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Design and Development of E-Cargo Bicycle

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Abstract: Electric vehicles are the upcoming future of the transportation system. These vehicles produce very low pollution, are silent, and also have high efficiency and flexibility. This paper outlines the designing of the electric vehicle(EV) which is a Cargo vehicle combined with bicycle and forming an Electric Cargo Bicycle. The main aim of the project is to develop an electric cargo bicycle which should be reliable, sustainable and mostly economical. Along with these in EV we have also installed some advanced features to ensure the security of the vehicle and comfort of the rider/user.

Keywords: Automatic Headlight, Hub motor, Battery, Fingerprint unlock system, Electric Vehicle

I. INTRODUCTION

As looking towards the current situation/scenario Electric Vehicles are in great demand there is a lack of suitable Electric cargo vehicles for carrying heavy duty/load applications. Because of this,it is difficult for the delivery and goods transport via cargo bicycle. We also conducted a market survey to ensure the requirement of the electric vehicles which could be used for carrying heavy load applications. And after conducting the market survey we understood the requirement of the society.

According to the requirements, we designed a prototype of an Electric cargo bicycle. And then actual implementation of the mechanical design was done. This Electric cargo bicycle which will be able to carry the load as well as it is economical so that it should be affordable. The main components required to develop an Electric cargo bicycle are controller, hub motor, lithium ion/lifepo4 battery.

Through this project, heavy-duty E-cargo bicycle can be made more safe and secure via installing smart innovative features such as an accident detection system, fingerprint unlock, theft protection, GPS tracking, automatic smart light at night. This special design still not implemented in India. And this E-cargo bicycle can be used for both applications that are private and commercial transportation. And the problem of the unavailability of electric vehicle for carrying load is overcome by the Electric cargo bicycle which will be able to meet the need of the society.

II. METHODOLOGY:

The basic working of an E-cargo bicycle is based on ideology to when the battery is charged it gives the supply to the motor and it converts the electrical input into mechanical output and as the motor is connected with back wheel of the bicycle the mechanical power is given/transferred to the wheel and it starts to rotate from this we can say that the working of this E-cargo bicycle is based on the speed, torque, power and resistance offered while the wheel is rotating.

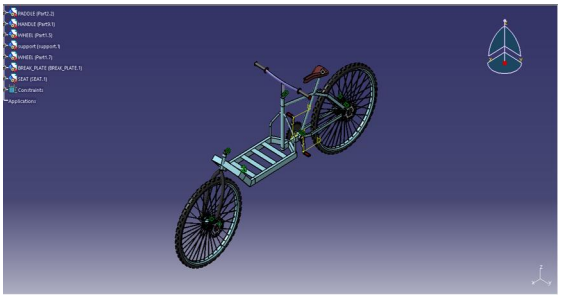

Fig .1.Prototype model of E-cargo Bicycle

The figure shows the prototype model of an Electric cargo bicycle. This prototype is developed on the catia software, with help of this prototype model we can be able to determine the mechanical construction of the Electric cargo bicycle. After completing the mechanical design, we have installed the motor and battery to make it an Electric cargo bicycle.

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MOTOR:

Fig.2.Hub motor

While looking towards the basic working of the E-cargo bicycle. The motor selected should have the sufficient power and torque so that it will be able to carry the load including the weight of the driver and weight of the bicycle and restrain the forces acting on it. In section 1, calculation done for the selection of the motor is shown.

There are various types of motors used in the Electric vehicles. In this E-cargo bicycle we are using the hub motor/ brushless dc motor. The advantages of using this specific motor is that it is has component inside the motor casing hence it leaves zero need of service. The gearless hub motor directly connect the lower RPM motor stator's axle to the bike. Hub motor offers more flexibility. This motor also cuts the mechanical losses which makes the vehicle run silently.It also weighs less which makes the travel more effective.

BATTERY:

Fig.3.Lithium ion battery

A battery is the one of the most important component of the E-cargo bicycle. A battery is a component which is made of many electrochemical cells which converts the chemical energy into electrical energy while it is getting discharged and electrical energy into chemical energy while it is getting charged. And this charged electrical energy is supplied to electric motor of an E-cargo bicycle. So,the selection of the battery parameters should be done most accurately so that it should be able to give the sufficient most of energy to run the electric motor efficiently. In section2,the calculation of the battery is explained.

There are various types of batteries used in the Electric vehicles .In our E-cargo bicycle we are using Lithium ion. The advantages of using this particular battery is that has better charging and discharging efficiency, longer life span, light weighted which makes it more suitable for Electric vehicles.

III. SMART FEATURES:

1. AUTOMATIC HEADLIGHT:

COMPONENTS REQUIRED: Light Dependent Resistor(LDR), Arduino UNO R305,Headlight, 1 channel Relay module 5A 10V.

An Automatic Headlight is the feature of the E-cargo bicycle which detects the intensity of the light with help of LDR (Light Dependent Resistor) Sensor and controls the turning ON & OFF condition of the headlight. At the day time the headlight remains at OFF condition and at night the headlight gets turned ON.

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2.FINGERPRINT UNLOCK SYSTEM:

COMPONENTS REQUIRED: Arduino UNO R305, Fingerprint module, Liquid crystal display (LCD), 1 channel Relay module 5A 10V.

Security is an important issue these days due to the rising number of vehicle thefts.So we install antitheft fingerprint unlock system is the feature of the E-cargo bicycle which sense the fingerprint with the help of fingerprint sensor using Arduino UNO. After senses the fingerprint supply goes to the motor and E-cargo bicycle start. This sensor only allows to authorized person to start the E-cargo bicycle. The fingerprint sensor check the given fingerprint if its authorized then the E-cargo Bicycle start. After installing the fingerprint we can protect this E-cargo bicycle from getting stolen by theft.

IV. DESIGN CONSIDERATONS:

Motor Calculation :

Gross Vehicle Weight(GVW)

Weight of vehicle =200kg

Weight of driver =100kg

Gross Vehicle Mass (GVM)

GVM=300/9.81=30.58

Radius of tyre = 13inch =0.33m

Circumference of tyre =c= $2\pi r$ =2m

Gear Ratio

Wheel (Rear) no. of teeth : Motor (Rear) no. of teeth

Speed of motor : Speed of wheel

Wheel Speed in RPM

Nw(rpm)=60/$2\pi r$ V(m/s) =60/$2\pi * 0.33 * \mathbf{6.94}$=201rpm

Velocity = 25km/hr= 6.94m/s

$v^2 = u^2 + 2aS$

but u=0

$S = ut + \frac{1}{2}at^2$

Consider s=100m

a =$v^2/2S = (6.94)^2/2*100 = 0.24$ m/s^2

Rolling resistance force =Fr

Fr =cw=GVM*Crr*g =300*0.004*9.81 =11.7 N

Crr =Coefficient of rolling resistance =0.004

Aerodynamic force = Drag force =Fd

$Fd = \frac{1}{2}\Delta v^2 C_D A$

$Fd = \frac{1}{2} * 1.2 * (6.94)^2 * 0.9 * 0.9$

Fd=23.40N

Where,

$$\Delta = Density\ of\ medium = 1.2\frac{kg}{m^2}\ at\ NTP$$

$$C_D = Drag\ Coefficient = 0.9$$

V=speed of bicycle

A= Cross sectional area

A=Width *Height =0.6*1.5=0.9m^2

Acceleration force= GVM*acceleration =300*0.24 =

=72N

Total forces

Ft =Froll +Fgradient +Faero +Facc

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Ft=11.7 +0+23.4+72 =107N

Power required = Ft*$\frac{v}{nm}$ =$\frac{107*6.94}{0.85}$ =873.62 watt

Required motor rpm of system =201

Required torque of the wheel = r*Ft = 0.33*107 =35.3

If Gradient force considered motor power required =1000 watt

2. Battery Calculation

Cell voltage =3.6

Capacity =2500mAh

Charging voltage= 4.2V

Weight per cell = 45g

Specific energy density =9.13Wh

Volume of cell = Vcc =$\frac{\pi * Battery\ cell\ diameter * Battery\ cell\ length}{4}$

Vcc =$\frac{\pi * 18 * 0.001*0.065}{4}$ = $0.00092m^3$

Battery cell energy = Battery cell capacity* Battery cell voltage

= 2.5*3.6 = 9Wh

Battery cell energy density =$\frac{Battery\ cell\ energy}{Battery\ cell\ mass}$ = $\frac{9}{0.045}$= 200 Wh/kg

Battery pack total energy = Motor voltage *$\frac{Ampere\ drawn}{speed(kmph)}$ *distance

= $\frac{48*20.83*50}{25}$ = 2000 kwh

No. of cells in series =$\frac{48}{3.6}$= 13 cells

Energy content each of string = Cells in series * Energy of battery cell

= 13*9 = 117Wh

No. of string of battery pack =$\frac{Battery\ pack\ total\ energy}{Energy\ content\ of\ each\ string}$ = $\frac{2000}{117}$ = 17

Total battery pack capacity = 17*2.5=43Ah

Total no. of cells = 13*17 = 221 cells

Battery pack mass = total no. of cells *0.045 =221*0.45=10kg

Peak current = crate * battery cell capacity =2*2.5 =5A

Battery pack peak current =Peak current * No. of strings of battery

=5*17 = 85

Battery pack peak power=Battery pack peak current*Battery pack voltage

= 85 *48 = 4080

V. RESULT

Protype Model

Firstly, we are going to observe the requirements which we are going to do in our project . According to the requirements we have developed the protype model in software based so we made this is in the catia software. And, then we got familiar with the catia software and developed the E-cargo bicycle protype.

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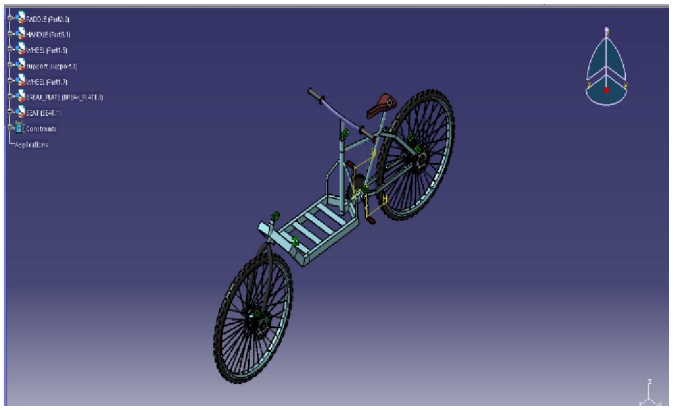

Fig.4.Prototype of E-cargo bicycle

Complete Mechanical Design:

After the protype development in catia software. We have worked for the Design parameters and their calculation to make the complete mechanical design and their fabrication process .

Fig.5. Complete mechanical design

Bicycle Electrification :

Without having battery and motor this is a simple cargo bicycle. In that we used hub motor and lithium-ion battery its having the rating of 1kw motor and 43Ah battery. Its load carrying capacity is 300kg with the gross weight of vehicle and driver**.**

Fig.6. Hub motor

Fig.7.Lithium ion battery

IT Features Implementation

Implementing smart features will make this Electric cargo bicycle more comfortable for the ride and even ehance the security of the Electric cargo bicycle. That why wehave installed two important features that is Antitheft fingerprint unlock system (i.e keyless, protect from theft)and Automatic headlight system (at the time of night it will be start).

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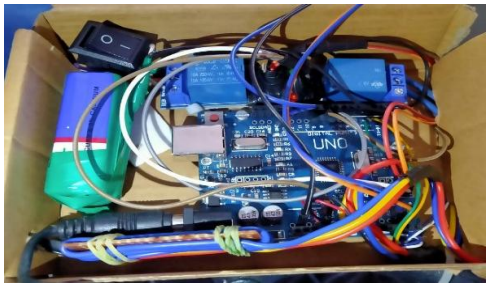

Fig.8.IT feature kit

Fig.9.Fingerprint unlock system

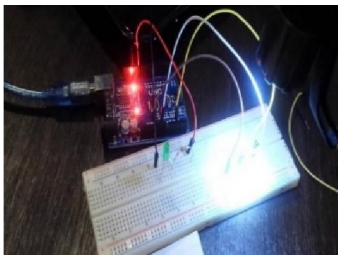
Fig.10Automatic headlight

Completely developed model of the E-cargo Bicycle :

This is the complete developed model of an E-cargo bicycle with having smart innovative features which is Antitheft fingerprint detection system and Automatic headlight.

Fig.11.Design and development of E-cargo bicycle

VI. CONCLUSION AND FUTURE SCOPE:

In this paper we conclude that E-cargo bicycle is a solution for how people carrying the load in their day-to-day life. So we have design a combinational smodel of a bicycle and cargo vehicle which is converted into an Electric-cargo bicycle. It has been also provided with Antitheft protection system which is achieved with the help of fingerprint technology and also featured with the automatic headlight system which turns ON/OFF according to the day and night condition. This E-cargo bicycle does not need a license and PUC certification to ride. This E-cargo bicycle mostly useful for Swiggy, Zomato,Parcel delivery and load transportation. And the further future scope of E-cargo bicycle is that we can install Accident detection systemwhich will help the person to get the medical aid quicklyand battery cooling system.

REFERENCES:

[1]. Suraj Ramu Gowda, Suraj Ramu Gowda, Samruddhi Vijay Karanjkar, Manisha Kailas Bhoskar ,"Cost-Efficient Electric Bicycle as a Sustainable Transportation Alternative for Delivery of Goods"(ijert) ISSN: 2278-0181 published by, JSPM's Rajarshi Shahu College of Engineering Pune, India
Link:https://www.ijert.org/research/cost-efficient-electric-bicycle-as-a-sustainable-transportation-alternative-for-delivery-of-goods-IJERTV10IS090070.pdf

[2]. Aaditya G. Samant, Shubham J. Patil, Ashutosh S. Patil3, Prof. Rahul Abhyankar, "The Calculation of Electric Motor and Lithium Battery Capacity of IIRED E-BICYCLE" ISSN(Online): 2581-7280 published by, VIVA-Tech International Journal for Research and Innovation

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Link: http://www.viva-technology.org/New/IJRI/2021/136.pdf

[3]. Saurabh Gawali, Vishal Kagade, Priyanka Vyavahare, Shravani Kulkarni, Shraddha Potadar, "Design and Development of Electric Bicycle", e-ISSN: 2395-0056 published by, Mechanical Engineering Department, Savitribai Phule Pune University, Maharashtra, India
Link:https://www.irjet.net/archives/V8/i3/IRJET-V8I381.pdf

[4]. Prathamesh Nigam, Deepak Sahu, Dr. Anil M. Bisen, "Design and Development of Modern Electric Bicycle", ISSN: 2278-0181 published by, Student, Department of Automobile and Manufacturing engineering, Symbiosis University of Applied Sciences, Indore, India 3 Provost (Vice - Chancellor), ITM Vocational University, Vadodara, India
Link: https://www.ijert.org/research/design-and-development-of-modern-electric-bicycle-IJERTV9IS110270.pdf

[5]. "Motor Torque Calculations For Electric Vehicle" , INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 4, ISSUE 08, AUGUST 2015, ISSN 2277-8616
Link:https://www.ijstr.org/final-print/aug2015/Motor-Torque-Calculations-For-Electric-Vehicle.pdf