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DEVELOPMENT OF SMART ELECTRIC BICYCLE

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A B S T R A C T

The goal of this study is to turn an old bicycle into an electric one with the possibility to increase mileage. Electric bicycles are a new sustainable means of transportation for smart cities in the future. The rising demand for fuel and its high cost as a result of the growing number of automobiles on the road are currently one of the biggest issues our nation is dealing with. In many Asian nations, especially those with dense populations like India, where the majority of people commute on two wheels, air pollution is a big concern. For short distance commuting, using an electric bicycle will contribute to some pollution reduction. As part of this project, we created an electric bicycle. A 36V, 250W brushless direct current (BLDC) hub motor and lithium ion (Li-ion) battery power this electric bicycle. The sealed maintenance-free (SMF) battery is replaced with the Li-ion battery. Compared to SMF batteries, Li-ion batteries have additional benefits.

This electric bicycle is less expensive, easier to build, and suitable for many short-distance users, including college students, office workers, villages, postmen, etc. It is ideal for both young and old persons. This bicycle saves money because it doesn't use expensive fossil fuels. Due to its lack of emissions, it is inexpensive, environmentally friendly, and pollution-free.

Keywords: Hub Motor, Controller, Li-ion Battery, Head light, Anti-theft alarm, Speedometer, DC-DC controller, mileage improvement.

1. INTRODUCTION

A standard bicycle is the basis for an electric bicycle, a form of electric vehicle to which an electric motor has been fitted to assist with propulsion. It is an ecological and urban means of transport and its source of energy is a battery. In the 20th century, electric bicycles began to play a more important role because they were an economic and simple option for urban transport problems and had environmental advantages. Esther et.al.(2018).American innovators have made an effort to integrate bicycles' standard mechanics with electric motors. Up to the technical advances of the 20th and 21st centuries, this concept was starting to materialize. A method to profit from the advantages of today's electric bikes and meet physical demands and fitness goals is made possible by light motors, rechargeable batteries with high capacity, smoothly running drive trains, and bicycle parts .Giri et.al.(2020) A battery, specifically a Li-Ion battery, serves as the bicycle's energy source. It is an environmentally friendly and urban mode of transportation. According to the present state of affairs, electric bicycles have started to take on a bigger role since they are an affordable, straightforward solution to the problem of urban mobility

and have positive environmental effects. Volume 8 issue 6(2021)

Li-ion batteries are great source of power. Their energy density is high compared to many other batteries. Li-ion batteries requires low maintenance. They have good battery life. They have self-discharge rate of 1.5-2% per month.Maliya et.al. (2021).BLDC motors are widely used in industries due to its advantages. The application of BLDC motors is increasing due to consumers demand for lower energy costs, better performance and reduced noise. Joseph et.al. (2020).Electrical assisted bicycles represent an emerging sustainable mode of transport for future smart cities. Several designs issues impact policy in several countries such as the UK, Europe and the USA. As e- bike usage continues to grow, so too will the need for further research, in order to provide the necessary data to inform industrialists what cycling features matters for a wider, diverse and sustainable adoption of this mode of transport.Stilo et.al.(2021)

In India, electric bicycles are quickly rising in popularity. A less expensive option for bike transportation may be an electric bicycle. The bicycle culture has declined as a result of rising traffic, travel distances between the workplace and home, and stress. Cycling is a sustainable and healthful option. An electronic bicycle has several benefits, primarily financial and environmental. One of the financial benefits is that the overall cost per kilometer is lower. Electric bicycle with an electric drivetrain. Electricity serves as the sole energy source for everything. The key benefit is the electric motor's proposal system's great efficiency in power conversion

Pollution reduction is a challenge for the automotive sector. Due to the rapidly depleting resources of petrol, diesel and natural gas. The energy crisis is one of the biggest issues facing the globe today.Matey et.al. (2017) Thus, the project's goal is to bring back bicycles with new, more convenient features at a lower price. The use of electric bicycles will lower the usage of oil (petrol and diesel).

Due to lack of understanding, the majority of people do not utilize electric bicycles despite their high demand due to urban air pollution and fuel scarcity. Different types of electric bicycles are currently on the market, but many people choose electric bikes instead because they offer more features than "electric bicycles" do. Additionally, existing electric bicycles lack speedometers and GPS trackers, increasing the likelihood that they will be stolen. There are less obstacles for e-bikes. Electric bicycles are lighter than e-bikes, allowing for the use of less potent and less expensive batteries. Additionally, electric bicycles are less expensive than bikes powered by petrol and can be charged more quickly and conveniently, frequently using existing plug points in houses.

2. LITERATURE REVIEW

Matey et.al. (2017) this study includes the Electric bike and others because it is necessary to identify new way of transport. Electric bike is a modification of the existing cycle by using electric energy and also solar energy if solar panels are provided, that would sum up to increase in energy production. Since it is energy efficient, electric bike is cheaper and affordable to anyone. It can be used for shorter distances by people of any age. It can be contrived throughout the year. The most vital feature of the electric bike is that it does not consume fossil fuels thereby saving crores of foreign currencies.

Lorenzo Stilo, Diana Segura-Velandia, et.al his paper presents the results of an online survey to gather information about preferred e- Bike features for next generation, user centric, intelligent e- Bike designs. Although a large number of responders (N = 638) participated, it is difficult to determine the fraction of the total e- Bike stakeholders in the UK that was reached. Nevertheless, whilst the results presented in this paper are not based upon a random sample of e- Bike owners and may not be necessarily representative of the e- Bike potential buyer population, respondents provided information on general intelligent e- Bike requirements which can be used for the development of new designs.

Mr. Ankit Giri, Mr. Darshan Gaikar, et.al. This work started with study of technology, the use of component and future of battery power electric car. On the basis of application used in accelerometer sensor ADXL345, relay, motor, motor controller as were dynamo were selected. From the result we can conclude that vehicle travels for long time. Alternator produces 12 to 14v, which uses rotational from wheel under fast motion. The result of fast motion is the charging of batteries.

Ram Bansal, Avinash Sharma.et.al. This project works effectively, we had a minor problem with the motor it kept getting heated when working. The problem was due to the extra load on the motor because we were starting the motor while the bicycle is not moving. One of the major challenges that we faced was the battery until finally, we solved that problem as mentioned before.

Esther Salmeron-Manzano et.al. It can be demonstrate that there are these main trends: countries with a large number of inhabitants are interested in electric bicycles because they are a sustainable form of mobility due to their long tradition as a means of transport, and countries with high environmental awareness. The most important part of this study has focused on finding out what scientific trends are observable in the research and how electric bicycle research is grouped. This has been obtained through the analysis of keywords. Thus, when they are analysed together one can see that the electrical subject is the one that dominates, using keywords such as electric, motor or batteries.

Ritvik Maliya et.al. There are present study some safety issues with li-ion batteries. These batteries are very expensive. They have overheat problems and can be damaged at high voltages. To overcome these problems we can give a limit to its voltage and use some safety mechanism in it but this can also reduce the performance of the battery. Li-ion batteries have some limitations which can be overcome by advancement in future technology.

JIlin Chen, Xuanyao Huang.et.al. In this article, LIB is discussed from multiple perspectives, from history to application, and its future and to economics and environmental impacts. It gives a general overview of the current development and research of LIB. Although the laser welding process in China is becoming more and more mature, the high quality power LIB still needs the close cooperation of manufacturer designers and laser welding technicians to optimize the design from the aspects of material, shape, thickness, process and real-time testing, so as to achieve the ideal weldingeffect.

George Joseph, Vishnu R.Kammath.et.al. The cost related issues of any type of E-Vehicle depends on the overall expenses on battery bank. The advantages of BLDC motors over conventional motors are valued. The concept of Hall Effect sensors and its use in BLDC motors are interesting Conventional BLDC motors are coupled with windings outside and permanent magnets tend to rotate in the electromagnetic field. It is the main feature of this hub motor that the permanent magnets are coupled on the rotor and windings are in stator.

3. METHODOLOGY

The primary goal of the project is to create an electric bicycle that is less expensive than those currently on the market. To this end, the cycle is constructed as simply as possible. In order to protect the battery, controller, and other wiring from mechanical damage, a metal box is first constructed inside the frame of the old cycle. This will increase the safety of the cycle and lengthen the lifespan of the electric and electronic components used to make the electric bicycle.

The lithium ion battery that powers the electric bicycle is its primary power source. It is constructed from a number of lithium ion cells that are connected in series and parallel to produce the desired voltage and current levels, which are used to power the cycle's controller, motor, light, horn, and other components.

Components

1. Electric hub motor
2. Li-ion Battery
3. BMS (battery management system)
4. Charger
5. Controller
6. PAS (paddle assist sensor)
7. Throttle, Battery Indicator and Lock.

4. ELECTRIC MOTOR DRIVE CIRCUIT DIAGRAM

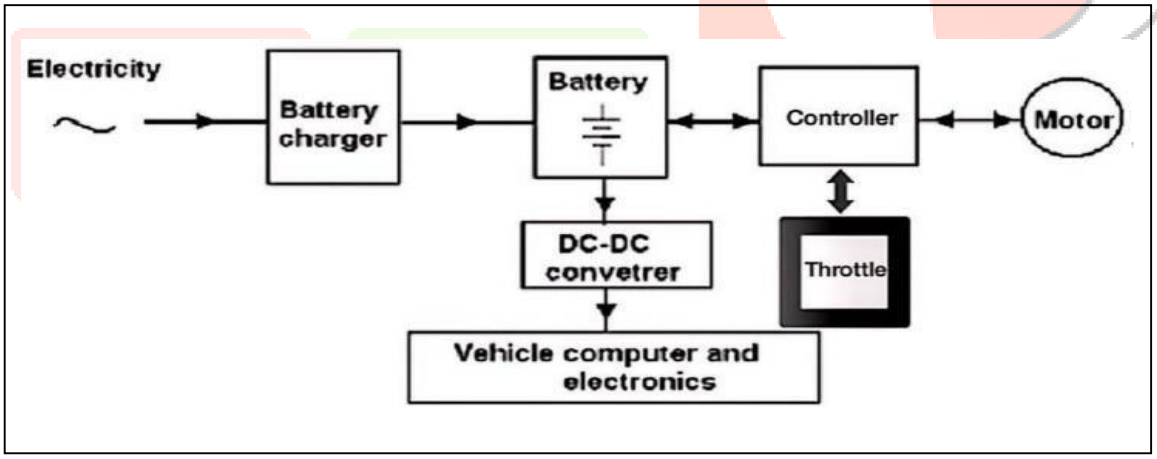

Fig.1 Design Electric Component

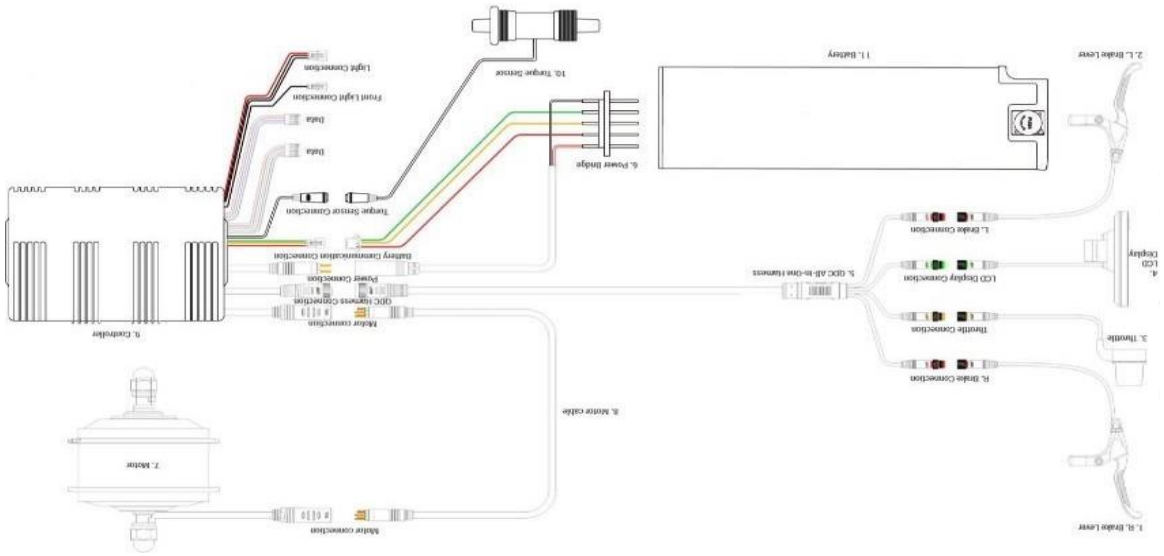

Fig.2 Overall wiring Diagram

4.1 Battery Charger

In order to utilize the battery to its maximum capacity the battery plays a crucial role. The remarkable feature of a battery charger are efficiency and reliability, Weight and cost, charging time and power density. The main characteristics of the charger depend on the components, switching strategies, control algorithm. These control algorithm can be implanted digitally using microcontroller.
A rechargeable battery is given energy by a device called a battery charger that pushes an electric current through it. This charger connects to a controller's charger socket and draws electricity from the main supply to provide the battery with current.Bansal.et.al. (2020)

Fig.3 Battery Charger

4.2 Battery

Batteries are the components that store electrical energy. The best battery for an electric bicycle is a lithium ion battery since it delivers a high energy density while still being relatively light and small in size. Lithium batteries are primary batteries that have metallic lithium as an anode. These types of batteries are also referred to as lithium-metal batteries. They stand apart from other batteries in their high charge density (long life) and high cost per unit.Karthi et.al. (2020)

Fig.4: Li-Ion Battery

4.3 Controller

We are utilising a sin wave controller in this project. The electric bike speed controller sends signals to the bike's motor in many voltages. The mechanism of an electric speed controller differs depending on whether you own an adaptive or purpose build electric bike. An adaptive bike includes an electric drive system installed on a normal bicycle. A purpose built bike, more expensive than an adaptive bike, provides easier acceleration and affords extra features.Kumar.et.al.(2018) The usage of a motor controller was put into practise to drive and control the BLDC motor. Differing types of controllers area unit used for brushed and brushless motors. For adaptive e-bikes, a conversion kit is employed and therefore the controller is that the main part of that kit. The electrical bike speed controller sends signals to the bike's motor in varied voltages. Bansal.et.al. (2020)

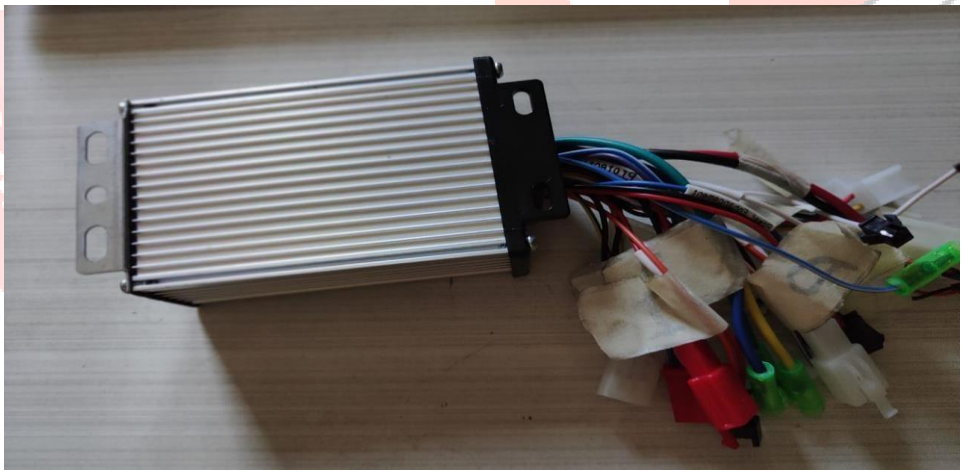

Fig.5: Controller

4.4 Motor

A brushless dc (BLDC) motor is a synchronous electric motor that uses an electronically controlled commutation system rather than a mechanical commutation system based on brushes. It is driven by direct current energy (DC). In such motors, the relationships between current, torque, and voltage are linear. In a BLDC motor, the permanent magnets rotate in place of the electromagnets, which stay stationary. This circumvents the issue of how to supply current to a moving armature. BLDC motors are widely used in industries due to its advantages. The application of BLDC motors is increasing due to consumers demand for lower energy costs, better performance and reduced noise. Also, the use of BLDC motors is restricted in low cost applications comparatively, which paves the way to reduce the cost related issues for E-Vehicle Joseph et.al.(2020). A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common

types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

Fig.6: BLDC Hub Motor

4.5 DC-DC Controller

A DC-to-DC converter is a circuit or electromechanical device that changes the voltage level of a direct current (DC) source. It's a particular kind of electric power converter. Low-voltage batteries have extremely low levels of power, whereas high-voltage power transmission has very high levels of power.

Fig.7: DC-DC Controller

5. BATTERY AND MOTOR SPECIFICATION

Table.1 Motor Specification

CONSTRUCTION	BRUSHLESS GEARLESS HUB MOTOR
RATED VOLTAGE	36V
RATED POWER	250W
CURRENT	7.5-10 A
TORQUE	9.95 Nm
RPM	450 RPM
RATED SPEED	25 kmph
RIM DIAMETER	22 inches
RIM THICKNESS	4 MM
SHAFT LENGTH	270 MM
SHAFT DIAMETER	19 MM
CABLE LENGTH	1.5 METER
APPROX WEIGHT	1.5 KG
MAX CARRYING CAPACITY	120 Kg

Table.2 Battery Specification

Battery	Lithium ion
Current	10 Ah
Voltage	36 V
Wattage	248Wh (watt.hr.)

6. CALCULATION FOR MOTOR AND BATTERY

Hub Motor Calculation Motor Specification
Volt (V) = 36 v
Power (P) = 250w

Power Equation

Power (P) = Current (I) ×Voltage (V)..... 1
Hence, I = P / V
= 250 / 36
= 6.95 Amp.

Speed of Motor in RPM

$N = K \div (d \times 0.001885)$ 2

Where,
N = Speed In RPMK
= Speed In km/h
d = Wheel Diameter in cm

Wheel Diameter (d) is 22 inch (Given)1
inch = 2.54 cm
So, d = 22 inch = 55.88cm

Speed In km/h (K) is 25 km/h (Given)
Hence,
$N = K / (d \times 0.001885)$
$= 25 / (55.88 \times 0.001885)$
$= 240$ RPM

Torque of the motor (T)
$T = (P \times 60) / (2 \times \pi \times N)$ 3
$= (250 \times 60) / (2 \times 3.14 \times 240)$
$= 9.95$ Nm
Torque of the wheel hub motor, **T = 9.95 Nm**

Battery Calculation
Calculation of battery Ah (Ampere hour)

From motor calculation we get,
Wattage = 250 w
Voltage = 36 v
So, to find watt.hr =250w × 1hr
= 250 w.hr

Out of the full battery 80% should in use and 20% should remaining in this case to find the battery watt.hr

= 250w.hr × 1.2
= 300w.hr hence, current in battery isCurrent
(Ah) = 300w.hr / 36v
= 8.33Ah

7. RESULT

This project is designed to improve the normal bicycle and make it extra efficient. The electric bicycleis a hybrid and so it can run electrically run as well as pedal their by still retaining the exercise people drive from riding bicycle. 70% of users migrate to electric bicycles from ordinary bicycles because they offer low cost and affordable private transportation, making them an appealing alternative to walking or driving.

Table.3:

Sr.no	Rider Weight	Speed km/hr.	Range	Range with pedal
1.	60	**25-30**	**35**	**50-55**
2.	**80**	**25-30**	**30-32**	**40-45**
3.	**100**	**25-30**	**20-25**	**35-40**
4.	**120**	**25-30**	**18-22**	**25-30**

8. FUTURE SCOPE

Calorie measurement: The calorie measurements will assist in measuring the number of calories burned and will be displayed to the user's mobile phone mounted and connected to the system of calorie measurement device on the handle. The calorie measurements will be based on the readings of the accelerometer placed on the cycle, gyroscope, and user profile.

Using his fingerprints, which are sent into the system, the rider may lock and unlock his bicycle using biometric (fingerprint lock detecting technology).

In our idea, the charging is the main challenge, but another source can be identified, and the problem will be fixed as soon as feasible. Electric bicycles are fairly environmentally friendly and they may contribute significantly to the advancement of civilization in the future.

9. CONCLUSION

In its early form, the electric-assisted bicycle had limitations that had to be worked around. The restrictions were mostly of an economic character. They describe parts of the design that had to be abandoned from earlier semesters. The battery, motor, and bicycle frame were the components of the equipment that were restricted. The sort of growth on the motor made it impossible to change the motor bicycle association. These inadequate restrictions did not, however, completely impair the team's ability to propose a "new" plan.

The help of this project, we were able to turn a scrap cycle into an E-cycle in good shape with practically all of the features of any cycle on the market. It is economical and adheres to the eco system's three principles. With a decent lithium-ion battery and a peak speed of 30 km/h, the vehicle has a range of 35 km (or even more, depending on driving circumstances).

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