iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** V **Month of publication:** May 2020

DOI: http://doi.org/10.22214/ijraset.2020.5287

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue V May 2020- Available at www.ijraset.com

Design, Analysis and Fabrication of Hybrid E-bicycle

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Abstract: ***In this paper, we are concerning about the growing demand of energy all over the world, which motivate us to switchover renewable resource of energy. There are many different ways by which we can save energy in different sectors. Our main focus is on automobile sector where we are converting old petroleum bike to electric bike. In these electric bikes we use Hub motor instead of combustion engine as there is less pollution, low maintenance cost, reduces noise. These bikes utilize chemical energy stored in the rechargeable battery packs. This paper deals with the design and development of electric bike which make use of electric energy as primary source. There is a distribution for charging the battery emitting it from the main system.***

.Keywords: Hybrid electrical vehicle, hub motor, electric bike, lead acid battery, electric bicycle

I. INTRODUCTION

Main reason to identify the need of finding and modifying E-Bike is to overcome the issue of the pollution because of vehicles in metro towns & urban zones is swelling uninterruptedly. Considering the all class of society it is not reasonable for all to purchase (scooters, mopeds or motorcycles). So, combining both issues, environmental progress supporting and economical affordable alternative would be the best solution. Typical parts of E-bike (Electric Bicycle) are Brushless DC Motor (Hub Motor), Throttle (Accelerator), Battery Storage (12 V), Chain Drive, Frame and other common bicycle parts. Electric bicycles which are propelled by a combination of pedaling and battery-powered electric motors, are a promising alternative to automobile transportation. Their primary advantages include lower purchase and operating costs compared to cars, ability to travel short distances and with less physical effort compared to traditional bicycles, and zero emissions during operation. The electric bicycle is an electrical-assisted device that is designed to deliver the electromagnetic momentums to a present bicycle therefore relieving the user of producing the energy essential to run the bicycle. It contains a strong motor and enough battery power that just needs charging to help in hill climbing, generate greater motoring speeds and provide completely free electric transportation.

II. COMPONENTS of E-BICYCLE

A. Hub Motor

The wheel hub motor is an electric motor that is incorporated into a hub of wheel and drives it directly. They are commonly found on electrical bicycles and motorcycles .Hub motor electromagnetic fields are supplied to the stationery windings of the motor. Electric motors have their greatest torque at startup, making them ideal for vehicles as they need the most torque at start.

Fig.1 : Hub Motor

B. Batteries

The battery is the heart of any electrical bicycle. The motor is useless without all the energy that is stored in the battery. It is one of the hardest components to come by and often the most expensive. Lead acid battery, being the oldest among the others, is also the type that presents less advantages or more drawbacks. As lead acid batteries are less expensive compared to other batteries, lead acid batteries are widely used even when inrush current is not important and other designs could provide higher energy densities. In the charged states, the chemical energy of the battery is stored in the potential.

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C. Throttle

The throttle used in e-bicycle performs the same operation as in motorcycle or scooter. When the throttle is engaged it helps to propels you and the bike forward. Throttle is usually mounted on the handlebar, and activated by twisting, you can get power from the electric motor without doing any pedalling at all. Some bikes come with just the throttle and not a pedal assist system, and others come with option to use pedal assist or throttle. A few bikes don't have pedals at all, and just have a throttle. Bikes with a throttle and pedal assist sometimes come with a throttle disabling setting, or can operate with throttle completely unplugged and removed from the bike.

D. Ignition Switch

The ignition switch is the switch that provides power for the vehicle's electrical accessories, computer, fuel and ignition systems. It is also used to routes current from the battery to the starter to crank the engine, accessory position that provides power to electrical accessories only, not the engine. In old days, ignition switches were key switches that requires the proper key to be inserted in order for the switch functions to be unlocked. These switches remain common in modern vehicles, further combined with an immobilizer i.e. a device which is used for immobilizing a motor vehicle in order to prevent theft to only activate the switch functions when a transponder signal in the key is detected.

E. Frame

It is the core structure on which other parts are assembled, it supports the motor, provides base for the location of starring and supports the passengers or luggage, batteries also attached to the frame. The material of the frame is mild steel and some adjustments have been done in the frame according to the requirement.

F. Controller

The speed controller of an electric bike is a electronic circuit that not only controls the speed of an electric motor but also serves as a dynamic brake. This controller unit uses its power from the battery pack and drives it to the hub motor. In adaptive e bikes, where conversion kit is used, the controller is the main component of that kit. You can switch to your electric speed control while climbing hills, exercise for longer duration or to reach your destination quicker gradually reducing your dependence on the electronic operation as your endurance increases.

G. E – Brake Lever

The e – brake lever is a replacement for the regular brake lever and either cuts out the controller or engages regenerative braking in the controller when the lever is squeezed. We have integrated levers for both mechanical and hydraulic brakes, as well as it can be added to your existing levers to turn them into e – brakes. Brake lever with e- brake switch cuts motor power when brakes are applied. The function is required with a throttle and is also useful when using pedal.

III. LITERATURE REVIEW

R.S. JADOUN & SUSHIL KUMAR CHOUDHARY (2016) authors discussed about the crucial components and its experiments of e- bike, alternator and batteries. First, alternator which is an electromechanical device that transforms mechanical energy to electrical energy in the form of alternating current. The brushes of a DC generator carries a small fraction of the current, which carry the generator's whole output. A set of rectifiers is essential to alter AC to DC. To provide direct current with low ripple, authors used a three-phase winding and the pole pieces of the rotor are shaped to produce a waveform similar to a square wave as an alternative of a sinusoid. Author used alternator of Yamaha bike which workings are done at high RPM since authors' electric bicycle is restricted to low RPM so they changed the windings of alternator and upsurge e the drive ratio. Hence, it can function at low RPM.

CARMELINA ABAGNALE(2015)The authors have directed an ecological investigation of the considered vehicle, especially contrasting the ebicycle and a thermal moped, as far as ecological effect. This paper spoke to the natural examination of an electrically supported bike under genuine driving circumstances of mimicked speed-time profiles. In think about, trial results of roller test seat estimations completed on a warm moped utilized so as to assemble the apropos emissive information amid genuine driving circumstances. The ecological appraisal was performed considering an examination with the emissive execution of this moped by utilizing kinematic parameters that assign the reenacted driving elements; an unmistakable advantage of e-bicycle likened to thermal mopeds was appeared and figured as far as emanations spared of CO, HC and NOX, which was a general report finding of this paper.

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JENNIFER DILL, GEOFERRYROSE (2012)This paper clarified that Electric bicycles are progressively regular in China however are moderately uncommon in the United States. The meetings uncovered a few conceivable statistic markets for e bicycles that would extend the bicycling populace; ladies, more established grown ups and individuals with physical impediments. Proprietars of e bicycles noticed their capacity to travel longer separations and over slopes without any difficulty and to touch base at a goal, for example ,work ,less damp with sweat and less drained than a customary bike would permit. These highlights may beat a portion of the regular hindrances to bicycling for all socioeconomics. The vast majority of the talked with e bicycle proprietors utilized their e bicycle to substitute for movement by either human fuelled bikes or customary engine vehicle. Thusly , the e bicycle can address worries about medical issues identified with inertias, contamination, and other open strategy issues to which private vehicles contribute. Further research is expected to decide if explicit approaches are expected to expand reception of e bicycles. The potential of strife between riders of e bicycles and of standard bicycles due to speed differentials is a worry. Regardless of whether speed differentials will represent a noteworthy issue will depend not just on degree of selection of e bicycles however the qualities of riders.

IV. ELECTRICITY GENERATION FROM PEDALING

The magnetic flux generated by a permanent magnet is used by a permanent magnet alternator (also called PMA, dynamo or magneto) to convert mechanical energy into electrical power. It generates alternating current which charges the battery. In this article the focus is on the typical structure of a permanent magnet structure and also a brief introduction to its working principle. A modern alternator consists of both the moving and stationary coils of wire. In the alternator, the rotor uses the current supplied through slip rings to generate a moving field also called flux. Power is extracted from the stationary field coils. The stator use the combination of six coils of copper wire cast in fiberglass resin. The stator is mounted onto the spine and does not move. The moving parts are the magnetic rotors mounted on the shaft. There are two rotors: the rear one behind the stator and the front one on the outside, which are connected by the long studs passing through a hole in the stator. The blades are mounted on the same studs. The blades will drive the magnet rotors to rotate and move through the coils. During this process electric energy is produced.

V. CALCULATIONS

A. Problem Statement

Diameter of wheel (D) = 622 mm
Speed (V) = 19.5 km/hr
Weight of Bicycle = 22 kg
Weight of Rider = 70 kg

B. Power Calculations

Normal reaction (N) on each tyre
= W/2 = 92/2 = 46 kg
= 46*9.81= 451.26 N
Friction Force (F) acting on each tyre:
For Static Friction, u = 0.03
F = u*N = 0.03*451.26 = 13.54 N
For Dynamic Friction, u = 0.004
F = u*N = 0.004*451.26 = 1.805 N
For Static Friction, T = F*R = 13.54*0.311 = 4.21 Nm
For Dynamic Friction, T = F*R = 1.805*0.311= 0.561 Nm

C. Speed Calculations

w = V/R = 19500/(0.311*3600) = 17.42 rad/sec

D. Power Requirement

On Plain ground,
For Dynamic Friction, P = T*w = 9.77 W
For Static Friction, P = T*w = 73.34 W
Overall power requirement = 73.34*2 = 146.68 W

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On Inclined Surface, a= 2'
Considering Static Friction,
total force required to move vehicle
F = u*mg*cos(a) + mg sin(a)F = 58.56 N
Therefore Power Required = F*V = 317.2 W
Extra Power Required = 317.2 – 146.68 = 170.52 W
Considering Dynamic Friction,
F = 0.004*92*9.81*cos(2) + 92*9.81*sin(2)= 35.105 N
Power = F*V = 190.15 W

E. Battery Selection

Since motor selected is of 48V hence battery voltage rating should also be 48V. Therefore we select four batteries of 12V and 7 Ah in series combination of it we get 48V and 7 Ah.

F. Charging Time

Time required to charge the battery by adapter 12V 12Ah P
=12*12 = 144 W T = (48*12)/144 = 4 hrs.
7. Expected results using pedal arrangement
Voltage rating for motor = 36-48 V
Rated speed = 404 rpm
Current rating = 28 Amps
Power rating = 350 W
Lead acid battery = 12 V
For one complete revolution of pedal, wheel completes 2.5 revolutions
1 min = 150 rev
It means, if we pedal for 5 mins i.e. 750 rpm of wheel
we get voltage of 6 - 7 V
It means that we required to pedal for 50 – 60 min to fully charge the batteries.

Fig.2 : Fabricated E-bicycle

VI. CONCLUSION

With this work it was possible to conclude that bicycles, and even more, electrically assisted bicycles, not only have played an important role as a mean of transportation but its importance tends to keep on growing, as they are continuously improving. With the technology advances and breakthroughs, electrical bicycles are a concept that is meant to grow increasingly more and tend to extend its range of applications. With this work we were also able to conclude that despite the technology surrounding the concept had seen great developments, the concept is still severely limited by it. This refers mostly to the batteries, as they constitute a crucial component, limiting the bicycle range and extending its weight. In a close future, and with the advance of technology, this major drawbacks are expected to be over comed, as batteries are in continuous update. New and more efficient motors are also starting to appear, as well as retroactive systems which allow to recharge the battery while the bicycle is being ridden.

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VII. ACKNOWLEDGEMENT

It apart from the efforts of ours, the success of any project depends largely on the encouragement and guidelines of many others. We would like to show our appreciation to the respected Prof. R. G. Telrandhe (HOD ME) for their support, we would also like to hank Prof. S. N. Aloni (Project Guide)for giving us this opportunity for making project based on next generation of E-vehicles. Without their assistance and dedicated involvement in every process, this project has never been accomplished. Lastly we are thankful to all those person, who have contributed directly or indirectly in the completion of this project.

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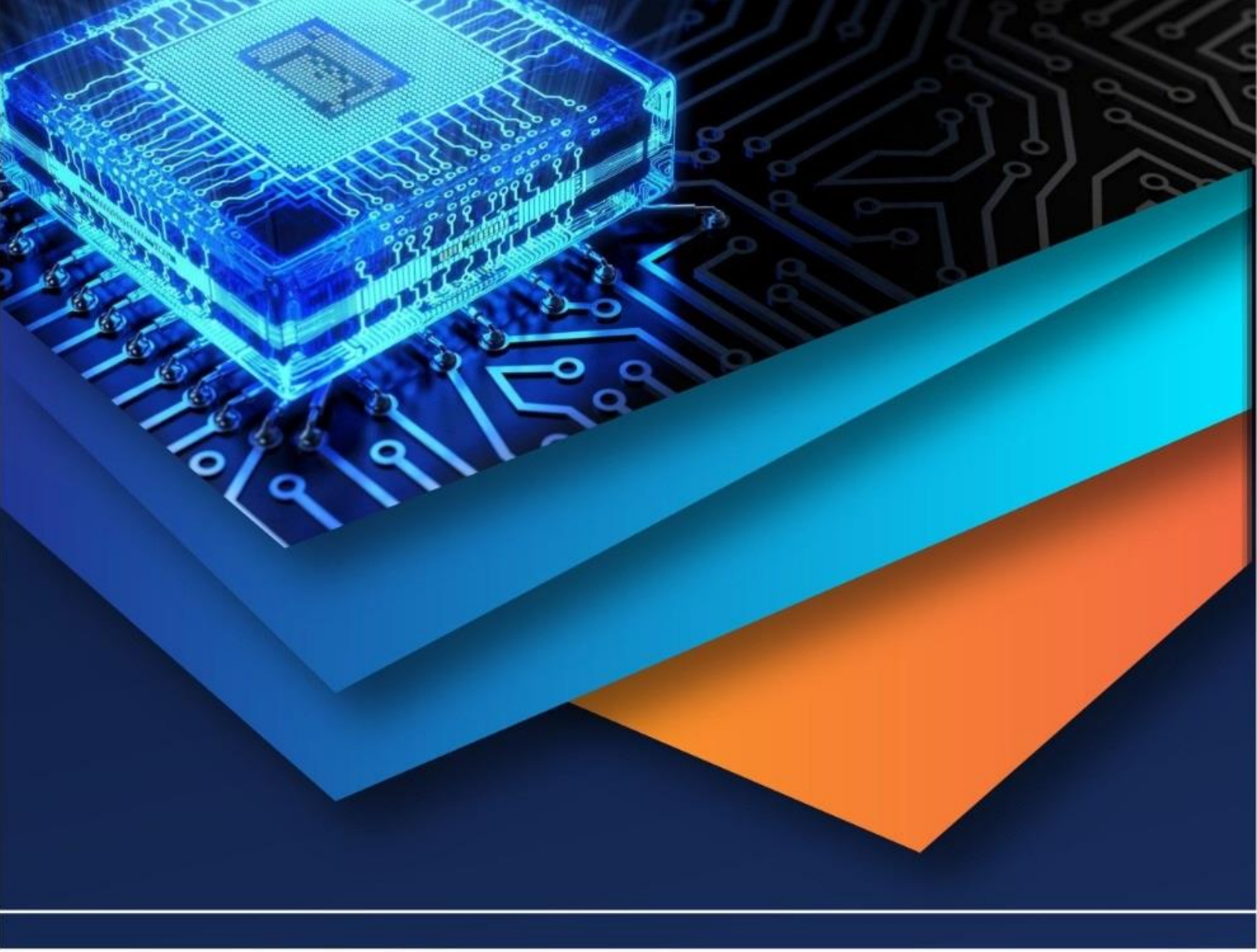

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