“Design and Development of E-cargo Bicycle”

A

Project Report

Submitted in the partial fulfilment of the requirements

For the Degree of

Bachelor of Engineering

In

Electrical (Electronics & Power)

By

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DEPARTMENT OF ELECTRICAL ENGINEERING

SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING

SHEGAON 444 203 M.S (INDIA)

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CERTIFICATE

Certified that the project report entitled, **"Design and Development of E-cargo Bicycle"** is a bonafied work done under my guidance by

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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 a 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.

ACKNOWLEDGEMENT

We first pray to our divine source of inspiration **"Shri Sant Gajanan Maharaj"** whose blessings are always with us.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND:

In the market, there is a lack of suitable E-cargo bicycle models for heavy duty applications. This makes the mass distribution of delivery and goods transport via cargo bicycle extremely difficult. Particularly, this concerns the implementation of micro-hub concepts and other professional cargo-bicycle applications, such as same-day shipping for retailers or as a transport vehicle in the craft business. Thus, a research project was carried out to develop a standard for a heavy-duty cargo bicycle in the class of a Light Electric Vehicle (LEV) for professional applications, that is able to withstand daily stress and to transport sufficient weight and volume. The assumption was that a cargo bicycle that can withstand the demanding everyday use through Courier Express Parcel services could withstand the demands of most industries. The result is a detailed, practice-based specification for a heavy-duty cargo bicycle for professional use, taking into consideration the following areas: usability, safety, and economic as well as efficient use. It can serve as a base for bicycle manufacturers to develop suitable heavy-duty cargo bicycles.

During the revolution for the eco-friendly technologies bicycles were 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 bicycle over a motor vehicle for short distance travelling. Imagine how useful would the bicycle be if even the small effort applied by man for climbing slopes and riding on rough terrain is reduced in it and will be able to. We thought the same way to develop the basics of our project "The E-cargo Bicycle". The unit developed by us is a combination of the standard geared bicycle with an electric power motor that would assist the rider throughout his journey. 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 bicycle 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 assembly onto a geared bicycle was to reduce the effort to-be applied for weight that the rider will have to take along with the bicycle.

According to the requirements, a prototype is designed 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 will be full-fledged with smart innovative features such as an accident detection system, fingerprint unlock, an automatic cooling system for battery using cooling fans, theft protection, GPS tracking, automatic smart light at night, alarm indication for overloading, the special design still not implemented in India.

1.2 PROBLEMS IN TRANSPORATION VEHICLES:

- The prices of conventional fuels such as gasoline and diesel are rising and will eventually run out. Traditional fuels, such as gasoline and diesel, pollute heavily. The government is taking steps to reduce pollution and encourage innovators to create new transportation solutions.
- It is observed that many day to day workers are carrying their goods on bikes, scooters and cycles which are heavily loaded which is not the right way to carry.
- In IC Engine bikes ,it require PUC (Pollution Under Control) Certification and also need a driving licence.
- Running cost of the traditional bike are higher.

1.3 OBJECTIVE:

Before starting with the plan we need to clearly point out the objective for developing the Electric cargo bicycle. The objectives framed to design and develop this Electric cargo bicycle are as follows:

- Designing of the unique cargo bicycle model, having good sitting posture and also load carrying capacity.
- Selection of energy efficient motor, controller and battery.
- Fabrication of design and assembly of all components on bicycle .
- Addition of smart innovative features in bicycle.
- On successful development of the bicycle, manufacturing bicycles and renting them to start a business module.
- Starting own start-up of manufacturing and selling E-cargo bicycle.
- Provide service to clients (like day to day seller, News paper distributor, food delivery agents like swiggy and zomato, courier partner like ekart logistics) by renting bicycles to them.

CHAPTER 2
LITERATURE SURVEY

A steadily growing number of cities worldwide are eager to become cities of bicycles as part of an overall strategy on sustainable development and the desire to become green cities.

Why do we need green mobility:

"Green mobility is sustainable transportation that allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations. Green mobility is affordable, operating efficiently, offering a choice of transport mode, and supporting a vibrant economy". "It limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise."

The Benefits of Green Mobility:

- A Less Polluted Environment
- Improved Health
- More Sustainable Economic Development
- Money-Saving

MAJOR FINDINGS

- It was found that most of the customers are not much satisfied with the price of the product.
- It was found that most of the customers were satisfied with the mileage of the Electric bikes and are convinced about the electric bike benefits, and were willing to refer it to their friends.
- It was found that most of the customers are not satisfied with after-sales service. It shows that customers are dissatisfied with after-sale service.

- It was found that the maximum numbers of the customers felt the speed of the electric bikes to be very low and were not satisfied with the current speed of the bikes.
- It was found that most of the respondents feel that the factors such as speed & power, battery life, and appearance of Electric Bikes are the main reasons for its lower market share.

Literature review is useful to understand in the depth knowledge of problem and for proper formation of problem statement. The following papers were obtained from a variety of publications.

Design and Development of Electric Bicycle:

The paper explains that the increasing global warming is extremely hazardous to the human life existence on the earth and completely opting out of the factors that affect the environment health negatively is necessary. This paper is an attempt to find alternative power source in place of the Internal Combustion Engine and its effective application in daily life. In the design process, various calculations are done to calculate the resistance which is offered by the electric bike and different forces act on it.

The Calculation of Electric Motor and Lithium Battery Capacity of IIRED E-BICYCLE:

This paper gives the idea about types of motor and battery and their calculation. BLDC motors have best working characteristics like high starting torque, high efficiency around 95-98%, etc. BLDC motors are preferred for high power density design as they display better characteristic with compare to other motors used. An electric-vehicle battery is used to power the electric motors of a electric vehicle. These batteries are rechargeable batteries and they are typically lithium-ion batteries. These batteries are specifically designed for a high Ah (or Wh) capacity. The most common battery type is lithium-ion and lithium polymer, due to their high energy density by weight value. The amount of charge stored in these batteries is measured in Ah and the total energy is

measured in kWh. In this Project, we are using Lithium-Ion (Li-ion) Batteries. There are many types of batteries available namely LiFePO4, Li- ion, Lead acid batteries. But we used Lithium-ion batteries because these batteries have higher efficiency than other batteries.

Cost-Efficient Electric Bicycle as a Sustainable Transportation Alternative for Delivery of Goods:

This paper gives the idea about Cost-Efficient Electric Bicycle by the implementation of many pilot projects and EV-related Events, public expectation on E.V.s is high. However, there is no clear indication for full-fledged diffusion. This is because of the high prices of E.V.s, limited models, lack of charging Infrastructure, and lack of trust in the market regarding the life Span of E.V.s and safety. The progress that the electric vehicle Industry has seen in recent years is highly welcomed and highly necessary in light of the increasing global greenhouse gas levels. As demonstrated within the economic, social, and environmental analysis sections of this webpage, the benefits of electric vehicles far surpass the costs. The biggest obstacle to the widespread adoption of electric-powered transportation is cost-related, as gasoline and the vehicles that run on it are readily available, convenient, and less costly.

CHAPTER 3

E-CARGO BICYCLE

3.1 WHAT IS AN E-CARGO BICYCLE?

This is a type of bicycle which will have the capacity of carrying certain amount of load and which is driven with the help of battery which coupled to electric motor.

3.2 PROPOSED MODEL OF THE E-CARGO BICYCLE:

The main aim was to fabricate a prototype that would be very light and comfortable for the rider to handle. As the motor and other drive components would take in most of the free space in the system our design challenge was to make the motor-alternator unit as a single system. This was our major challenge, for this purpose we developed the motor cum alternator at its minimum possible size and also at the lowest possible cost. Mounting the battery was another challenge, the location of the mounting could have been anywhere in the rest of the space available near the motor or we could have used up the empty space near the carrier. Keeping in mind the comfort of the rider the battery casing was mounted behind the rider, near the carrier location Looking at the complicated arrangement of the system one may easily think that the drive arrangement could have been completed in a single step ie the direct link from the motor to the drive But the real fact is that this would make the cranking for self- recharging mechanism difficult, since the speed for alternator recharging cannot be achieved by simple cranking a flywheel has to be used to store the cranking energy and thus the rotation and cranking at normal cycling becomes easier.

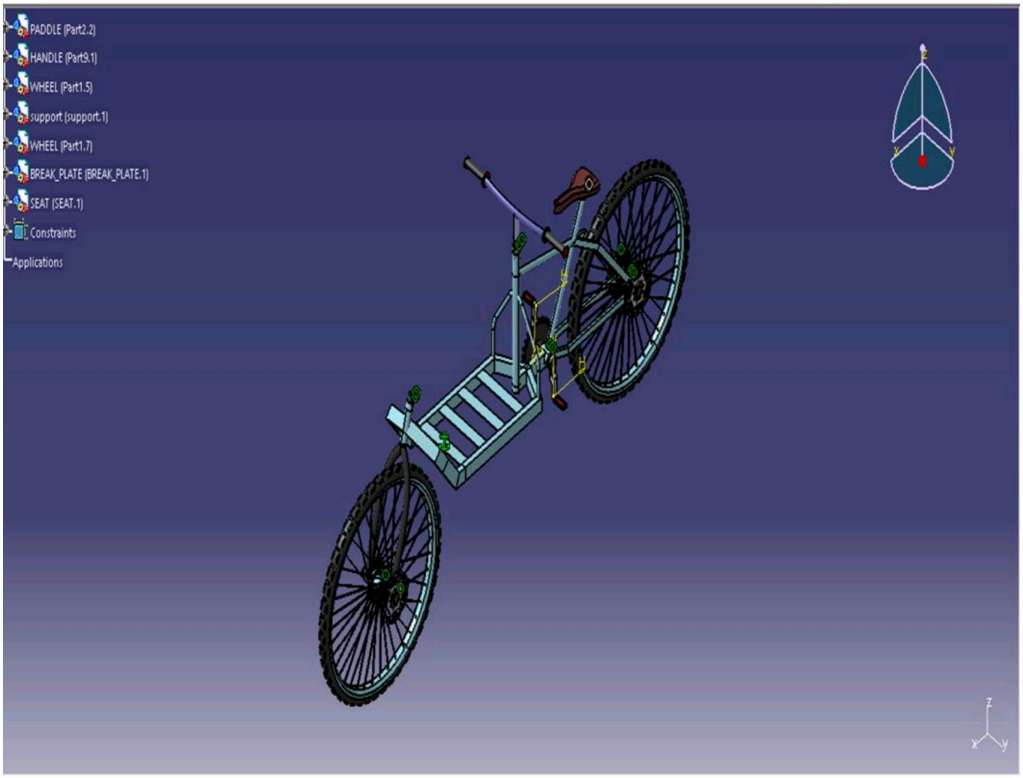


Figure 1 :Proposed model

The Vehicle is an advance version of cargo vehicles used today. It is a combinational model of a bicycle and cargo vehicle which is converted into an Electric-cargo bicycle. It has been also provided with theft 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.

CHAPTER 4

CUSTOMER REQUIREMENT

To understand the demand/requirements of the consumers the best possible way to know that is via conducting a market survey. And as a team decided to conduct this research and analysis into shegaon by interrogating the customers as well as the sellers of the Electric Vehicles.

The questions which was asked to know the requirement of an E-cargo bicycle are as follows:

1) What mode of transport do you currently use to do your logistics work ?
2) Do you need an E-cargo bicycle for your business ?
3) Are you convinced about the benefits of electric vehicles/bicycles ?
4) Does your vehicle has fingerprint unlock system ?
5) Do you want the anti-theft security for the electric bicycle ?
6) What should be the price of the E-cargo bicycle with smart features installed in it in the market ?

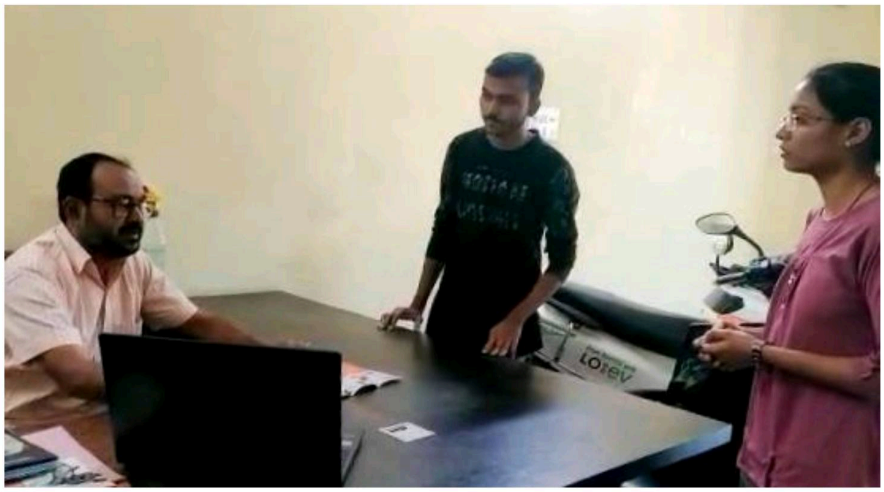


Figure 2: Survey

After conducting the market survey ,it concluded that at the current scenario there is a need in the market of an alternative best option of vehicle to carry the load safely as well as economical.

INITIAL PROJECT MANAGEMENT PLAN:

The initial project timeline consisted of seven main phases. These phases include project definition, research of new designs, development of conceptual designs, initial prototype preparation, initial testing, initial prototype construction, and final design construction. The project schedule and project timing was organized the seven main phases, which were further broken down into tasks. These tasks consisted of a start date and an end date. The project schedule consisted of a critical path. Tasks on the critical path could not be started unless the task before was completed. These tasks were the most critical to the project because any delay caused a delay to the whole project. It was important to try to shift the critical path. For the most part, The only modification came near the end of the design process in the "Construct Final Design" phase. Since the team decided to go with the one design of fingerprint unlock system and tasks were moved to the "Construct Initial Prototype" phase. The project prototype and final design were very similar, and the system was fabricated before testing efficiency. This was because in order to run and test the system.

CHAPTER 5

DESIGN AND IMPLEMENTATION OF E-CARGO BICYCLE

Global warming and scarcity of traditional resources are becoming major problems in the current scenario. Due to the economic challenges India is facing in automotive sector the hybrid bicycle market has a huge growth potential. People try to move towards "clean" energies. These facts among others will leverage the electric bicycle industry on the top of the agendas not only in India. Moreover the vision of an electric engine, which supports the muscular strength, became reality. Bicycles with such a supporting electric engine belong to the innovative vehicles, which are wholeheartedly suitable for everyday life. In face of continuous climate discussions and permanent traffic jams, electric bikes have the potential of solving such issues and making a more energy efficient and environment friendly mobility possible. Accordingly a continuous trend towards electric bicycles can be expected simultaneously in whole of India. So it becomes very necessary to manufacture the electric cycles so cheaply that the common people in our country can afford to buy it. The currently existing electric scooters are far more costly and due to budgetary constraints a middle class person cannot afford such a locomotive at his place. Along with the development of technologies the theory must be also implemented to design and manufacture a product that can be sold off at a greater frequency, which has a very low production cost and one that is of good quality. In order to implement all the above ideas, we planned to make the design and product in such a manner that it can be completed with the existing "EVs" in the market.

COMPONENTS IN E-CARGO BICYCLE:

The E-cargo bicycle consists of the following components that are Hub motor, Battery, Throttle, Platform, Frame, Chain drive, Braking system, Light Dependent Resistor(LDR), Arduino UNO R3, Headlight, 1 channel Relay module 5A 10V, Fingerprint sensor, LCD.

5.1ELECTRICAL COMPONENTS

HUB MOTOR:

The hub motor is of 1 kwatts having capacity of 25km/hr. The specification of the hub motor are as follows:

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. 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.

Figure 3 : Motor

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.

A battery is made up of an anode, cathode, separator, electrolyte, and two current collectors (positive and negative). The anode and cathode store the lithium. The electrolyte carries positively charged lithium ions from the anode to the cathode and vice versa through the separator. The movement of the lithium ions creates free electrons in the anode which creates a charge at the positive current collector. The electrical current then flows from the current collector through a device being powered (cell phone, computer, etc.) to the negative current collector. The separator blocks the flow of electrons inside the battery.

CHARGE/DISCHARGE:

While the battery is discharging and providing an electric current, the anode releases lithium ions to the cathode, generating a flow of electrons from one side to the other. When plugging in the device, the opposite happens: Lithium ions are released by the cathode and received by the anode.

Figure 4 : Battery

CONTROLLER:

The motor controller is a component that is unfamiliar to many people. However, it is essential to any bike hardware since you cannot directly connect a brushless motor to a battery pack. The motor controller serves two critical functions.

- It converts the D.C. voltage of the battery pack into 3 phase alternating current for the motor windings without which the motor could not spin.
- It can continuously adjust the voltage going to the motor, from 0V up to the total battery pack voltage, in response to the user's throttle signal, pedal sensors, and various current limits.

Motor controllers usually have a specific voltage range they will work in, and they will also have a current limit that defines the maximum amperage that they will draw from the battery pack. A small low current motor controller might be rated for 14 amps, which means it will only draw a maximum of 14 Amps from the battery pack. When the motor attempts to draw more current than this, the controller automatically reduces the voltage provided to the motor to keep the battery current drawn right at the limit. If you use a low amperage motor controller with a large hub motor, the system will work fine, but you will not be getting nearly as much power from the motor as it is capable of. Conversely, if you use a high amperage motor controller with a small motor, you risk overheating and damaging the motor or stripping the internal gears or clutch.

Figure 5 : Controller

5.2 MECHANICAL COMPONENTS

THROTTLE:

A throttle was needed to provide a user interface to the motor. The throttle needed to be rugged and bike mountable. This throttle uses a Hall effect sensor, instead of the variable resistor sometimes found in electric throttles. Twisting the throttle varies the strength of the magnetic field adjacent to the sensor, which sends a corresponding voltage to the microcontroller. By using the hall effect sensor, the throttle is more rugged and reliable as there are no moving electrical components, in contrast to the variable resistor which can wear over time.

Figure 6 : Throttle

PLATFORM:

The Platform is designed with robust base so that it can hold the load along with the weight of the driving person uniformly. It is fabricated from Mild Steel at a specific angle in cross section and welded with a sheet of metal of specific thickness. The platform's alignment is kept horizontal irrespective whether it is loaded or unloaded and this is directly bolted and welded to the frame.

CHAIN DRIVE:

A Chain is an array of links held together with each other with the help of steel pins. This type of arrangement makes a chain more enduring, long lasting and better way of transmitting rotary motion from one gear to another.

A chain drive is a way of transmitting mechanical power (rotational motion) from one place to another. Chain drives are used apart from transmitting mechanical

power but also for conveying goods, as well as lifting and dragging objects. However, the power is said to be output when the chain is rotating.

Chain drives can also be seen as a series of connected links using pin joints. It consists of endless chains wrapped around two or more sprockets

The major advantage of chain drive over traditional gear is that, the chain drive can transmit rotary motion with the help of two gears and a chain over a distance whereas in traditional many gears must be arranged in a mesh in order to transmit motion

Figure 7 : Chain drive

BRAKING SYSTEM:

For the braking system it is convenient to use braking system used in band brake system which consist of spring loaded friction- shoe mechanism, which driven with the help of hand leaver. In a vehicle, the brake is the most important device to control the vehicle. It reduces the speed of any rotating parts of electrical and mechanical equipment. It is a crucial part of the safe operation of systems. It uses friction on the two surfaces of a vehicle. This converts kinetic energy into heat. Almost all the vehicle wheels have a braking system. Even shopping cars and aircraft have braking systems. It has several characteristics like peak force, fade, continuous part dissipation, power, smoothness, noise, weight, durability, drag, pedal feel. Foundation components at the wheels are the basis for forming the braking system.

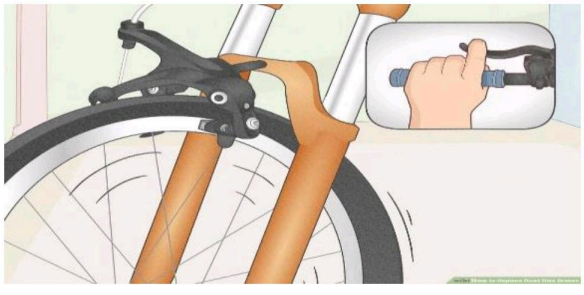


Figure 8 : Braking system

SPROCKETS:

The chain with engaging with the sprocket converts rotational power in to rotary power and vice versa. The sprocket which looks like a gear may differ in three aspects:

- Sprockets have many engaging teeth but gears have only one or two.
- The teeth of a gear touch and slip against each other but there is basically no slip page in case of sprocket.
- The shape of the teeth are different in gears and sprockets.

A sprocket or sprocket-wheel is a profile wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which are radial projections that engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth. Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.

Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel, which drives a chain, which, in turn, drives a small sprocket on the axle of the rear wheel. Early automobiles were also largely driven by sprocket and chain mechanism, a practice largely copied from bicycles. Sprockets are of various designs, a maximum of efficiency being claimed for each by its originator.

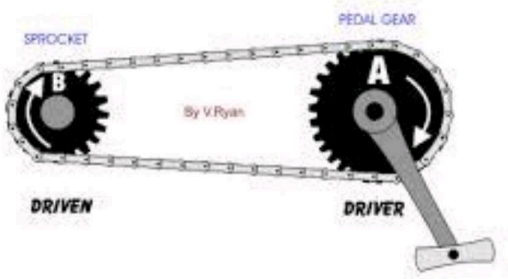


Figure 9 : Sprockets

5.3 ELECTRONICS COMPONENTS :

1.Light Dependent Resistor:

An electronic component like LDR or light-dependent resistor is responsive to light. Once light rays drop on it, then immediately the resistance will be changed. The resistance values of an LDR may change over several orders of magnitude. The resistance value will be dropped when the light level increases.

The resistance values of LDR in darkness are several megaohms whereas in bright light it will be dropped to hundred ohms. So due to this change in resistance, these resistors are extremely used in different applications. The LDR sensitivity also changes through the incident light's wavelength.

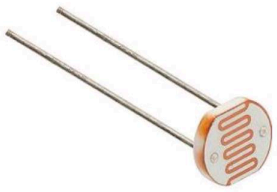


Figure 10: Light Dependent Resistor

LDR Symbol:

In electronic circuits, the LDR symbol is used that mainly depends on the resistor symbol; however, it illustrates the light rays in the arrows form. In this way, it follows the same principle which is used for phototransistor & photodiode circuit symbols wherever arrows are utilized to demonstrate the light dropping on these types of components. The LDR circuit symbols are shown below.

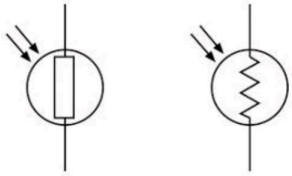


Figure 11:Symbol of LDR

Characteristics of LDR

The light-dependent resistor is very responsive to light. When the light is stronger, then the resistance is lower which means, when the light intensity increases then the value of resistance for the LDR will be decreased drastically to below 1K.

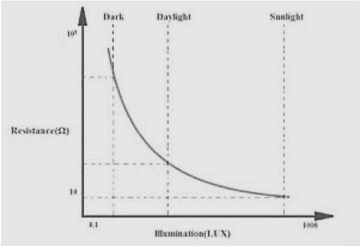


Figure 12: Characteristics of LDR

When the light drops on LDR, the resistance will be decreased and when the resistor is placed in the dark then the resistance will be increased which is called dark resistance. If any device absorbs light then its resistance will be reduced radically. If a stable voltage is given to it, the light intensity will be increased & the flow of current starts increasing. So, the following diagram represents the characteristics between resistance & illumination for a specific LDR.

2.Arduino UNO R305:

The Arduino UNO R3 is frequently used microcontroller board in the family of an Arduino. This is the latest third version of an Arduino board and released in the year 2011. The main advantage of this board is if we make a mistake we can change the microcontroller on the board. The main features of this board mainly include, it is available in DIP (dual-inline-package), detachable and ATmega328 microcontroller. The programming of this board can easily be loaded by using an Arduino computer program. This board has huge support from the Arduino community, which will make a very simple way to start working in embedded electronics, and many more applications.

Arduino Uno R3 Specifications:

The Arduino Uno R3 board includes the following specifications:

- It is an ATmega328P based Microcontroller
- The Operating Voltage of the Arduino is 5V
- The recommended input voltage ranges from 7V to 12V
- The i/p voltage (limit) is 6V to 20V
- Digital input and output pins-14
- Digital input & output pins (PWM)-6
- Analog i/p pins are 6
- DC Current for each I/O Pin is 20 mA
- DC Current used for 3.3V Pin is 50 mA
- Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader
- SRAM is 2 KB
- EEPROM is 1 KB
- The speed of the CLK is 16 MHz
- In Built LED
- Length and width of the Arduino are 68.6 mm X 53.4 mm
- The weight of the Arduino board is 25 g

Arduino Uno R3 Pin Diagram:

The Arduino Uno R3 pin diagram is shown below. It comprises 14-digit I/O pins. From these pins, 6-pins can be utilized like PWM outputs. This board includes 14 digital input/output pins, Analog inputs-6, a USB connection, quartz crystal-16 MHz, a power jack, a USB connection, resonator-16Mhz, a power jack, an ICSP header an RST button.

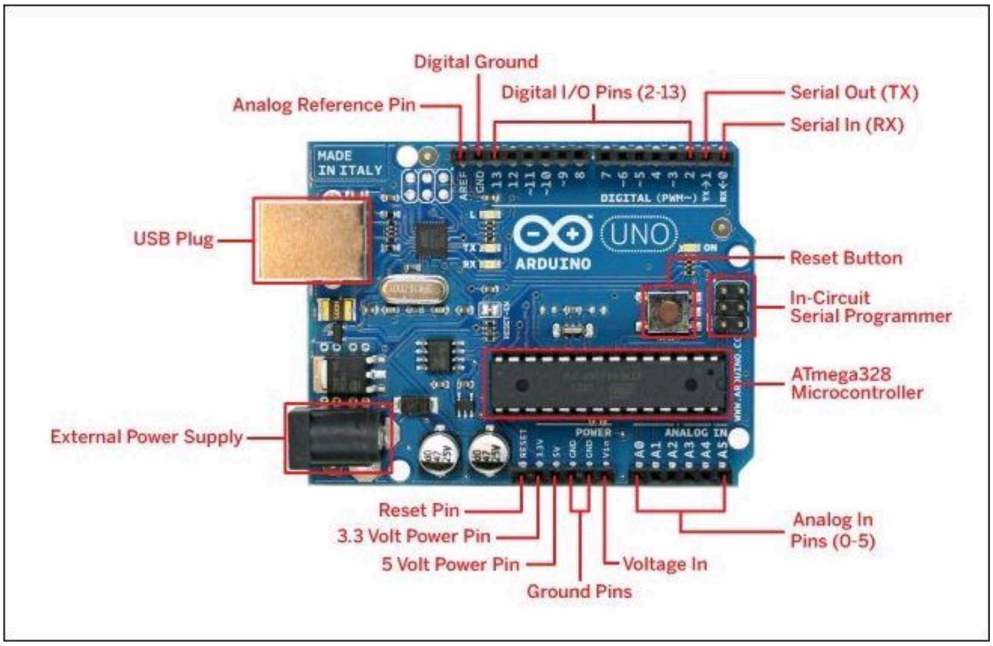


Figure 13:Arduino Uno Pin Diagram

Power Supply:

The power supply of the Arduino can be done with the help of an exterior power supply otherwise USB connection. The exterior power supply (6 to 20 volts) mainly includes a battery or an AC to DC adapter. The connection of an adapter can be done by plugging a center-positive plug (2.1mm) into the power jack on the board. The battery terminals can be placed in the pins of Vin as well as GND. The power pins of an Arduino board include the following.

Vin: The input voltage or Vin to the Arduino while it is using an exterior power supply opposite to volts from the connection of USB or else RPS (regulated power supply)**.** By using this pin, one can supply the voltage.

5Volts: The RPS can be used to give the power supply to the microcontroller as well as components which are used on the Arduino board. This can approach from the input voltage through a regulator.

3V3: A 3.3 supply voltage can be generated with the onboard regulator, and the highest draw current will be 50 mA.

GND: GND (ground) pins

Memory:

The memory of an ATmega328 microcontroller includes 32 KB and 0.5 KB memory is utilized for the Boot loader), and also it includes SRAM-2 KB as well as EEPROM-1KB.

Input and Output:

We know that an arguing Uno R3 includes 14-digital pins which can be used as an input otherwise output by using the functions like pin Mode (), digital Read(), and digital Write(). These pins can operate with 5V, and every digital pin can give or receive 20mA, & includes a 20k to 50k ohm pull up resistor. The maximum current on any pin is 40mA which cannot surpass for avoiding the microcontroller from the damage. Additionally, some of the pins of an Arduino include specific functions.

Serial Pins:

The serial pins of an Arduino board are TX (1) and RX (0) pins and these pins can be used to transfer the TTL serial data. The connection of these pins can be done with the equivalent pins of the ATmega8 U2 USB to TTL chip.

External Interrupt Pins:

The external interrupt pins of the board are 2 & 3, and these pins can be arranged to activate an interrupt on a rising otherwise falling edge, a low-value otherwise a modify in value.

PWM Pins:

The PWM pins of an Arduino are 3, 5, 6, 9, 10, & 11, and gives an output of an 8-bit PWM with the function analog Write ().

SPI (Serial Peripheral Interface) Pins:

The SPI pins are 10, 11, 12, 13 namely SS, MOSI, MISO, SCK, and these will maintain the **SPI communication** with the help of the SPI library.

LED Pin:

An arguing board is inbuilt with a LED using digital pin-13. Whenever the digital pin is high, the LED will glow otherwise it will not glow.

TWI (2-Wire Interface) Pins:

The TWI pins are SDA or A4, & SCL or A5, which can support the communication of TWI with the help of Wire library.

AREF (Analog Reference) Pin:

An analog reference pin is the reference voltage to the inputs of an analog i/ps using the function like analog Reference().

Reset (RST) Pin:

This pin brings a low line for resetting the microcontroller, and it is very useful for using an RST button toward shields which can block the one over the Arduino R3 board.

Communication:

The communication protocols of an Arduino Uno include SPI, I2C, and **UART serial communication.**

UART:

An Arduino Uno uses the two functions like the transmitter digital pin1 and the receiver digital pin0. These pins are mainly used in UART TTL serial communication.

I2C:

An Arduino UNO board employs SDA pin otherwise A4 pin & A5 pin otherwise SCL pin is used for I2C communication with wire library. In this, both the SCL and SDA are CLK signal and data signal.

SPI Pins:

The SPI communication includes MOSI, MISO, and SCK.

MOSI (Pin11)

This is the master out slave in the pin, used to transmit the data to the devices

MISO (Pin12)

This pin is a serial CLK, and the CLK pulse will synchronize the transmission of which is produced by the master.

SCK (Pin13):

The CLK pulse synchronizes data transmission that is generated by the master. Equivalent pins with the SPI library is employed for the communication of SPI. ICSP (in-circuit serial programming) headers can be utilized for programming **ATmega microcontroller** directly with the boot loader.

Arduino Uno R3 Programming

The programming of an Arduino Uno R3 can be done using IDE software. The microcontroller on the board will come with pre-burned by a boot loader that permits to upload fresh code without using an exterior hardware programmer. The communication of this can be done using a protocol like STK500.We can also upload the program in the microcontroller by avoiding the boot loader using the header like the In-Circuit Serial Programming

3.Headlight:

A Headlight is a lamp attached to the front of a vehicle to illuminate the road ahead. Headlights are also often called headlamps but in the most precise usage, headlight is the term for the device itself and headlight is the term for the beam of light produced and distributed by the device. The primary task of headlights on cars is to illuminate the roadway and facilitate fatigue-free and safe driving. Headlights and their light sources are thus vehicle components that are relevant to safety. They require official approval and must not be tampered with. The nature and location of light functions on a vehicle

Safety:

At dark and cold times of the year when bad weather (rain, fog, storms) is commonplace, it is important to be able to see and be seen. For drivers, this means being well lit! Good light is essential to be able to see hazards in traffic in good time and thus react appropriately to aquaplaning, skid hazards or obstructions on the road. It is equally important in order to be able to detect pedestrians, cyclists and other road users in good time. Unfortunately, good light and therefore safety cannot always be taken for granted. The latest studies show that an average of 35% of drivers on the road do not have sufficient lighting, thereby creating safety risks for themselves and others. "See and be seen" is the mantra of every foresighted, responsible driver and their design, light sources, colours and photometric values are regulated by law.

4.Relay module:

Relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. The single-channel relay module is much more than just a plain relay, it comprises of components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active or not.

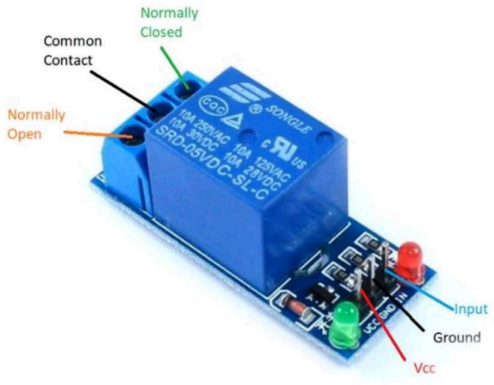


Figure 14: Relay module

Single-Channel Relay Module Pin Description:

Pin Number	Pin Name	Description
1	Relay Trigger	Input to activate the relay
2	Ground	0V reference
3	VCC	Supply input for powering the relay coil
4	Normally Open	Normally open terminal of the relay
5	Common	Common terminal of the relay
6	Normally Closed	Normally closed contact of the relay

Single-Channel Relay Module Specifications:

- Supply voltage – 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: ~70mA
- Relay maximum contact voltage – 250VAC or 30VDC
- Relay maximum current – 10A

Alternate Relay Modules:

Dual-channel relay module, four-channel relay module, 8-channel relay module.

Alternate Switching Modules:

Solid State Relay Module, TRIAC, SCR.

Components Present on a 5V Single Channel Relay Module:

The following are the major components present on a relay module; we will get into the details later in this article.

5V Relay, Transistor, Diode, LEDs, Resistors, Male Header pins, 3-pin screw-type terminal connector, etc.

Understanding 5V Single-Channel Relay Module:

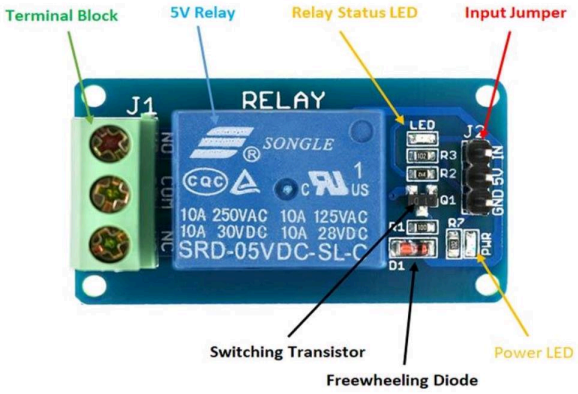


Figure 15: 5V Single Channel Relay Module

The single-channel relay module is much more than just a plain relay, it contains components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active.

First is the screw terminal block. This is the part of the module that is in contact with mains so a reliable connection is needed. Adding screw terminals makes it easier to connect thick mains cables, which might be difficult to solder directly. The three connections on the terminal block are connected to the normally open, normally closed, and common terminals of the relay.

The second is the relay itself, which, in this case, is a blue plastic case. Lots of information can be gleaned from the markings on the relay itself. The part

number of the relay on the bottom says “05VDC”, which means that the relay coil is activated at 5V minimum – any voltage lower than this will not be able to reliably close the contacts of the relay. There are also voltage and current markings, which represent the maximum voltage and current, the relay can switch. For example, the top left marking says “10A 250VAC”, which means the relay can switch a maximum load of 10A when connected to a 250V mains circuit. The bottom left rating says “10A 30VDC”, meaning the relay can switch a maximum current of 10A DC before the contacts get damaged.

The 'relay status LED' turns on whenever the relay is active and provides an indication of current flowing through the relay coil.

The input jumper is used to supply power to the relay coil and LEDs. The jumper also has the input pin, which when pulled high activates the relay.

The switching transistor takes an input that cannot supply enough current to directly drive the relay coil and amplifies it using the supply voltage to drive the relay coil. This way, the input can be driven from a microcontroller or sensor output. The freewheeling diode prevents voltage spikes when the relay is switched off.

The power LED is connected to V_{CC} and turns on whenever the module is powered.

5.Fingerprint module:

The fingerprint sensor works on the principle of processing which includes two elements like enrolment & matching. In enrolment, each individual has to put the finger on the sensor device, so that the device checks the fingerprints to process & generate the finger pattern & it will be stored. In matching, once an individual places the finger then the system will generate a pattern of the finger & compares it with the stored data. So a fingerprint sensor is used to authenticate and recognize the fingerprints of a person. These sensors are very reliable and secure devices used for any security authentication.

In the fingerprint sensor working, first authorized persons' fingerprint scans are recorded for a specific system and these scans are saved within a database. Whenever an individual needs to access the system then he places a finger on a hardware scanner, then the scanner scans & copies the input from the person & verifies with the previously stored scans for any similarity. If it matches, then the individual gets access. These sensors normally use the thumbprint of an individual as an identification.

R307 Fingerprint Module consists of optical fingerprint sensor, high-speed DSP processor, high-performance fingerprint alignment algorithm, high-capacity FLASH chips and other hardware and software composition, stable performance, simple structure, with fingerprint entry, image processing, fingerprint matching, search and template storage and other functions.

Figure 16: Fingerprint module

Pinouts :-

Pin#	Pin Name	Details
1	5V	Regulated 5V DC
2	GND	Common Ground
3	TXD	Data output - Connect to MCU RX
4	RXD	Data Input - Connect to MCU TX
5	TOUCH	Active Low output when there is touch on sensor by finger
6	3.3V	Use this wire to give 3.3V to sensor instead of 5V

USB Cable Connections are 5V/D+/D-/GND

Features:-

- Supply voltage: DC 4.2 ~ 6.0V
- Supply current: Working current: 50mA (typical) Peak current: 80mA
- Fingerprint image input time: <0.3 seconds
- Window area: 14x18 mm
- Matching method: Comparison method (1: 1)
- Search method (1: N)
-
- Characteristic file: 256 bytes
- Template file: 512 bytes
- Storage capacity: 1000 pieces
- Security Level: Five (from low to high: 1,2,3,4,5)
- Fake rate (FAR): <0.001%
- Refusal rate (FRR): <1.0%
- Search time: <1.0 seconds (1: 1000 hours, mean value)
- Host interface: UART \ USB1.1
- Communication baud rate (UART): (9600xN) bps Where N = 1 ~ 12 (default N = 6, ie 57600bps)
- Working environment: Temperature: -20 ℃ - +40 ℃ Relative humidity: 40% RH-85% RH (no condensation)
- Storage environment: Temperature: -40 ℃ - +85 ℃ Relative humidity: <85% H (no condensation)

6.LIQUID CRYSTAL DISPLAY (LCD):

The principle behind the LCDs is that when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. This causes the angle of light which is passing through the molecule of the polarized glass and also causes a change in the angle of the top polarizing filter. As a result, a little light is allowed to pass the polarized glass through a particular area of the LCD.

Thus that particular area will become dark compared to others. The LCD works on the principle of blocking light. While constructing the LCDs, a reflected mirror is arranged at the back. An electrode plane is made of indium-tin-oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device. The complete region of the LCD has to be enclosed by a common electrode and above it should be the liquid crystal matter.

Next comes the second piece of glass with an electrode in the form of the rectangle on the bottom and, on top, another polarizing film. It must be considered that both the pieces are kept at the right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. That particular rectangular area appears blank.

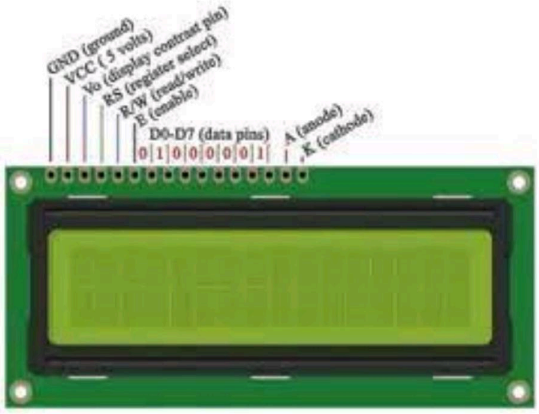
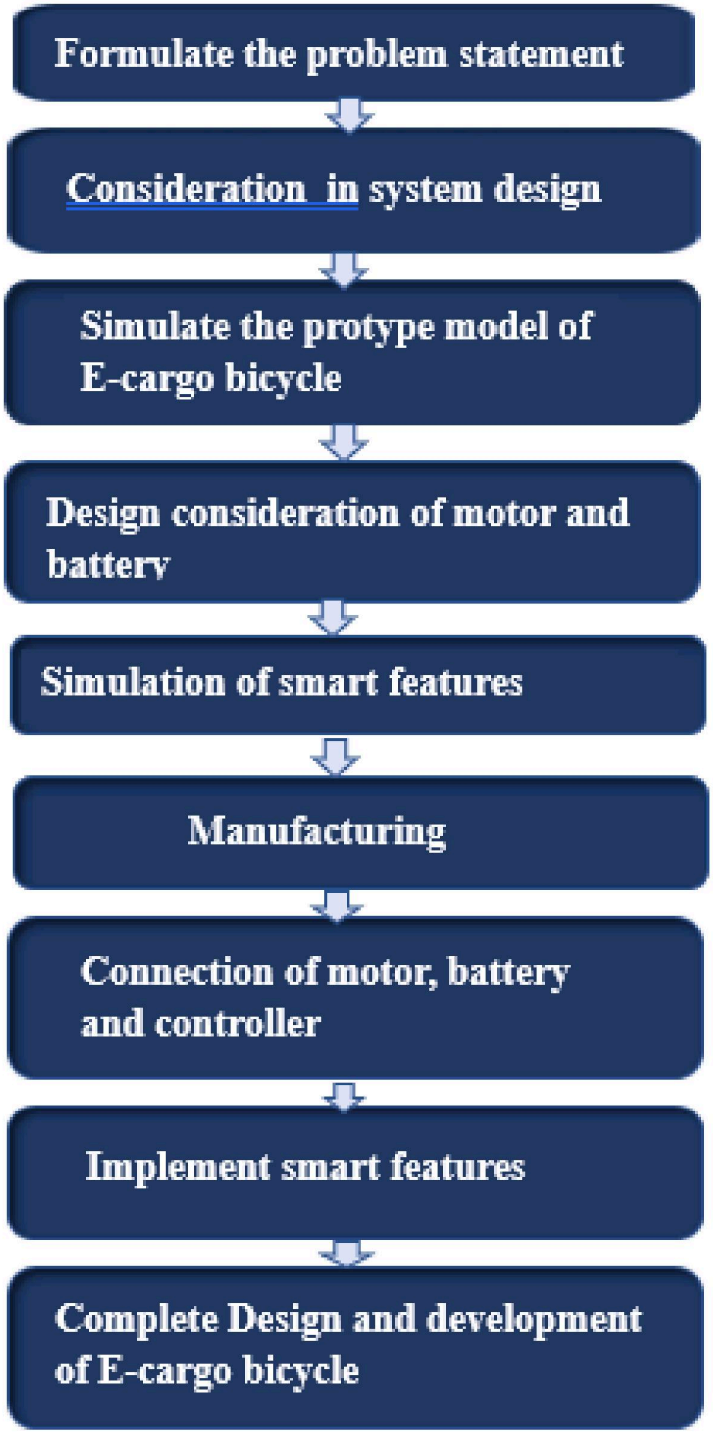


Figure 17: Liquid crystal display (LCD)

CHAPTER 6

METHODOLOGY



CHAPTER 7

DESIGN CONSIDERATONS

1. Motor Parameters :

1. Gross Vehicle Weight(GVW)

   Weight of vehicle =200kg

   Weight of driver =100kg

2. Gross Vehicle Mass (GVM)

   GVM=300/9.81=30.58

3. Radius of tyre = 13inch =0.33m

4. Circumference of tyre =c= 2πr =2m

5. Gear Ratio

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

   Speed of motor : Speed of wheel

   Wheel Speed in RPM

   Nw(rpm)=60/2πr V(m/s) =60/2$\pi * 0.33 *$ **6.94**=201rpm

6. Velocity = 25km/hr= 6.94m/s

7. 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

8. Rolling resistance force =Fr

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

   Crr =Coefficient of rolling resistance =0.004

9. 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

10. Acceleration force= GVM*acceleration =300*0.24 =
    =72N
11. Total forces
    Ft =Froll +Fgradient +Faero +Facc
    Ft=11.7 +0+23.4+72 =107N
12. Power required = Ft*$\frac{v}{nm}$ = $\frac{107*6.94}{0.85}$ =873.62 watt
    Required motor rpm of system =201
13. Required torque of the wheel = r*Ft = 0.33*107 =35.3
14. If Gradient force considered motor power required =1000 watt

2. Battery Calculation :

1. Cell voltage =3.6
2. Capacity =2500mAh
3. Charging voltage= 4.2V
4. Weight per cell = 45g
5. Specific energy density =9.13Wh

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

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

7. Battery cell energy = Battery cell capacity* Battery cell voltage
   = 2.5*3.6 = 9Wh

8. Battery cell energy density = $\frac{Battery\ cell\ energy}{Battery\ cell\ mass} = \frac{9}{0.045}$ = 200 Wh/kg
9. Battery pack total energy = Motor voltage * $\frac{Ampere\ drawn}{speed\,(kmph)}$ *distance

   $= \frac{48*20.83*50}{25}$ = 2000 kwh
10. No. of cells in series = $\frac{48}{3.6}$ = 13 cells
11. Energy content each of string = Cells in series * Energy of battery cell

    = 13*9 = 117Wh
12. No. of string of battery pack = $\frac{Battery\ pack\ total\ energy}{Energy\ content\ of\ each\ string} = \frac{2000}{117} = 17$
13. Total battery pack capacity = 17*2.5=43Ah
14. Total no. of cells = 13*17 = 221 cells
15. Battery pack mass = total no. of cells *0.045 =221*0.45=10kg
16. Peak current = crate * battery cell capacity =2*2.5 =5A
17. Battery pack peak current =Peak current * No. of strings of battery

    =5*17 = 85
18. Battery pack peak power=Battery pack peak current*Battery pack voltage

    = 85 *48 = 4080

CHAPTER 8

SIMULATION

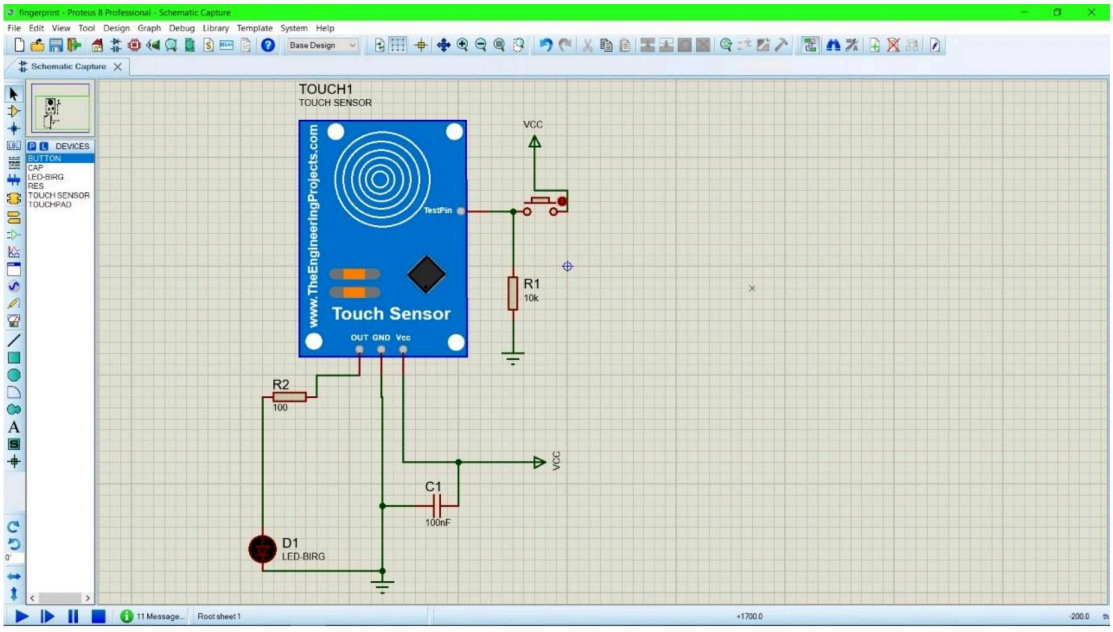


Figure 18: Simulation of fingerprint unlock system

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

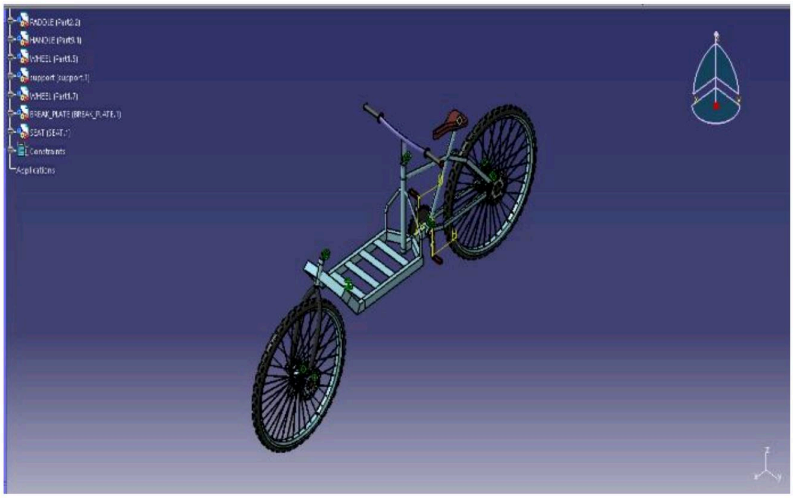


Figure 19: Simulation of proposed model

CATIA V5 Engineering Excellence is an extended set of CATIA V5 applications for the creation and management of sophisticated mechanical projects, including part design, sheet metal, tooling, assembly design, functional tolerances and annotations, kinematics and fitting simulation, DMU review, advanced surface design, and more.

Start a new design and engineering journey while mitigating risk, by providing your team with extensive 3D modelling solutions, by protecting IP as well as CATIA V5 skills, by bringing new collaborators into the overall design and engineering process.

CATIA Engineering Excellence is the ultimate one-stop shop for CATIA V5 engineers, leveraging the free-of-charge 3DEXPERIENCE Social Collaboration Services (if implemented).

CHAPTER 9

WORKFLOW

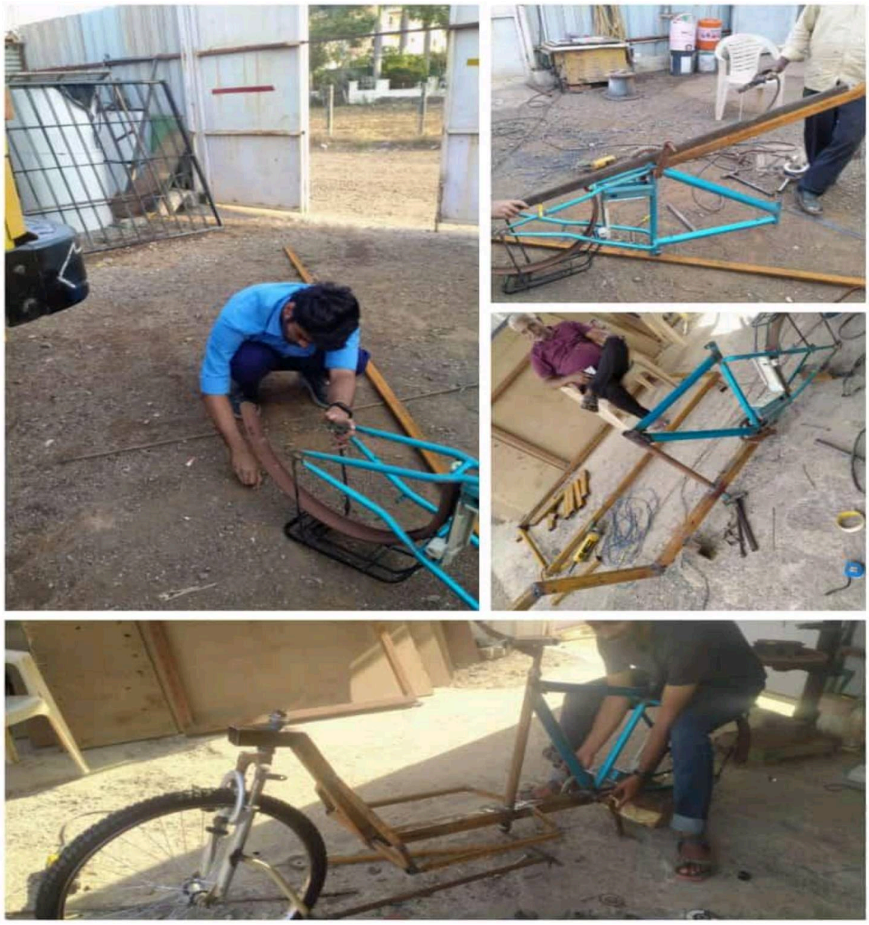


Figure 20: Framework

In this figure, it is showing the part of constructing the frame of Electric cargo bicycle at the mechanical workshop. The bicycle is been modified in the cargo bicycle by providing the space to carry the heavy load applications,

Figure 21:Wheel

In the above figure , the wheel has 36 spokes and the motor has been installed in the back wheel of the bicycle.

Figure 22: Painting of the E-cargo bicycle

In this figure ,after the completion of mechanical model of the bicycle. The painting of the cargo bicycle is done.

Figure 23: Designing and implementation of IT features implementation

In the above figure the designing of the module of automatic headlight system and fingerprint unlock system and the process of the implementing the features on the bicycle.

CHAPTER 10

RESULT AND DISCUSSION

Proposed Model:

Firstly, it is observed that the requirements which will be implemented in the project . According to the requirements the protype model is been developed in software based with the help of catia software. And, after getting familiar with the catia software and developed the E-cargo bicycle protype.

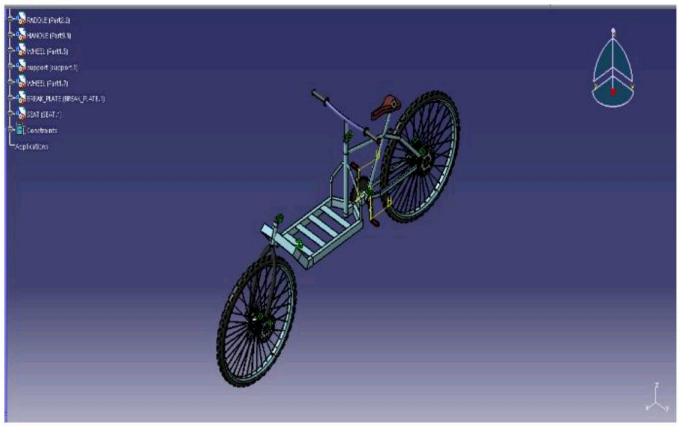


Figure 24: Proposed model

Complete Mechanical Design:

After the protype development in catia software. The former work had to be done was the Design parameters and their calculation to make the complete mechanical design and their fabrication process.

Figure 25 : Complete mechanical design

Bicycle Electrification :

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

Figure 26: Hub motor

Figure 27: Lithium ion battery

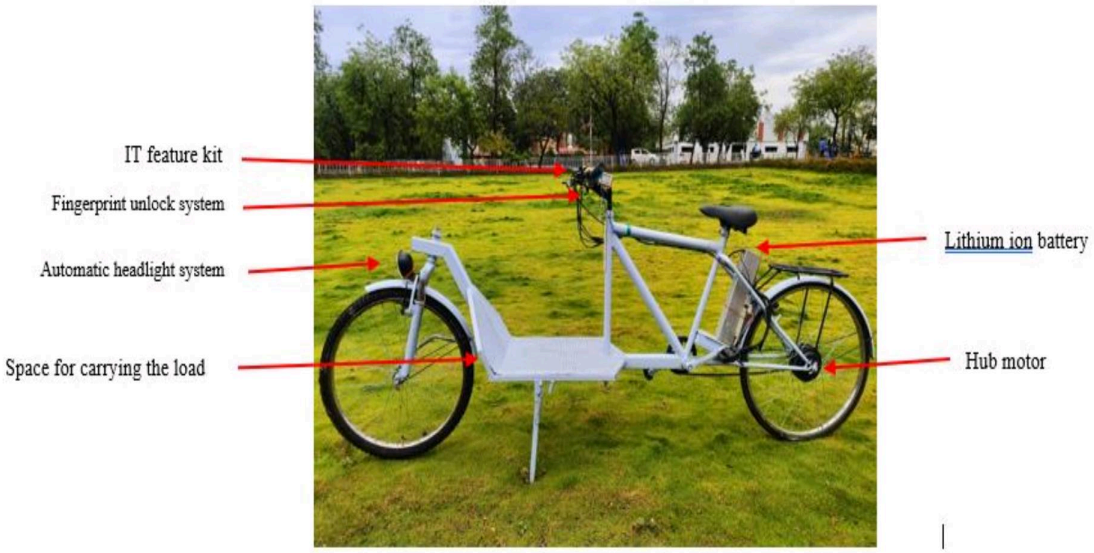


Figure 28 : Electrified E-cargo bicycle

IT Features Implementation:

Implementing smart features will make this Electric cargo bicycle more comfortable for the ride and even enhance the security of the Electric cargo bicycle. That is why, two important features has been installed which are Antitheft fingerprint unlock system (i.e keyless, protect from theft) using components and rating which is Arduino UNO R305, Fingerprint module, Liquid crystal display (LCD), 1 channel Relay module 5A 10V and Automatic headlight system (at the time of night it will be start) using components and rating which is Light Dependent Resistor(LDR), Arduino UNO R305, Headlight, 1 channel Relay module 5A 10V.

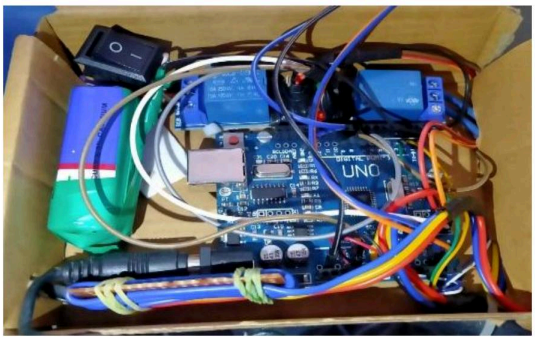


Figure 29:IT feature connection box

FINGERPRINT UNLOCK SYSTEM:

Figure 30:Fingerprint unlock system

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. The components used in this system are Arduino UNO R3, Fingerprint module, Liquid crystal display (LCD), 1 channel Relay module 5A 10V.

AUTOMATIC HEADLIGHT:

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. The components used in this system are Light Dependent Resistor(LDR), Arduino UNO R3, Headlight, 1 channel Relay module 5A 10V.

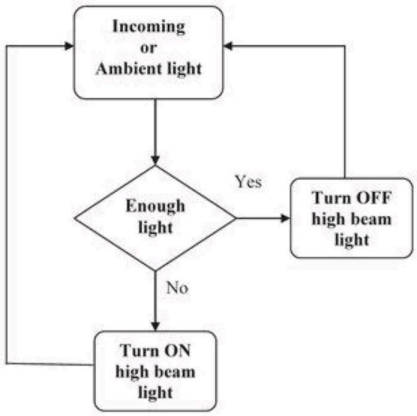


Figure 31:Flowchart of automatic headlight system

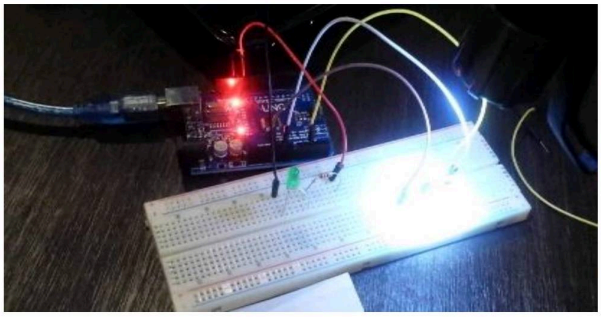


Figure 32:Automatic headlight system

Complete E-cargo Bicycle:

This is the complete developed model of an E-cargo bicycle in which using 1 kw hub motor and 43 Ah lithium ion battery with having smart innovative features which is Antitheft fingerprint detection system using components and rating which is Arduino UNO R305, Fingerprint module, Liquid crystal display (LCD), 1 channel Relay module 5A 10V. And Automatic headlight system using components and rating which is Light Dependent Resistor(LDR), Arduino UNO R305, Headlight, 1 channel Relay module 5A 10V.

Figure 33: Complete model of E-cargo bicycle

CHAPTER 11

CONCLUSION:

In this report it is conclude that E-cargo bicycle is a solution for how people carrying the load in their day-to-day life. So, a design of combinational model 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 the E-cargo bicycle is that by installing Accident detection system (to protect from accident) and battery cooling system the safety and security of the Electric cargo bicycle can be improved.

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 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 2277-8616Link:https://www.ijstr.org/final-print/aug2015/Motor-Torque-Calculations-For-Electric-Vehicle.pdf