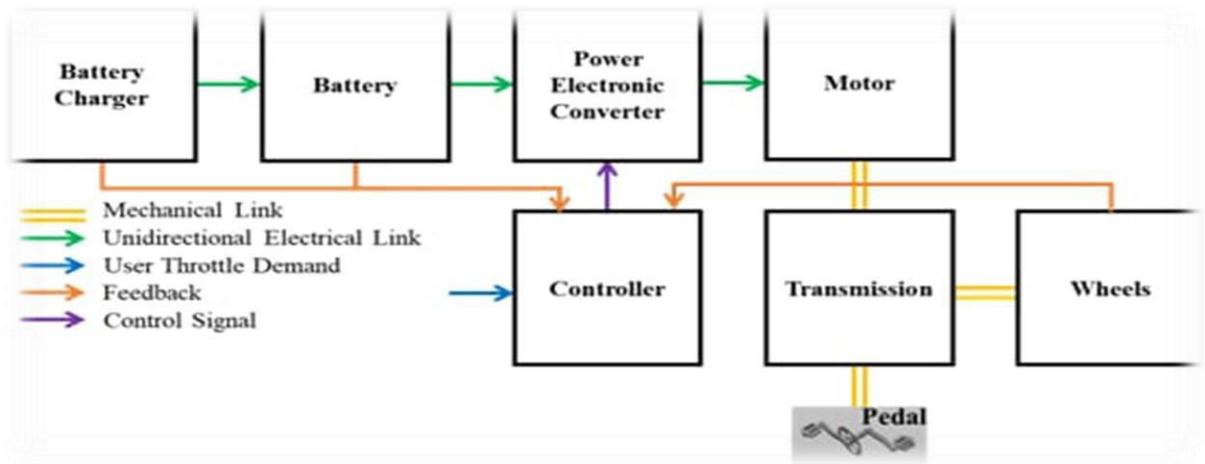
The working of our project basically explain by using the five blocks as follows a) Battery.

b) Motor Controller Circuitry.

c) Electric motor.

d) Chain and Sprocket.

e) Bicycle speed Rotation.



A) Battery:-

Two lead acid rechargeable batteries of 12v, 9 amp are used which are connected in parallel position. It basically stores the electrical energy generated and utilise it to run the motor. In a similar way as with the battery market, careful selection of the battery could reduced the heavy battery weight. For example a laptopsize battery that could be easily put on and taken of the would be sufficient for short rides up to 45 min then the bicycle recharging would be handled in a similar way as it today common with cell phone. Lighter weight, higher energy density battrirs are use.

B) Motor Controller Circuitry:-

It used to control all the working of cycle. The motor should be designed to be most efficient Over the operating cycle. Motor assistance is available both assist peddling and motor operation.

C) Electric Motor:-

Use the specific motor having suitable power and torque according to design.

D) Chain and Sprocket:-

Take the suitable material & no. of teeth according to centre distance. Gear provide desired gear ratio enable easir torque sensing ,hub motor intrgrated in the wheel and friction is lightweight.

E) Bicycle Wheel Rotation:-

Provide the torque and speed to the wheel throughout sprocket. Regenerative braking will be more usefull in hilly area when braking is used often .

Specification

- Bicycle = Hero standard bicycle
- Total Load=130kg
- BLDC Motor=500watt, 3000rpm
- Battery=24volt, 500watt
- Motor Controller=24volt, 370watt (Aluminium wiring connection on controller 1 brake wire, 2 charging ports and 3 dereillure)
- Speed Input N1=160.60rpm, Speed Output N2=2700rpm, Torque=29Nm
- Gear Ratio = 9:16

CALCULATION

Load Carrying and Motor Power Calculation:-

1. Diameter of wheel=660.40mm

Circumference of wheel = $3.14 \times 660.40 = 2073.65\text{mm}$

Speed of vehicle = speed of wheel X circumference of wheel

$$\begin{aligned} &= 169 \times 2041 \\ &= 344418075 \text{ mm/min} \\ &= 344.41 \text{ m/min} \\ &= 20665 \text{ m/hr} \\ &= 20.66 \text{ Km/hr} \end{aligned}$$

2. Total load act on bicycle is as follow Normal weight of person =100 kg = $100 \times 9.81 = 981\text{N}$

Weight of bicycle = 20 kg = $20 \times 9.81 = 196.2\text{N}$

Other Miscellaneous load =10Kg = $10 \times 9.81 = 98.1\text{N}$

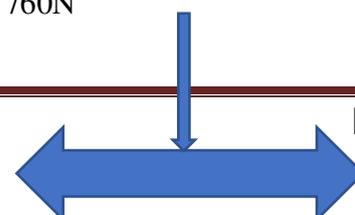
The total load = $(981+196.2+98.1) = 1275\text{N} = 130\text{kg}$

3. To find reaction on each wheel, The above total load which is divideid equally on both wheel

Force

760N

$$(F_{rw}) = \text{Force } (F_{rw}) = 1275/2 = 637.65\text{N}$$



Where reaction on rear and front wheel are as follows

$$\begin{aligned} R_{fw} &= R_{rw} \\ &= 0.2 * 216.8 & R_{fw} &= 0.68 & R_{rw} \\ &= 43.36N \end{aligned}$$

4. To find torque on each wheel Total torque = $T_{fw} + T_{rw}$

To find Torque on Front Wheel

$$T_1 = R_{fw} \times (D \div 2) = 43.36 \times [(66 \times 10^{-2}) / 2] = 14.30Nm$$

$$T_1 = T_2 = 14.30Nm$$

Total torque on wheel = 29Nm

5. REQUIRED POWER TO DRIVE BICYCLE

Consider Velocity $V = 20Km/hr$

$$= 5.55m/s$$

$$V = \pi DN / 60$$

$$5.55 = \pi * 0.66 * N / 60$$

$$N = 160.60rpm$$

POWER

$$P = 2 \pi NT / 60$$

$$= 2 \pi * 160.60 * 29 / 60$$

$$= 490w$$

6. Power output = 490w

Total Acceleration on cycle = change in velocity dv / change in time dt

$$= 5.55 / 10 = 0.55m/s^2$$

Force apply in bicycle = mass * acceleration

$$= 130 * 0.55$$

$$= 71.5kgm/s^2$$

7. Torque required if centre of tyre to move cycle = $F * r$

$$= 71.5 * 0.66 / 2$$

$$= 23.59N$$

PLANING OF PROJECT WORK

After selecting a topic and getting it approved by the research guide we have divided the work among our team, that consists of 4 students. We have visited the library, read various books & journals for pertaining

to technical side of our project we have collected some ideas in the form of rough data for our project then we have compared the feasibility of project and

reached at the decision to enhanced “ Modification of standard bicycle into electric bicycle” as final project.we have also decided to analysed and study the different components to finalise the project

ADVANTAGES & LIMITATION ADVANTAGE:-

- 1) Easy to assemble and disassemble
- 2) Easy to handle
- 3) Separately use of bicycle
- 4) Low cost
- 5) Environmental Eco-friendly
- 6) Less effort

LIMITATION:-

- 1) Required high torque DC motor.
- 2) Less speed
- 3) Proper alignments are required

APPICATION OF PROJECT

- 1) To travel purpose of roadway
- 2) It is use industrial area under pollution control.
- 3) For driving purpose in pollution control area in some country Iike USA, Japan, china etc.

CONCLUSION

At the conclusion of the project, we had accomplished full system integration physically. The major challenge remaining is creating a set of software that the microcontroller can use to control the system given all the feedback systems that communicate with it. Some additional features we may implement include creating a display and circuitry for monitoring the battery state. In conclusion, we have designed an electromechanical bicycle with a minimal amount of additional weight, an integrated control system, based on the decision-making of the rider and microcontroller, and that is capable of greater efficiency

than typical bicycle through its use of regenerative motor control and various other feedback control mechanisms.



References

1. Abhishek Doiphode, Chetan Lakde, Ajit Prasad, Rushikesh Boche, Prof. N. D. Bankar, “Design and Fabrication of Electric Cycle”, IJARIE, Vol-5 Issue-2 2019.
2. Ranjan Kumar, Munna Kumar, Pradyumn Sah, Mustaim Alam, “Design and Fabrication of Electric Bicycle”, International Journal of Engineering Research & Technology (IJERT), Special Issue – 2018.
3. Deep R Prajapati, Kunjan Shinde, Abhishek Mhaske, Aniket Prabhu, “Design and Fabrication of Electric Bike”, International Journal of Mechanical Engineering and Technology (IJMET), Volume 8, Issue 3, March 2017.
4. A Karthi, N Afridhin, D Aravind, G Kamalesh, K Rathish Kumar, “Design and Fabrication of an Electric Bike”, International Research Journal of Engineering and Technology (IRJET), Volume: 07, Issue: 02, Feb 2020.
5. Vladimir Dimitrov, “Overview of the Ways to Design an Electric Bicycle”, Proc. IX National Conference with International Participation "Electronica 2018", May 17 - 18, 2018, Sofia, Bulgaria.

Matteo Corno, Daniele Berretta, Pierfrancesco Spagnol, and Sergio M. Savaresi, “Design, Control, and Validation of a Charge-Sustaining Parallel Hybrid Bicycle”, IEEE Transactions on Control Systems Technology, 1063-6536 © 2015