Design, Analysis and Fabrication of Green Technology Two Wheeler

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***Abstract*- The team's primary objective is to design a safe and functional vehicle based on rigid and torsion free frame, well Mounted power train to understand the finer aspects of vehicle design, while strictly adhering to the competition role. E-bikes are the electric motor-powered versions of motorized bicycles, which have been in use since the late 19th century. Some bicycle-sharing systems use them. Our objective is to design various parts of E-bike and make analysis on them under design restrictions of fabrication and finally assembled all the parts together using software. This will help us to approach real world engineering problems in the field of Automobiles. As students working towards to improve our skills and knowledge to meet Industrial requirements.**

Index Terms- Electric bike, Solid works, Lithium Ion, BLDC, Fiber glass.

I. INTRODUCTION

The early history of electric motorcycles is somewhat unclear. On 19 September 1895, a patent application for an "electrical bicycle" was filed by Ogden Bolton Jr. of Canton Ohio. On 8 November of the same year, another patent application for an "electric bicycle" was filed by Hosea W. Libbey of Boston. At the Stanley Cycle Show in 1896 in

London, England, bicycle manufacturer. Humber exhibited an electric tandem bicycle. Powered by a bank of storage batteries, the motor was placed in front of the rear wheel. Speed control was by a resistance placed across the handlebars. This electric bicycle was mainly intended for racetrack use. The October 1911 issue of Popular Mechanics mentioned the introduction of an electric motorcycle. It claimed to be having a range of 75 miles (121 km) to 100 miles (160 km) per charge. The motorcycle had a three-speed controller, with speeds of 4 miles (6.4 km), 15 miles (24 km) and 35 miles (56 km) per hour. In 1919, Ransomes, Sims & Jefferies made a prototype electric motorcycle in which the batteries were fitted under the seat of the side bike. Even though the vehicle was registered for road use, it never went past the trial stag.

Electric motorcycles are plug-in electric vehicles with two or three wheels powered by electricity. The electricity is stored on board in a rechargeable battery, which drives one or more electric motors. Electric bikes are an ecofriendly way of transportation. As there is ever growing population and pollution, it is important to control it, hence it is very necessary to GO GREEN using Zero emissive vehicle. Our main objective is to design a vehicle which is ecofriendly (non emission of pollutants) and economic as well. The weight of an electric bike is very less when compared to a commercial bike, plus the amount of toxins released into the atmosphere is completely avoided. The initial cost and the maintenance is also very less. The speed of the vehicle depends upon the type of the motor used as well as the amount and the capacity of the battery used. In January 2013, the Indian government announced a plan to provide subsidies for hybrid and electric vehicles. The plan will have subsidies up to 150000 for bikes and 50000 on two wheelers. India aims to have seven million electric vehicles on the road by 2020

Zhikun Wang[01] discussed about the application of CAD technology to establish three-dimension geometric model, using the kinetic analysis on the frame and other parts for numerical simulation and static strength analysis for the vehicle model design, virtual assembly, complete frame dynamics analysis and vibration analysis, with considering other factors, first on the frame structure improvement, second on security of design calculation analysis and comparison, finally get the ideal body design.

Simachalam bade[02] Structural analysis is carried out to support the product development team in validating the designs and improving the existing designs. Approach using beam finite models is developed to quickly analyze the structure. Detailed analysis using shell elements is done to accurately predict the stresses. FEA results are validated with component level testing and strain gauge measurement. The frame is strengthened in the improved design at the critical locations. Vibrational characteristics are studied by carrying out the modal analysis with specific emphasis on handle bar modes and battery box modes.

Muhsin Abdur-Rahman[03] describes the process of planning, designing, and testing a hybrid electric bicycle. It provides a lot of detail into the challenges of modifying an existing mechanical system to one that is based on both human propulsion as well as a set of electro-mechanical interfaces that provide assists. Through designing an electro-mechanical system, with various nonhuman inputs and feedback channels, a major challenge was centralizing the control of the system. After establishing criteria for speed, control, efficiency, and weight, we began a process of selecting parts and developing models for how the overall system including the rider could be integrated in a way that is both safe, and easy to use.

WiebeEngelmoer[04] investigates whether the Ebike might be suitable for mitigating accessibility problems and reducing the environmental impact of commuter traffic. Secondly, this thesis might provide valuable information for policy makers, when they want to continue their efforts to promote the use of E-bikes in daily commute traffic. Lau Jaromir Konecnyet[05] E-bike testing station, which is capable to provide complete quality check and replace testing drive. The station is assembled in assembly line and it is used for quality check. One test takes approximately two or three minutes and it replaces test drives, which are subjective. The E-bike testing station is also able to provide sophisticate measurements. In addition, the E-bike testing station includes measurement module, which is able to measure three-phase power. The module sample frequency is 100 khz. Moreover includes display test, battery test and any other test. E-bike testing stand provides complex measuring and testing station for quality check and research and development.

DESIGN METHDOLOGY

- Study of rule book
- Design calculations
- Preliminary cad modeling
- Material selection and survey
- Analasys final cad model

E-BIKEDESIGN

We completed our E-Bike design by considering all possible alternatives for the System and modeling them in Solid works software, analyzed the strength and properties of bodies using solid works simulation software. Based on analysis result, the model was modified and re- tested and a final design was frozen. The design process of the vehicle is iterative and is based on various engineering and reverse engineering processes depending upon the availability, cost and other such factors.

VEHICLE DIMENSIONS

Width = 698mm ;Height = 963mm;Length =1963mm ;Wheel base =1430mm ;Ground clearance =250mm

CHASSIS DESIGN

So the design process focuses on the following objectives:-

- Safety
- Strength
- Standardization
- Serviceability
- Cost
- Driving comfort
- Ergonomics

The design objectives set out to be achieve three simple goals applied to every component of the E-Bike. They are Durability, light-weight and high performance which optimizes the design by avoiding over designing which would also help in reducing the cost. With this we had a view of our bike. This started our goal and we set up some parameters for our work.

SELECTION OF CHASSIS MATERIAL

In this project our aim is to build an E-BIKE efficiently, full strength, more power, and main

importantly within in 1 lakh budget. AISI 1020 material is less cost comparative to AISI 1018 and AISI 4130 and AISI 1020 has good weld ability nature, good machine ability. With comparative to AISI 1018 both chemical properties, physical properties and mechanical properties are almost same, but we are having AISI 1020 at Rs 330, whereas AISI 1018 at more than Rs 400 and AISI 4130 is having more strength than AISI 1020, but its cost is very much higher than other two materials, which will hike our budget without any doubt. So considering all these mechanical, physical, chemical properties and mainly price of the material we opted AISI 1020 will be the best pipe to design chassis for our E-BIKE.

FEATURE	BRUSHLESS	BRUSHED
Mechanical structure	Field magnets on stator and rotor are made of permanent magnets	Field magnets on the rotor and stator are made of permanent magnets or electromagnets
Maintenance	Low or no maintenance	Periodic maintenance because of brushes
Speed-Torque characteristics	Flat-operation at all speeds with rated load	Moderate-loss in torque at higher speed because of brushes
Torque to Size ratio	High	Low
Efficiency	High- no losses in brushes	Moderate-losses in brushes
Commutation Method	Electronical: Hall Sensors	Mechanical contact b/w brushes and commutator
Speed Range	High	Moderate
Electrical Noise	Low	High-because of brushes
Detecting Method of Rotor's position	Hall sensor, optical encoders etc.	Automatically detected by brushes and commutator
Direction Reversal	Reversing the commutation sequence	Reversing the terminal voltage
Control Requirements	A controller always required to control the commutation sequence	No controller is required for a fixed speed; controller required for variable speed
System Cost	High-because of external controller requirement	Low (only if controller is not required)

HALL SENSORS

BLDC motors use electronic instead of mechanical commutation to control the power distribution to the motor. So, it is essential to maintain the commutation sequence i.e. the frequency at which the phases are energized should be the same as that of the frequency of rotation of rotor and the phases being energized should produce maximum torque. Latching Hall-effect sensors, mounted in the motor, are used to measure the motor's position, which is communicated to the electronic controller to spin the motor at the right time and right orientation. These magnetic sensors determine when the current should be applied to the motor coils to make the magnets rotate at the right orientation. Within a BLDC MOTOR, this is called "feedback" and it is implemented by using multiple feedback sensors.

WORKING

In the BLDC motor used in our vehicle we are using Hall sensor. It works on the principle of "hall effect". Current is fed to the sensors mounted on a PCB inside the motor through the battery. Whenever rotor magnetic poles (N or S) pass near the hall sensor, they generate a HIGH or LOW level signal, which can be used to determine the position of the shaft, responding to South (operate) and North (release) poles.

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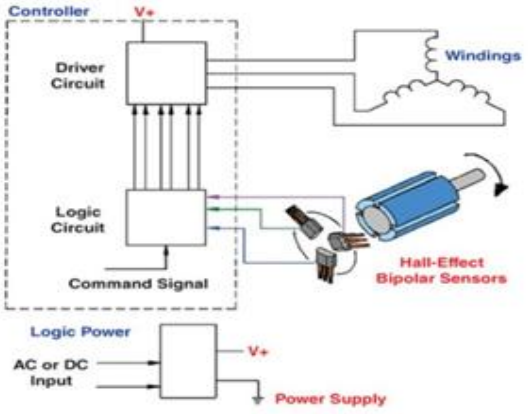

SELECTION OF BATTERY

Batteries are the components that store electrical energy, allowing for the motor of the vehicle in question to run. There are two types of battery: non-

rechargeable batteries known as primary cells and rechargeable batteries known as secondary cells. Both types of cells operate the same way through an electrochemical reaction involving an anode, cathode, and electrolyte to produce electrical current. With primary cells this reaction eventually runs to completion by exhausting all electrical potential within the closed system.

LEAD ACID BATTERY It is most economical for larger power applications where weight is of little concern. It consists of two lead plates a positive plate covered with a paste of lead dioxide and a negative made of sponge lead, with an insulating material (separator) in between. The plates are enclosed in a plastic. Battery case and then submersed in an electrolyte consisting of water and sulphuric acid.

Li ION BATTERY

It is the fastest growing battery system. Li-ion is used where high-energy density and lightweight is of prime importance. The technology is fragile and a protection circuit is required to assure safety. The electrodes of a lithium-ion battery are made of lightweight lithium and carbon. This translates into a very high energy density for lithium-ion batteries .Here is a way to get a perspective on the energy density. After considering the above options in the selections of battery we have decided to use Lead Acid battery.

SELECTION OF MOTOR DRIVER

The motor driver is the main logic and control unit for the motor. It is the device which interfaces practical input from the driver side like throttle and brake pedal pressure to the motor. Controls the stator voltage and frequency and hence the output torque of the machine.

Electrical Connections

Connection of E-bike

1. Lithium Ion Battery: Lithium ion battery is a rechargeable battery in which lithium ions move from the negative electrode to the positive electrode during discharge and vice versa when charging. Thus we can obtain the DC supply.
2. Junction Box: Junction box is a essential piece of kit as they protect and insulate the electrical connections. The supply from the battery is connected to control unit through Junction box and output from the BLDC motor.
3. B.L.D.C Motor: Brushless DC motor is hybrid motor which acts as the major driver of the vehicle.
4. Controller: The controller is connected in between the battery and the motor. It takes the supply from the LI-ION battery. It takes the reference value from the throttle and comparator compare the reference value and output value from the motor. It gives the resultant to the PI controller and the controlled output is measured by voltage measurement and then passes to inverter which converts DC to AC. It gives as input to the motor.
5. Throttle: The throttle controls the speed of the vehicle by controlling the voltage. The throttle is connected to the controller. The power controller, which regulates the flow of energy between the battery in the electric motor, controlled by an electronic throttle
6. Chain Sprockets: These are used to transmit the power from motor to rear wheel. The gear ratio is 1:3.

Features:

1. Extended fault detection and protection. The LED flashing pattern indicates the fault Sources.
2. Monitoring battery voltage. It will stop driving if the battery voltage is too high and it will progressively cut back motor drive power as battery voltage drops until it cuts out
3. Altogether at the present “Low Battery Voltage” setting.
4. Built-in current loop and over current protection.
5. Configurable motor temperature protection range.
6. Current cutback at low temperature and high temperature to protect battery and controller.

Tests Conducted on Ebike

The following tests that are conducted on the designed bike

- Design Inspection
- Rain Water test
- Brake test
- Auto Cross
- Terrain Test
- Endurance Test

Design Inspection:

It is to ensure that the manufacturing process is producing components that meet the specification requirements. Inspection does not assure the quality of the product, only a robust and repeatable manufacturing process can achieve this. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets, often with a standard inspection produce in place to ensure consistent checking.

S.No	Parameter	Maximum Dimension
01	Length	2160 mm
02	Height	1200 mm
03	Weight	150kg
04	Wheel base	1530 mm
05	Width	900 mm
06	Ground clearance	152 mm
07	Battery	48v 80AH
08	Motor	2KWhr, 3000RPM

Rain Water Test:

Rain water test is nothing but the bike is get wet by the water so that the circuit should not get damaged by the water. Entire bike is sprinkled by the water so that each and every part of the bike gets wet.

Brake test:

Brake test is generally to check about the efficiency of the brakes of the bike. At certain point the bike will start and gradually attains its maximum speed. On the mark the brakes are applied so that the bike should stop immediately within the range.

Auto Cross:

Autocross courses are typically one or two kilometers long and tend to place demands on bike handling and driver skill rather than on engine power and outright speed. Courses may be temporary and marked by traffic cones or be permanent tracks with approval by a motor sport body.

Terrain Test:

This test is to check how the bike will run on different types of roads. Different types of roads arranged on the ground and the bike should run on them.

Endurance Test:

This test is usually known to everyone. The arena is arranged and the bike should run continuously for 90 min. The bike should complete more number of laps within the time.

TEST RESULTS

DESIGN INSPECTION:

S. No	Parameter	Dimension
01	Length	1963 mm
02	Height	963 mm
03	Weight	72.5kg
04	Wheel base	1430 mm
05	Width	698 mm
06	Ground clearance	250 mm
07	Battery	48v ,40AH
08	Motor	1kw,1000 rpm ,48v

The designed bike has qualified the design inspection test by attaining the above specifications

RAIN WATER TEST:

The designed bike has qualified in this test by successfully working after getting wet by the water.

ACCELERATION & BRAKE TEST:
The designed bike is qualified by Stopping at 250cm apart from the point the brakes applied.

AUTO CROSS:
The designed bike is qualified in this test by successfully running throughout the arena without any jerks anywhere.

TERRAIN TEST:
The designed bike is qualified in this test by successfully running on different types of roads in 12.21 seconds.

ENDURANCE TEST:
The bike has successfully qualified this test by doing 52 laps in 90mins in an arena of2kms.

CONCLUSION

There has never been a more exciting time than now to become an electric bike owner. Having established itself as a hugely popular, effective, and important mode of transportation in countries around the world—most notably China and several nations throughout Europe–the electric bike is beginning to take off in the United States as well.
The primary appeal of an electric bike is its unique ability to combine pedal power with motor power, giving riders an unprecedented level of control over their riding experiences. By allowing riders to choose precisely how much power the motor will provide, ebikes have quickly become some of the most flexible and accessible vehicles in the world.
Whether it's used to go on recreational rides with family or friends, as a way to get back into shape, or as a vehicle for completing your daily commutes, an electric bike is the key to easy, comfortable, and convenient travel.

FUTURE SCOPE

In future the following features can be added to the designed bike in order to get additional benefits

Fingerprint Sensor
Fingerprint is one of the very important and reliable human identification method. For every person fingerprint is unique. So this helps us to improve the security system for our vehicle. We use a fingerprint module to read the identity to start the 'E-Bike Vehicle'. By using a microcontroller the security system of our bike is controlled. The GSM and GPS

module is also added with our system and make our system safer.

BATTERY LEVEL INDICATOR

The innovation done in the Energy Transmission department is related to the battery indicator. In the Battery Indicator device, we will indicate the level of battery i.e., how much voltage capacity does the battery have at that instant time as well as does the battery is in charging mode or in discharging mode. The battery indicator will be design with the help of voltmeter as well as galvanometer. The voltmeter will help us in indicating the present level of battery. As a voltmeter indicates the voltage present in the circuit as well as in the battery which will be connected across the voltmeter. Same way, the voltmeter will check the voltage status of the two batteries connected in the series in the vehicle. The scale of the voltmeter is changed from the numerical values to the indication levels of High, Medium and Low.

Anti-Theft Protection using GPS Module

It will provide information about latitude and longitude location of bike. It directly connect to Arduino board if the finger prints matches then it will also start work using this driver come to know location of bike . We can display this info on 16x2 LCD display

Smart Helmet using GSM Module

Everyday around the world a large percentage of people die from road accident. An effective approach is made to solve the problem by using smart helmet band. Smart helmet band is an idea which make motorcycle driving safer than before. The working of this smart helmet band is very simple, Limit switch is placed inside the helmet, which will detect whether the rider has worn the helmet or not, if not then the bike will not start. Smart helmet band provides help in case of accident by using GSM and GPS technology.

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