A Project Report on

Twin Powered Hybrid Electric Bike Integrated with On-Wheel Charging

Submitted in partial fulfilment of the requirements for the award of the

Bachelor of Technology

in

Electrical and Electronics Engineering

By

P. Sravan Kumar 20A91A0281

Under the Esteemed Supervision of

Dr. V. SRINIVASA RAO, M. Tech., Ph.D.

Professor& HOD-EEE

Department of Electrical and Electronics Engineering

ADITYA ENGINEERING COLLEGE

(An Autonomous Institution)

Approved to AICTE, Permanently Affiliated to JNTUK & Accredited by NAAC with ‘A++’ Grade,

Accredited by NBA, Recognised by UGC under the section 2(f) and 12(b) of the UGC act 1956

Aditya Nagar, ADB Road – Surampalem – 533447, Kakinada Dist., A.P.

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2020-2024

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

CERTIFICATE

This is certify that the main project report entitled

"TWIN POWERED HYBRID ELECTRIC BIKE INTEGRATED WITH ON-WHEEL CHARGING"

being submitted by

P. Sravan Kumar 20A91A0281

in partial fulfilment of the requirements for the award of degree of B. Tech in Electrical and Electronics Engineering from Jawaharlal Nehru Technological University Kakinada is a record of bonafide work carried out by them at Aditya Engineering College (A).

The results embodied in this Project report have not been submitted to any other University or Institute for the award of any degree or diploma.

PROJECT GUIDE	HEAD OF THE DEPARTMENT
Dr. V. SRINIVASA RAO, M. Tech., Ph.D.	**Dr. V. SRINIVASA RAO,** M. Tech., Ph.D.

ACKNOWLEDGEMENT

I take great pleasure in expressing our deep sense of gratitude to our project guide

Dr. V. SRINIVASA RAO, M. Tech., Ph.D. ,Professor, for his valuable guidance during the course of our project work.

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My Family Members and Friends receive my deepest gratitude and love for their support throughout our academic year.

With sincere regards

P. Sravan Kumar 20A91A0281

COURSE OUTCOMES

PROJECT

Regulation: AR20 L T P C

Course Code: 201EE8P01 0 0 16 8

CO1	Build a team to communicate and work together for the project
CO2	Identify a real time problem in electrical engineering to solve the problem.
CO3	Design and analyze solution for the problem.
CO4	Plan and schedule the project work in line with societal needs.
CO5	Use modern tools to derive conclusions.
CO6	Evaluate and present a report on the results.

CO-PO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	1	3	3	2	1
CO2	3	3	1	1	-	1	1	1	3	2	2	1
CO3	3	2	3	2	3	1	1	2	3	3	2	1
CO4	3	2	1	1	2	1	1	1	3	1	2	1
CO5	3	3	2	2	3	1	1	2	3	3	2	-
CO6	3	3	2	2	3	1	1	3	3	3	2	1

ABSTRACT

The studies for hybrid electrical vehicle (HEV) have attracted considerable attention because of the necessity of developing alternative methods to generate energy for vehicles due to limited fuel based energy, global warming and exhaust emission limits in the last century. HEV incorporates internal combustion engine, electric machines and power electronic equipment. In this document, an overview of HEVs is presented. Aim of this project is to introduce the efficient and affordable HEVs. The system combines an internal combustion engine with an electric propulsion system to achieve improved fuel efficiency and reduced emissions. The primary objective of these studies became to enhance the efficiency, variety, and versatility of wheeled motors by integrating electric powered propulsion with a twin-fuel functionality. The results obtained from various checks and analyses highlight numerous key findings and implications for the destiny of hybrid electric powered vehicles. In conclusion this project the development and assessment of the changed hybrid electric two-wheeler constitute a great advancement in sustainable transportation technology like Impressive Mileage and Speed, Dual Fuel Capability, On-Wheel Charging System, Regenerative Braking, Enhanced Safety Features.

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NOMENCLATURE

HEV	**Hybrid electric vehicles**
IC	**Internal Combustion**
EV	**Electric Vehicles**
ICE	**Internal Combustion engine**
BLDC	**Brushless dc motor**
PHEV	**Plug-in hybrids**
BEV	**Battery electric vehicles**
FCV	**Fuel cell vehicles**
CO2	**Carbondioxide**
BMS	**Battery Management system**

CHAPTER-1
INTRODUCTION

1.1 OVERVIEW:

Environmental pollution and limited resources of fossil fuels are two serious problems that urge us for finding a solution. Electrification of the conventional vehicles can be the best solution for these problems. Electrification means the addition of an electric motor as a secondary power source besides Internal Combustion Engine (ICE) [2]. The pure Electric Vehicles (EV) are still not ready to conquer the market from the conventional vehicles due to high cost, low range of travel, lack of infrastructure for battery charging stations and high maintenance of batteries. Biggest barrier to market penetration of EVs in India is the impact that large numbers of EVs will have on an already strained electricity grid. Properly predicting the impact of EVs on the Indian grid will allow better planning of new generation and distribution infrastructure as the EV mission is rolled out. Properly predicting the grid impacts from EVs requires information about the electrical energy consumption of different types of EVs in Indian driving conditions [4]. HEV's play crucial in this transition, from shifting traditional engine to Hybrid vehicles. The hybrid architecture combines the benefits of a conventional vehicle of higher range with the environmental benefits of low emissions of an electric vehicle. This improves the fuel economy of the vehicle and lowers the emissions. Hybrid electric vehicle (HEV) is a type of hybrid vehicle that combines a conventional internal combustion engine (ICE) system with an electric propulsion system (hybrid vehicle drivetrain). The main drawbacks with a Hybrid Electric Vehicle (HEV) are complexity in design and higher price than conventional vehicles [3]. Hybrid Electric Vehicles (HEVs) combine propulsive power from an ICE with the electric motor which is driven by electric energy stored in battery pack [5]. HEVs utilizes power from one or more than one green power sources can effectively reduce air pollution and improve fuel economy at the same time [2].

In this work, the design and development of a 2-wheeler Hybrid Electric Vehicle (HEV) is developed by combining the conventional internal combustion engine (ICE) system with an electric propulsion system is implemented.

1.2. LITERATURE SURVEY:

K. Mohan, S. Sankaranarayanan, Shyam Sundar Devi Prasad, V. Sivasubramaniam and V.Sairam, “Solar powered Hybrid vehicle", presented that global warming is a threat to the society. One of the major reasons is the release of carbon-di-oxide from an automobile exhaust due to the combustion of fossil fuels which pollutes the environment. One of the optimistic solutions for this problem is to use of hybrid vehicles [6] [7].

Yasmeen Malik, Vikas Kumar, “A Review on Hybrid Electric Vehicle”, proposed with growing oil prices and escalating environment worries, cleaner and supportable energy solutions are demanded. Present transportation contributes large amount of energy consumption and emission of pollutants [8]. In this work HEV technology has been analysed, by combining internal combustion engine and battery as the power source. "The document is based on the explanation of hybrid electric vehicle design and development of vehicle, their function, efficiency of Hybrid vehicles.

Saxena “Electrical consumption of two-, three- and four-wheel light-duty electric vehicles in India,” Applied Energy, presented the current scenario of Electrical vehicles. Hybrid Electric Vehicles play a vital role in bridging the gap between EVs and conventional vehicles. With better battery technology, they could be more efficient and provide engaging driving experience. Given its importance in current and future emission scenarios and its near-complete dependence on fossil fuels, innovations in road transport - and particularly vehicle technology - are receiving a lot of attention from decision makers and consumers searching for more efficient mobility [4].

1.3 OBJECTIVE:

The main objective of this project deals with the design and development of two wheeler hybrid electric vehicle and ensures the efficiency of the vehicle. The objective is to proof that the concept of the idea can be realized. The system is capable of on wheel charging with impressive mileage, speed and Advanced sensor integration. The system is capable to show information such as location, by incorporating GPS system to detect the coordinate and display it on the Google Maps which enhances the safety. The system uses smart switching mechanism. Regenerative braking is the hit technology .This function contributes the better fuel economy and reduced emissions compared to traditional vehicles. These hybrid electric vehicles optimizes energy efficiency and enhances performance through intelligent integration of electric propulsion and internal combustion engine technologies.

CHAPTER-2

COMPONENTS DESCRIPTION

2.1 INTRODUCTION

A Hybrid Electric Vehicle is a type of vehicle that uses a combination of an Internal Combustion (IC) engine and an electric propulsion system. The electric powertrain may enhance fuel efficiency, increase performance, or independently propel the vehicle on pure electric power, depending on the type of hybrid system. In simple words, an HEV is a vehicle that comprises a conventional fuel engine and an electric powertrain, wherein the electric motor assists the engine to extract more performance, and better fuel economy, depending on the type of the system.

Unlike an electric vehicle, the working mechanism of an HEV is relatively simple to understand. The below points explain how an HEV works.

- Powering a hybrid electric vehicle is an IC engine and an electric motor.
- The electric motor utilizes the electrical energy stored in the battery pack.
- The battery pack gets charged via regenerative braking or through a generator that is run by the internal combustion engine.
- The electric motor and IC engine work in conjunction to propel the vehicle.
- The additional power from the electric motor assists the engine, and it enhances the performance and improves the fuel economy.
- The battery pack can also power other electrical components such as lights.
- The electric powertrain also saves fuel via the engine start/stop technology, wherein the engine automatically shuts off when idle and starts automatically when the driver presses the throttle pedal.

The rapid growth and development of HEVs has also spurred the development of other emerging technologies that share critical components (e.g. electric motors, batteries) with HEVs, i.e. plug-in hybrid electric vehicles and fuel cell electric vehicles.

Both plug-in hybrids and fuel cell vehicles require technologies for electric propulsion. However, as these emerging technologies are still expensive and require a reliable supply of electricity or hydrogen, these technologies are not expected to play an important role in developing countries soon.

The four key policy-relevant and consumer choice advantages of HEVs over conventional and comparably clean and efficient technology (clean diesel, CNG) can be summarized as follows:

l. Emissions – Available HEV technology will decrease emissions of conventional air pollutants substantially as compared to a standard vehicle on the roads today. While similar emission reductions can be achieved with, e.g. CNG and clean diesel vehicles with advanced emission control technologies, the HEV combines both non-CO2 and CO2 reductions.

2. Energy - HEVs decrease fuel consumption substantially compared to conventional vehicles used today and also compared to CNG and the new generation of cleaner diesel vehicles. Calculations have shown that over the average HEV useful lifetime savings can amount to 6,000 L of fuel.

3. Life Cycle Cost – While HEVs are more expensive initially, the fuel savings are recouped based on mileage and driving conditions.

4. Strategic Steppingstone Technology - HEVs, plug-in hybrids (PHEVs), full electric vehicles (EVs), and fuel cell vehicles (FCVs) share basic technologies such as electric motors, batteries, and power electronics. Therefore, HEVs and plug-in hybrids function as steppingstone technologies to the large-scale electrification of fleets that is required for a long-term reduction of CO2 emissions from road transport, and a low carbon transport sector.

Types of hybrid electric vehicles:

- Battery Electric Vehicles (BEVs)
- Plug-in Hybrid Electric Vehicles (PHEVs)
- Hybrid Electric Vehicles (HEVs)
- Fuel cell electric vehicle

Principles Involved in HEV System:

The HEV system incorporates principles from both internal combustion engine (ICE) and electric motor sides:

Internal Combustion Engine (ICE) Integration: Evaluate existing ICE for efficiency and compatibility. Implement hybridization strategy (series, parallel, or series-parallel) for optimal power delivery. Integrate on-wheel charging through dynamo principle to generate electrical power during motion.

Electric Motor System: Select appropriate electric motor based on performance requirements. Implement regenerative braking system to capture kinetic energy and recharge the battery. Develop battery management system (BMS) for monitoring and controlling battery state-of-charge (SOC) and health.

Energy Storage and Management: Utilize advanced battery packs (e.g., lithium-ion) for storing electrical energy. Integrate ultra-capacitors for rapid energy storage and discharge during peak power demands. Implement power electronics (inverters, converters) to regulate electrical power flow and optimize efficiency.

Additional Points on HEV Operation

In addition to the conversion process, consider the following aspects of HEV operation: Regenerative Braking System: Captures kinetic energy during deceleration, improving overall efficiency and reducing reliance on friction brakes. Optimal Power Distribution: Control systems allocate power between ICE and electric motor based on driving conditions to minimize fuel consumption and emissions.

Basic Components:

The basic components of a hybrid system can vary depending on the specific design and type of hybrid vehicle, but here are some common components:

- **Internal Combustion Engine (ICE)**: This is typically the primary power source in a hybrid system. It can be a gasoline or diesel engine and is responsible for providing propulsion and/or charging the hybrid battery.
- **Electric Motor/Generator**: The electric motor is used to assist the internal combustion engine during acceleration and to provide power during low-speed driving. It also acts as a generator during braking or deceleration to recharge the battery through regenerative braking.

2.1.1. BIKE

Fig 2.1 PULSAR BIKE

Bajaj Pulsar 150(2010) Specifications

Mileage	-
Displacement	149.5 cc
Engine Type	4-Stroke, 2-Valve, engine
No. of Cylinders	1
Max Power	14 PS @ 8500 rpm
Max Torque	13.25 Nm @ 6500 rpm
Front Brake	Disc
Rear Brake	Drum
Fuel Capacity	15 L

2.1.2 Motor:

DC MOTOR

A dc motor or direct current electrical motor is a rotating electro-mechanical device that turns electrical energy into mechanical energy. When dc voltage is applied to the motor terminals, an Inductor (coil) generates a magnetic field that creates rotary motion, as indicated in figure 2.11 below.

Inside the electric motor is an iron shaft wrapped in a coil of wire. This shaft contains two fixed, North and South, magnets on either side. These magnets cause both a repulsive and attractive force, in turn producing torque.

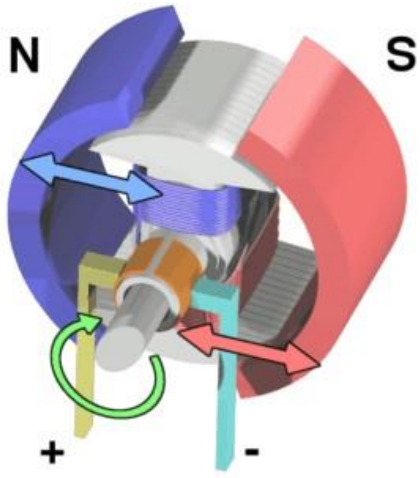


Figure 1 - Inside the DC Motor


Figure 2 - DC Motor

Fig 2.11 DC MOTOR

The Motor Selection Process

The following key points can help us to determine and select the most appropriate motor for application.

1. **Design Requirements** – A design assessment phase where the product development requirements, design parameters, device functionality, and product optimization are studied.
2. **Design Calculations** – Calculations used to determine which motor would be the best solution for the application. Design calculations determine gear ratio, torque, rotating mass, service factor, overhung load, and testing analysis.
3. **Types of DC Motors/** – The most common electrical motors convert electrical energy to mechanical energy. These types of motors are powered by direct current (DC).
   - Brushed Motor
   - Brushless Motor (BLDC)
   - Planetary Gear Motor
   - Spur Gear Motor
   - Stepper Motor
   - Coreless
   - Coreless Brushless

- Servo
- Gear box type

Brushless DC Hub Motor:

Fig 2.12 BLDC HUB MOTOR

A hub motor is an electric motor that is integrated into the hub of a wheel, typically used in electric bicycles, scooters, and some electric vehicles. Instead of having a separate motor connected to the drive train, the hub motor is built directly into the wheel hub, providing propulsion.

This design offers several advantages, including simplified drive train systems, better weight distribution, and often easier maintenance. Hub motors can be located in either the front or rear wheel, or even in both for all-wheel drive setups, depending on the vehicle's design and intended use.

Hub motor working principle:

The working principle of a hub motor is an electronic phase changer (switching circuit). According to the position sensor signal, it controls the sequence and time of energizing the stator winding to generate the rotating magnetic field and drive the rotor to rotate.

The electric vehicle wheel hub motor assembly and control system belong to the automotive parts, which is the key core component of electric vehicle parts. The system is characterized by the unique design of the motor system, brake system and suspension system in one, with permanent magnet brush-less synchronous electric vehicle hub motor and switched reluctance hub motor, which can be controlled by PWM and AC frequency control. This perfect product design has the features of high efficiency, lightweight, long life, low noise, strong matching, simple structure, easy assembly, complete function, independent suspension, safety and reliability, without axle, transmission and other mechanical parts and directly hanging on the body to install tires, transmission consumption is equal to zero, and rotation efficiency is 100 percent. The working principle of a hub motor is relatively straightforward. Essentially, it functions like any other electric motor but is integrated into the hub of a wheel. Here's a breakdown of its operation:

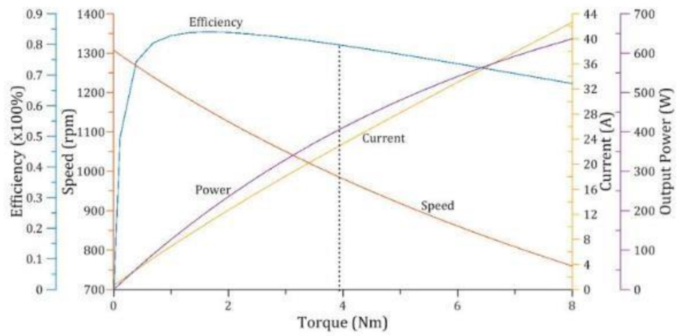
1. Electromagnetic Interaction: Like all electric motors, a hub motor relies on the interaction between magnetic fields to generate rotational motion. It consists of a stationary part (the stator) and a rotating part (the rotor).

2. Stator: The stator is typically fixed within the wheel hub and contains a series of coils wound around a core. These coils are connected to an external power source, usually a battery, and when an electric current flows through them, they generate a magnetic field.

3. Rotor: The rotor is the part of the motor that rotates. It contains permanent magnets arranged in a specific configuration. When the stator's magnetic field interacts with the magnetic field produced by the rotor, it creates a force that causes the rotor to rotate.

Motor Specifications – Once the design calculations are performed and the application parameters are defined, you can use this data to determine which motor will best fit application. Some of the most common specs to consider when selecting a motor would be:

- Voltage
- Current
- Power
- Torque
- RPM
- Life Expectancy/Duty Cycle
- Rotation (CW or CCW)
- Shaft Diameter and Length
- Enclosure Restrictions



Characteristic curves (efficiency, speed, current and output power as a function of torque) of the designed BLDC motor.

FIG 2.13 CHARACTERISTIC CURVES

FIG 2.14 HUB MOTOR

When determining the load capacity of a hub motor for a particular application, it's essential to consider not only the motor itself but also factors such as the vehicle's frame, suspension, tires,

and overall design. Additionally, manufacturers may provide specific load ratings or guidelines for their hub motors based on testing and engineering analysis.

Without the carbon brushes and copper commutator, the only wear items in a BLDC motor are the bearings. This makes the BLDC motor far superior when long operating life is required.

Because the windings are stationary and in thermal contact with the outer case, heat is dissipated more easily, allowing for higher power operation in the same package size. Also, with no brushes and commutator, the overall length is shorter.

Without the mechanical contact of the brushes, higher speeds and peak loads are practical.

Carbon brushes are a design feature from early electric motors. They are still used today as an inexpensive alternative to brushless motors.

In brushed motors, a carbon brush serves as the means to conduct electricity to the rotor. The disadvantage is that friction between the stationary brushes and moving rotor can cause wear and loss of power.

Brushless motors replace the less-durable brush design with an electronic controller. The controller controls which coils in the stator are active, making for an ever-changing magnetic pull.

BLDC motors boast a higher speed range and better torque to speed ratio. They also deliver a higher level of torque relative to their size making them ideal in applications such as power tools.

2.1.3 IC ENGINE (Four Stroke):

A four-stroke engine is an internal combustion engine that utilizes four distinct piston strokes (intake, compression, power, and exhaust) to complete one operating cycle. A complete operation in a four-stroke engine requires two revolutions (7200) of the crankshaft.

Parts of a Four Stroke Engine Piston: In an engine, a piston transfers the expanding forces of gas to the mechanical rotation of the crankshaft through a connecting rod.

Crankshaft: A crankshaft is a part that converts the reciprocating motion to rotational motion.

Connecting Rod: It transfers motion from a piston to a crankshaft, acting as a lever arm.

Flywheel: The flywheel is a rotating mechanical device that is used to store energy.

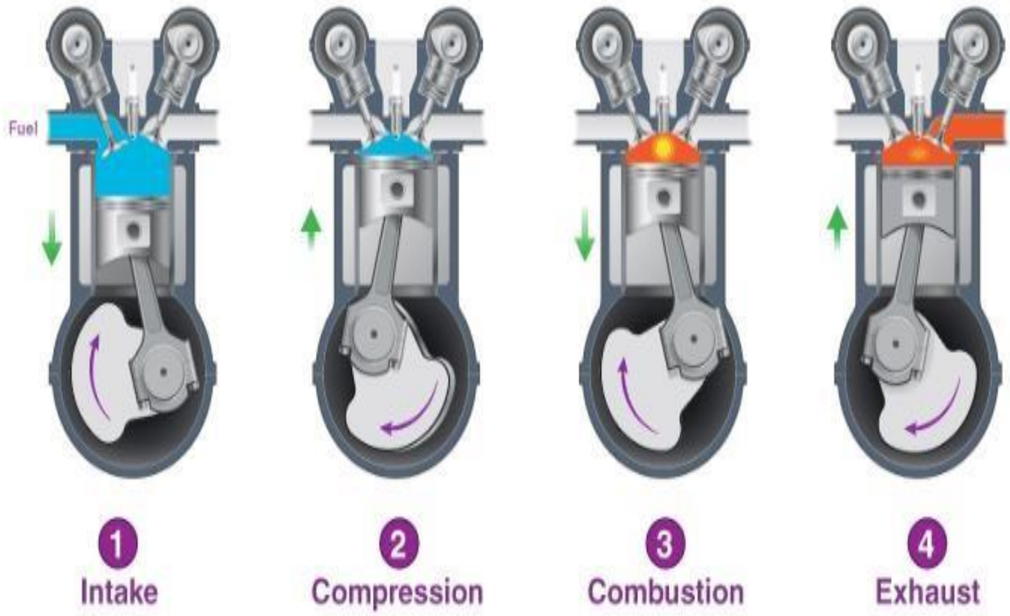


FIG 2.15 IC ENGINE

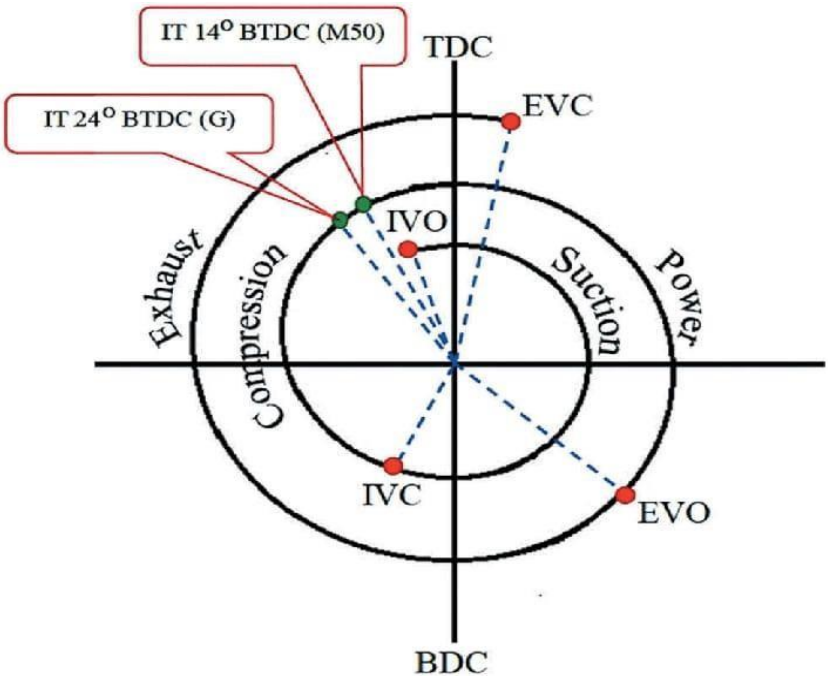


FIG 2.16 TIMING DIAGRAM OF FOUR STROKE ENGINE

Inlet and Outlet Valves: It allows us to enter fresh air with fuel & to exit the spent air-fuel mixture from the cylinder.

Spark Plug: It is a device that delivers electric current to the combustion chamber, which ignites the air-fuel mixture leading to the abrupt gas expansion.

Four Stroke Engine Cycle:

Suction/Intake Stroke: Intake stroke occurs when the air-fuel mixture is introduced to the **combustion** chamber. In this stroke, the piston moves from TDC (Top Dead Center – the farthest position of the piston to the crankshaft) to BDC (Bottom Dead Center – the nearest position of the piston to the crankshaft.) The movement of the piston towards the BDC creates a low-pressure area in the cylinder.

The inlet valve remains to open a few degrees of crankshaft rotation after BDC.

The intake valve then closes, and the air-fuel mixture is sealed in the cylinder

Key points

- Inlet Valve – Open
- Outlet Valve – Closed
- Crankshaft Rotation – 1800

Compression Stroke: In compression stroke, the trapped air-fuel mixture is compressed inside the cylinder. During the stroke, the piston moves from BDC to TDC, compressing the air-fuel mixture. The momentum of the flywheel helps the piston move forward. Compressing the air-fuel mixture allows more energy to be released when the charge is ignited. The charge is the volume of compressed air-fuel mixture trapped inside the combustion chamber ready for ignition. The inlet and outlet valves must be closed to ensure that the cylinder is sealed, resulting in compression.

- Key points
- Inlet Valve – Closed
- Outlet Valve – Closed
- Crankshaft Rotation – 1800 (Total 3600)

Power/Combustion Stroke: The second rotation of the crankshaft begins when it completes a full rotation during the compression stroke. The power stroke occurs when the compressed air-fuel mixture is ignited with the help of a spark plug. Ignition or Combustion is the rapid, oxidizing chemical reaction in which a fuel chemically combines with oxygen in the atmosphere and releases energy in the form of heat. The hot expanding gases force the piston head away from the cylinder head.

- Key points
- Inlet Valve – Closed
- Outlet Valve – Closed
- Crankshaft Rotation – 1800 (Total 5400)

Exhaust Stroke: As the piston reaches BDC during the power stroke, combustion is complete, and the cylinder is filled with exhaust gases.

The exhaust valves open during this stroke, and the inertia of the flywheel and other moving parts push the piston back to TDC, forcing the exhaust gases through the open exhaust valve. At the end of the exhaust stroke, the piston is at TDC, and one operating cycle has been completed.

- Key points
- Inlet Valve – Closed
- Outlet Valve – Open
- Crankshaft Rotation – 1800 (Total 7200).

2.1.4 BATTERY

Lithium**-ion is** a type of rechargeable battery which uses the reversible reduction of lithium ions to store energy. The anode (positive electrode) of a conventional lithium-ion cell is typically graphite made from carbon. The cathode (negative electrode) is typically a metal oxide. The electrolyte is typically a lithium salt in an organic solvent. It is the predominant battery type used in portable consumer electronics and electric vehicles.

It also sees significant use for grid-scale energy storage and military and aerospace applications. Compared to other rechargeable battery technologies, Li-ion batteries have high energy densities, low self-discharge, and no memory effect .Chemistry, performance, cost and safety characteristics vary across types of lithium-ion batteries. Most commercial Li-ion cells use intercalation compounds as active materials. The anode or positive electrode is usually graphite, although silicon-carbon is also being increasingly used. Cells can be manufactured to prioritize either energy or power density.

FIG 2.17 LITHIUM ION BATTERY

During charge and discharge, lithium ions shuttle between the positive and negative electrodes without destroying their core structures in LIBs.

Lithium Ferro Phosphate LFP battery is a type of lithium-ion battery using lithium-ion phosphate ($LiFePO_4$) as the cathode material, and a graphitic carbon electrode with a metallic backing as the anode. Because of their low cost, high safety, low toxicity, long cycle life and other factors, LFP batteries are finding a number of roles in vehicles.

LFP chemistry offers a considerably longer cycle life than other lithium-ion chemistries. Under most conditions it supports more than 3,000 cycles, and under optimal conditions it supports more than 10,000 cycles.

Higher discharge rates needed for acceleration, lower weight and longer life makes this battery type ideal for forklifts, bicycles and electric cars. 12 V $LiFePO_4$ batteries are also gaining popularity as a second (house) battery for a caravan, motor home or boat.

LiFePO4 batteries are not the cheapest in the market, but due to a long life span and zero maintenance, it's the best investment you can make over time.

2.1.5 Sensors:

The Temperature sensor is a key component in Li-Ion battery charging and safety. They provide critical temperature data required to keep the Li-Ion battery in optimum condition during the charging cycle. Careful management of temperature during charging prolongs battery life and avoids hazards inherent to Li-Ion battery. However, it is important that these sensors be protected from the working environment of EVs, such as vibration, shock, water, contaminants, etc. in extreme conditions they will help to prevent catastrophic events such as battery meltdowns, motors overheating, power component malfunction and ultimately fires.

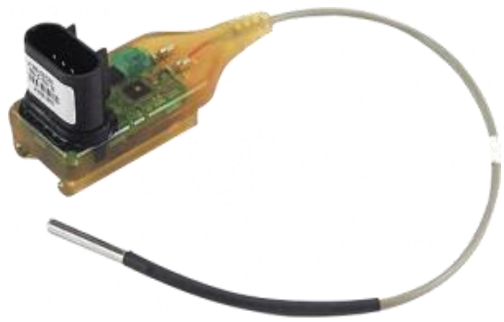


Fig 2.18 TEMPERATURE SENSOR

A Hall Effect Sensor is essentially a transducer based on the principle of Hall Effect. A voltage is produced across an electric conductor when a magnetic field is applied to it in a direction perpendicular to the flow of current, is called Hall Effect.

A Hall Effect Sensor is a solid-state device that applies this principle to determine the position, speed and various other attributes required to run a BLDC motor efficiently. While internal combustion engines have auxiliary systems running on electric motors such as ABS and power windows, electric vehicle's drivetrain itself runs on motors. In such case, hall-effect sensors become all the more important as their accuracy directly impacts the EV"s performance.

The use of Hall Effect sensors in electric vehicles allows for precise monitoring and control of the motor's speed and position, which in turn enables the vehicle to deliver efficient and reliable performance. For example, the sensor allows the vehicle to accurately control the motor's torque output, which is essential for maintaining the vehicle's stability and traction control.

The Hall Effect sensor also has some role to play in regenerative braking, which is a key feature of electric vehicles. It allows them to recover energy during braking and store it in the battery for later use. This not only improves the vehicle's overall energy efficiency, but also extends the vehicle's range which is USP of any EV model. In addition, the Hall effect sensor also plays a role in the safety of electric vehicles.

FIG 2.19 HALL SENSOR

By monitoring the position of the wheels and other components, the sensor can detect any potential issues or malfunctions in the system.

The diver can be alerted in time and corrective action can be taken to prevent accidents or damage to the vehicles.

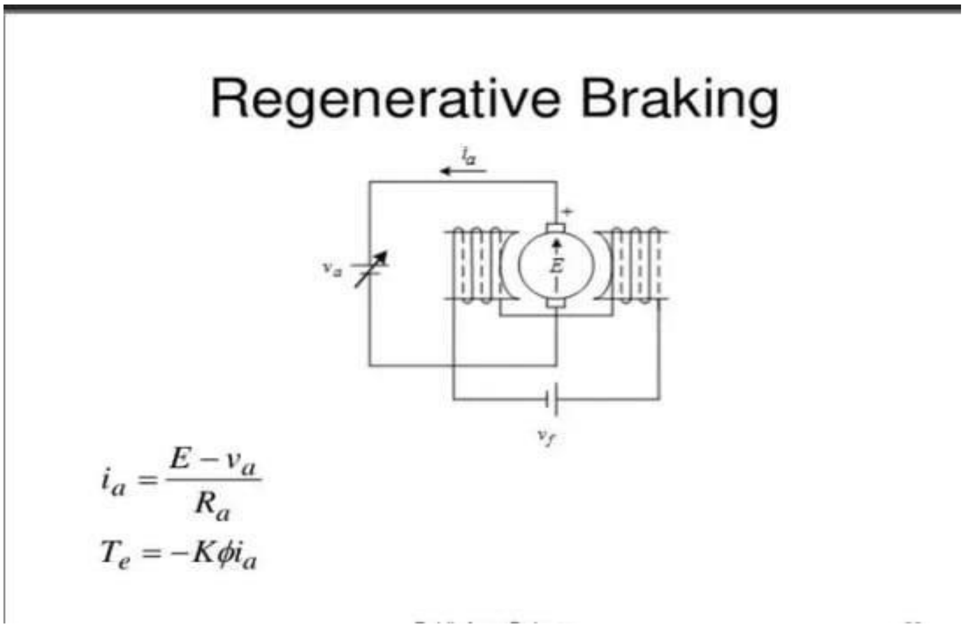
- Hall Effect Sensor is a very simple device comprising of magnets, hence, very cost-effective for motor control systems.
- For the same reason, these sensors are easy to implement in advanced motor control systems for EVs and other automotive solutions.
- Most BLDC motors come equipped with these sensors.

2.1.6 Regenerative braking:

Regenerative braking is a mechanism found on most hybrid and full-electric vehicles. It captures the kinetic energy from braking and converts it into the electrical power that charges the vehicle’s high voltage battery. Regenerative braking also slows the vehicle down, which assists the use of traditional brakes.

In a conventional braking system, a vehicle slows down due to friction between the brake pads and rotors. But this system is highly inefficient when it comes to conserving energy. Nearly all of the kinetic energy propelling vehicle forward is lost as heat when you apply the brakes. That’s a lot of wasted energy!

Regenerative braking solves this problem by recapturing upwards of 70% of the kinetic energy that would otherwise be lost during braking.



The amount of energy recovered depends on the vehicle model and driving behaviour. The drivetrain is powered by a battery pack that powers a motor (or motors), creating torque–rotational force–on the wheels. In other words, electrical energy from the battery becomes mechanical energy that spins the wheels. With regenerative braking, the energy from your spinning wheels is used to reverse the direction of electricity - from the electric motor(s) to the battery.

The benefits of regenerative braking are reflected on the fact that the vehicle batteries are recharged during braking, vehicle maintenance costs are reduced, the service life of discs and drum brakes on the vehicle is extended, brake non-exhaust emission is reduced, and heat energy emission is reduced, too.

Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution.
Electric vehicles and hybrids use both regenerative braking. Regenerative braking works just fine in low-speed, stop-and-go situations.

2.1.7 Arduino:

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board.

There are currently two versions of the Arduino IDE, one is the IDE 1.x.x and the other is IDE 2.x. The IDE 2.x is new major release that is faster and even more powerful to the IDE 1.x.x. In addition to a more modern editor and a more responsive interface it includes advanced features to help users with their coding and debugging.
Arduino Uno is popular for several reasons. Firstly, it is a low-cost electronic board that is affordable for a wide range of users. Secondly, it follows an open hardware approach, allowing users to modify and customize it according to their needs. Thirdly, Arduino Uno is flexible and versatile, making it suitable for various applications such as prototyping, small product runs, Internet of Things (IoT) projects, and educational projects.

Lastly, Arduino Uno offers a wide range of software and hardware features, including communication capabilities, which make it a powerful tool for creating innovative projects.

The following steps can guide you with using the offline IDE (you can choose either IDE 1.x.x or IDE 2.x):

Download and Install the IDE: You can download the IDE from the official Arduino website. Since the Arduino uses a USB to serial converter (which allows it to communicate with the host computer), the Arduino board is compatible with most computers that have a USB port. Of course, you will need the IDE first. Luckily, the Arduino designers have released multiple versions of the

IDE for different operating systems, including Windows, Mac, and Linux. In this tutorial, we will use Window 10, so ensure that you download the correct version of the IDE if you do not have Windows 10.

FIG 2.23 ARDUINO APPLICATION

Once downloaded, install the IDE and ensure that you enable most (if not all) of the options, INCLUDING the drivers.

Get the Arduino COM Port Number:

Next, you'll need to connect the Arduino Uno board to the computer. This is done via a USB B connection. Thanks to the wonderful world of USB, we do not need to provide power to the Arduino, as the USB provides 5V up to 2A. When the Arduino is connected, the operating system should recognize the board as a generic COM port (for example, Arduino Uno uses a CH340G, which is an RS-232 serial to USB converter).

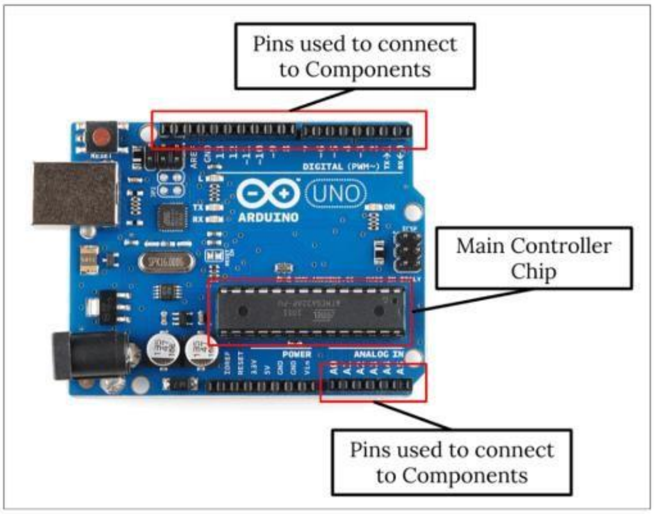


FIG 2.2 ARDUINO

Once it’s recognized, we will need to find out what port number it has been assigned. The easiest way to do this is to type “device manager” into Windows Search and select Device Manager when it shows.

CONNECT AND DETECT AN ARDUINO:

- Download Arduino IDE using below References URL. https://www.arduino.cc/en/software
- Once you Download the Arduino IDE and install using below References URL. https://www.arduino.cc/en/guide/windows

How to write Connect the port and board the Arduino IDE:

You'll need to select the entry in the Tools > Board menu that corresponds to your Arduino board.

FIG 2.22 ARDUINO TOOLS

Select the serial device of the board from the Tools | Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your board and re-open the menu; the entry that disappears should be the Arduino board. Reconnect the board and select that serial port.

UPLOAD THE PROGRAM:

Now, simply click the "Upload" button in the environment. Wait a few seconds - you should see the RX and TX leds on the board flashing. If the upload is successful, the message "Done uploading." will appear in the status bar.

Figure 2.23 Upload the Program

2.1.8 GSM TECHNOLOGY:

GSM is a mobile communication modem; it stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970.

FIG 2.24 GSM MODULE

It is a widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operate at the 850MHz, 900MHz, 1800MHz, and 1900MHz frequency bands.

GSM technology was developed as a digital system using the time division multiple access (TDMA) technique for communication purposes. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has the ability to carry 64 kbps to 120 Mbps of data rates.

There are various cell sizes in a GSM system such as macro, micro, Pico, and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, Pico, and umbrella cells. The coverage area of each cell varies according to the implementation environment.

A GSM (Global System for Mobile Communications) module is a specialized type of modem that enables devices to communicate wirelessly over a cellular network. The module is typically a small electronic device that contains a SIM card slot and various communication components, such as a microcontroller, radio frequency (RF) circuitry, and antenna.

Here's a general overview of how a GSM module works:

The GSM module is powered on and initializes itself by connecting to the cellular network using the SIM card.

The module searches for a network and establishes a connection with a base station or cell tower. This allows the device to communicate with other devices over the network.

The module can then send and receive data, such as voice calls, text messages, and internet data, over the cellular network

When the device needs to communicate with another device, it sends the data to the GSM module, which then encodes the data into a format that can be transmitted over the cellular network.

The GSM module then sends the data over the network to the intended recipient.

Similarly, when the device receives data from another device, the GSM module decodes the data and sends it to the device

2.1.9 THROTTLE

A throttle is a device used to regulate the flow of a fluid or energy source in an engine or motor system. In the context of engines, particularly internal combustion engines, the throttle controls

FIG 2.25 THROTTLE

The amount of air-fuel mixture entering the engine cylinders, thereby regulating engine power and speed.

In the case of electric vehicles, including those with hub motors, a throttle typically controls the power output of the electric motor. It allows the user to adjust the speed or acceleration of the vehicle by regulating the amount of electrical power delivered to the motor.

Throttles in electric vehicles can take various forms, such as:

1. Hand Throttle: A hand-operated lever or twist grip that the rider can manipulate to increase or decrease the motor's power output. This is common in electric bicycles and scooters.

2. Pedal Assist Sensor: In some electric bicycles, a pedal assist sensor detects the rider's pedaling motion and adjusts the motor's power output accordingly. The rider effectively controls the throttle indirectly by pedaling.

FIG THROTTLE

3. Foot Pedal: In electric vehicles with foot-operated controls, such as some electric scooters or go-karts, a foot pedal can serve as a throttle, allowing the user to vary the motor's power output by pressing down on the pedal.

4. Throttle Control Unit: In more advanced electric vehicle systems, the throttle may be controlled electronically through a throttle control unit, which interprets input from the user interface (such as a throttle lever or pedal) and adjusts the motor's power output accordingly. Overall, the throttle is an essential component of motor control systems in electric vehicles, providing the user with convenient and intuitive control over the vehicle's speed and performance. The throttle in electric vehicles, including those with hub motors, is used to control the vehicle's speed or acceleration by regulating the power output of the electric motor. Here's how it's typically used:

1. Acceleration: When the user wants to accelerate, they manipulate the throttle control mechanism, such as a hand lever or twist grip on an electric bicycle or scooter, or a foot pedal in other types of electric vehicles.

By opening the throttle, they increase the amount of electrical power delivered to the motor, which in turn increases the vehicle's speed or acceleration.

2. Deceleration: Conversely, when the user wants to slow down or stop, they release the throttle or apply the brakes, depending on the vehicle's design and control system. Releasing the throttle reduces the power delivered to the motor, which slows down the vehicle. In some cases, regenerative braking may also be employed, where the motor functions as a generator to convert kinetic energy back into electrical energy, further assisting in slowing down the vehicle.

3. Speed Control: Throughout the vehicle's operation, the user can adjust the throttle to maintain a desired speed. By modulating the throttle position, they can fine-tune the vehicle's speed to suit the road conditions, traffic, or personal preference.

4. User Interface: The throttle control mechanism often includes a user interface that provides feedback to the user, such as an LCD display showing speed, battery level, or other relevant information. This allows the user to monitor the vehicle's status and adjust their throttle input accordingly.

5. Integration with Motor Controller: The throttle input is typically integrated with the motor controller, which interprets the user's commands and adjusts the motor's power output accordingly. The motor controller regulates the flow of electrical power from the battery to the hub motor based on the throttle input, ensuring smooth and responsive operation of the vehicle.

2.20 Chopper

A chopper refers to an electronic device designed to control or convert the electrical power in a direct current system. It operates by interrupting or "chopping" the input DC voltage into pulses using semiconductor switches like thyristors or transistors .

The key advantage of choppers lies un their ability to efficiently control the average output voltage by adjusting the duty cycle of the pulse-width modulation waveform.
Choppers are often classified based on their operating modes , such as :

- Step Up Chopper
- Step Down Chopper
- Step up/ down chopper

A step-up chopper increases the output voltage from the input , while a step-down chopper decreases it . Step-up/down chopper offer versatility by providing both higher and lower output voltages. A chopper refers to an electronic device designed to control or convert the electrical power in a direct current system. It operates by interrupting or "chopping" the input DC voltage into pulses using semiconductor switches like thyristors or transistors. The key advantage of choppers lies un their ability to efficiently control the average output voltage by adjusting the duty cycle of the pulse-width modulation waveform. Choppers are often classified based on their operating modes , such as :

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A step-up chopper increases the output voltage from the input, while a step-down chopper decreases it. Step-up/down chopper offer versatility by providing both higher and lower output voltages.

A step-up chopper operates based on the principle of controlled switching to increase the output voltage. The fundamental principle involves the manipulation of duty cycle of a semiconductor switch, typically a transistor. The chopper circuit alternately connects and disconnects the input voltage source to an energy storage element, such as an inductor at a high frequency.

During the on state of the switch, energy accumulates in the inductor, storing magnetic flux. When the switch turns off, the inductor discharges its stored energy through a diode, and the output voltage across the load is the sum of the input voltage and the induced voltage from the inductor.

By adjusting the duty-cycle is the ratio of the on-time to the total switching period is the average output voltage can be controlled. This process allows a step-up chopper to boost the input voltage to a higher level, making it valuable in applications where an elevated voltage is required, such as in DC-DC converters and renewable energy systems.

Efficient energy transfer and regulation are achieved by carefully modulating the switches on/off periods, ensuring that the output voltage meets the desired specifications.

The energy stored in the inductor during on state is transferred to the load during off state, resulting in an increased output voltage.

The relationship between the input and output voltages is influenced by the duty cycle of the PWM signal .A higher duty cycle leads to a higher output voltage and vice versa.

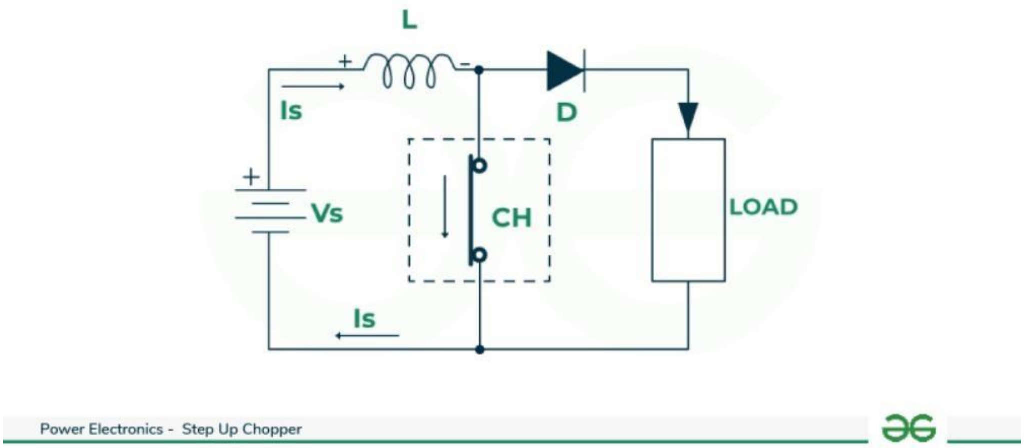

FIG 2.28 CHOPPER

CHAPTER-3

MODELLING AND HARDWARE DESIGNING

Conventional Two Wheeler:

We start through deciding on a suitable two-wheeler that meets our necessities that is Pulsar 150. The present elements are then modified or replaced to accommodate the brand new hybrid gadget. This contains structural modifications to the vehicle body and the elimination of a few parts.

On-Wheel Charge Mechanism:

We then deploy an alternator and join it to the on-wheel fee mechanism. This involves both mechanical and electrical modifications. The alternator is configured to fee the battery every time the automobile is in movement.

Smart Switching Mechanism:

A manage unit is hooked up and programmed to interchange between the IC engine and the electric motor based at the automobile's pace, battery degree, and other factors. This entails each hardware installation and software program programming.

Re-modeling of suspension:

To cut the front wheel of suspension rods by fixing of disc break. The hub motor is fixing in front wheel of bike because the back wheel will not support the bike. The main Reason is breaking system, so that we are fixing hub motor to front wheel. It is freely moving any load is not applied in front wheel.

Hub Motor connection and trail run:

During our testing phase, we conducted trials to assess the performance of the hub motor under no load conditions. Our objective was to understand the motor's capabilities and behavior in a controlled environment without external load factors influencing its performance.

Test Parameters:

Motor Type: Hub Motor

Load Condition: No load (free spinning)

Speed Mode: First speed mode

Test Results: Upon conducting the test, we observed that the hub motor achieved a speed of 49 km/h in the first speed mode under no load conditions. This speed was achieved through the motor's inherent capabilities without any external resistance or load applied.

Observations:

The motor demonstrated smooth operation and responsiveness in the absence of load.

The first speed mode allowed the motor to reach a significant speed, showcasing its potential performance range.

The achieved speed of 49 km/h provides valuable insights into the motor's maximum speed capacity under ideal, unloaded conditions.

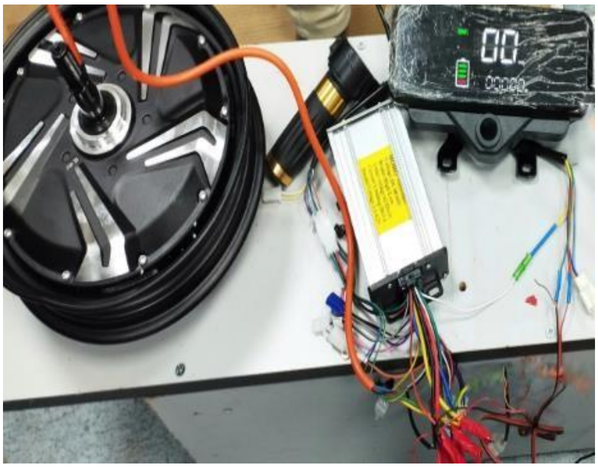

FIG 3.1 BLDC TESTING

Calculations:

Motor Efficiency (η_motor) = 90% = 0.90

Battery Efficiency (η_battery) = 95% = 0.95

Motor Power (P_motor) = 2000 W

Battery Voltage (V_battery) = 72 V

Battery Capacity (Ah) = 34.7 Ah

Step 1: Calculate Battery Capacity in Watt-hours (Wh) Battery Capacity

(Wh)=battery×Capacity (Ah)

Battery Capacity (Wh)=(V)battery×Capacity (Ah) Battery Capacity

(Wh)=72 V×34.7 Ah=2498.4 Wh

Step 2: Calculate Motor Efficiency-adjusted Power Consumption motor effective=motor×Motor Efficiency motor effective=Pmotor×Motor Efficiency motor effective=2000 W×0.90=1800 W

Step 3: Calculate Energy Consumption per Kilometer (Wh/km) consumption=motor effective/(V)system consumption=1800 W/72 V=25 Wh/km

Step 4: Energy Consumption per Kilometer considering Battery Efficiency consumption =consumption/Battery Efficiency consumption=25 Wh/km/0.95 ≈26.32 Wh/km

Step 5: Estimate Range (Mileage) Estimated Range (km)=Battery Capacity

(Wh)/consumption

Estimated Range (km)=(2498.4 Wh)/26.32 Wh/km ≈94.88 km

The internal combustion (IC) engine vehicle achieved a mileage of 45 kilometers per liter under manual testing conditions with a speed range of 60 to 80 kilometers per hour.

2. Electrical Connections:

In electric vehicle (EV) bikes, the electrical connections are crucial for transmitting power from the battery to the electric motor, controlling various systems, and enabling communication between different components. Here's a brief overview of the electrical connections in EV bikes:

1. Battery Pack: The battery pack is the primary power source in an EV bike. It is connected to the electric motor controller and other electronic components through highvoltage cables.

2. Electric Motor Controller: This component regulates the power supplied to the electric motor based on inputs from the throttle and other sensors. It is connected to the battery pack, throttle, brake sensors, and motor.

3. Electric Motor: The electric motor converts electrical energy from the battery into mechanical energy to drive the wheels of the bike. It is connected to the motor controller and the bike's drivetrain.

4. Throttle: The throttle is used by the rider to control the speed of the bike. It sends signals to the motor controller to adjust the power output of the electric motor.

5. Brake Sensors: Sensors in the brake system detect when the rider applies the brakes and send signals to the motor controller to engage regenerative braking or cut power to the motor for safety.

6. Display Panel: The display panel provides information to the rider, such as speed, battery level, and assist mode. It is connected to the motor controller and other sensors on the bike.

7. Lights and Accessories: Electrical connections also power the bike's lights, horn, and other accessories. These components may be connected directly to the battery or through the bike's electrical system.

Overall, the electrical connections in EV bikes enable the efficient and safe operation of the vehicle by facilitating power distribution, control, and communication between various components.

Connection of Controller:

In electric vehicles, including EV bikes, the controller plays a critical role in managing the flow of electricity from the battery to the electric motor. Here's how the controller is typically connected within an EV bike system:

1. Battery Connection: The controller is directly connected to the battery pack. This connection allows the controller to draw power from the battery to drive the electric motor and other electrical systems on the bike.

2. Motor Connection: The controller is also connected to the electric motor. This connection enables the controller to regulate the speed and torque output of the motor based on input from the rider (via the throttle) and other sensors.

3. Throttle Connection: The controller receives input from the throttle, which is typically a hand-operated device that controls the speed of the bike. The throttle sends signals to the controller, indicating the desired level of acceleration or deceleration.

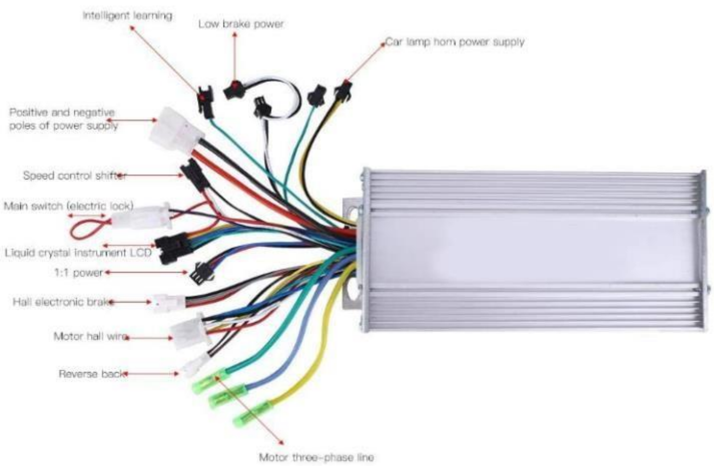

FIG 3.2 CONTROLLER

4. Brake Sensors Connection: The controller may also be connected to sensors in the brake system. These sensors detect when the rider applies the brakes and send signals to the controller to engage regenerative braking or cut power to the motor for safety.

5. Display Panel Connection: In some EV bike setups, the controller communicates with the display panel. The display panel provides information to the rider, such as speed, battery level, and assist mode. The controller may send data to the display panel for real-time monitoring and feedback.

6. Temperature Sensors Connection: In high-performance EV bikes, temperature sensors may be connected to the controller to monitor the temperature of critical components such as the motor and battery pack. This helps prevent overheating and ensures safe operation.

These connections allow the controller to efficiently manage the power flow within the EV bike system, optimizing performance, efficiency, and safety. Additionally, the controller may have other connections for programming, diagnostics, or communication with external devices such as smartphone apps or telemetry systems.

E connection process of an EV bike involves assembling and linking various electrical and mechanical components to create a functional electric propulsion system. Here's a generalized overview of the connection process:

1. Battery Installation: Begin by installing the battery pack onto the bike frame. Depending on the design, the battery might be integrated into the frame or mounted externally.

2. Motor Mounting: Attach the electric motor to the bike frame or wheel hub, depending on whether it's a hub motor or mid-drive motor. Ensure proper alignment and secure mounting.

3. Controller Placement: Install the motor controller in a suitable location on the bike frame. This can vary depending on the bike's design and available space. Ensure adequate ventilation to dissipate heat generated by the controller.

4. Wiring Routing: Route the wiring harnesses from the battery, motor, throttle, brake sensors, display panel, and other electrical components to the controller. Secure the wiring to the frame using zip ties or cable clips, ensuring they are protected from damage and do not interfere with moving parts.

5. Battery Connection: Connect the battery pack to the controller using high-voltage cables. Ensure proper polarity and secure connections to prevent short circuits or electrical faults.

6. Motor Connection: Connect the electric motor to the controller using appropriate motor phase wires. Ensure proper phase sequence and secure connections to prevent electrical issues or motor damage.

7. Throttle and Brake Sensors Connection: Connect the throttle and brake sensors to the controller according to the manufacturer's instructions. Ensure proper routing of wires and secure connections to enable smooth operation and safety features like regenerative braking.

8. Display Panel Installation: Install the display panel on the handlebars or another convenient location. Connect it to the controller using the provided cable or wireless connection, depending on the model.

9. Final Checks and Testing: Double-check all connections for proper tightness and polarity. Test the bike's electrical system by turning on the power and verifying that all components function correctly. Test the throttle, brakes, motor response, and display panel readings.

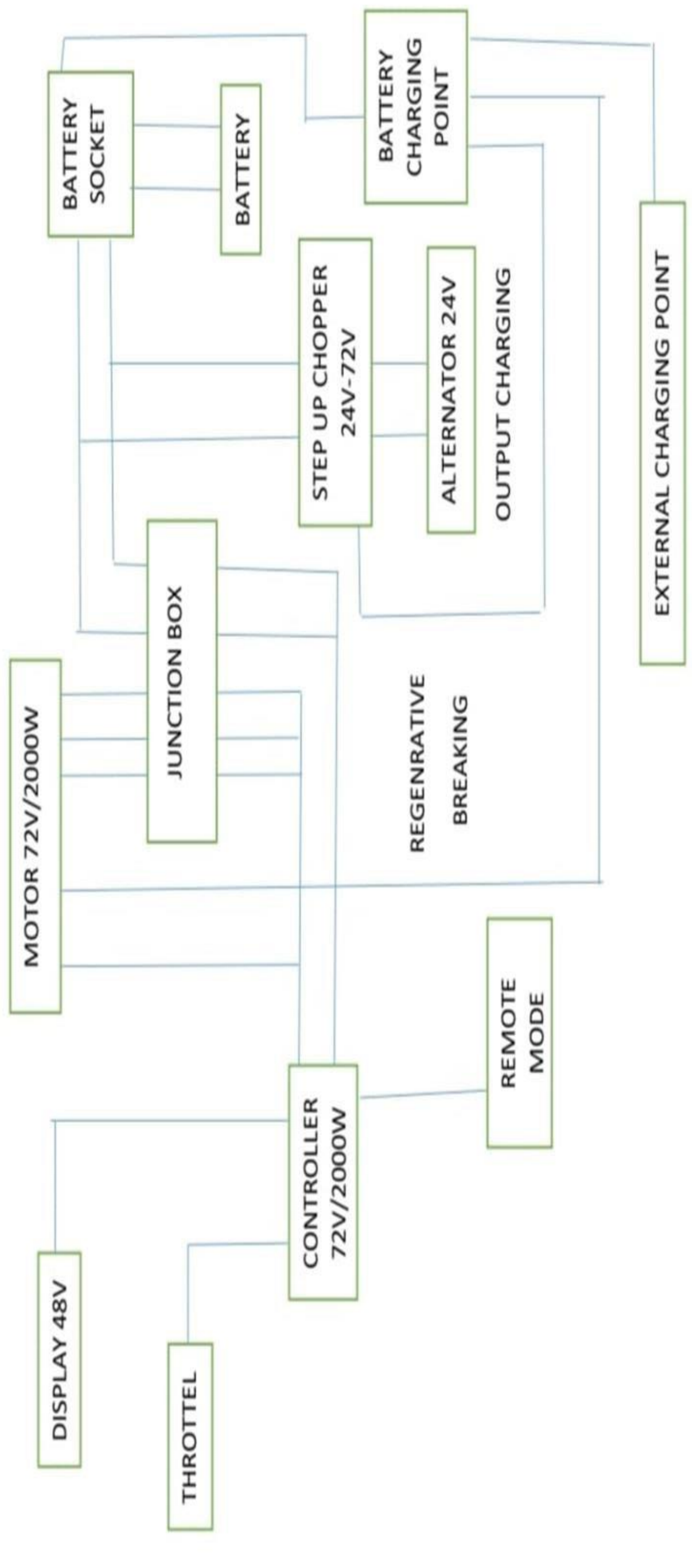

FIG 3.3 BLOCKS DIAGRAM

CHAPTER-4

IMPLEMENTATION OF HYBRID ELECTRIC VEHICLE

FIG 4.1

1. Modification of a Conventional Two Wheeler:

The challenge begins with the modification of a conventional - two wheeler into a hybrid electric bike. This involves changing the prevailing shape and mechanics to deal with the new components and systems.

FIG 4.2

2. Integration of Hub Motor:

The subsequent step is the integration of a hub motor to the front wheel force. This 2KW, 72V hub motor will provide the vital electricity for the electric mode of the vehicle.

FIG 4.3

3. Battery Installation:

A 2.5KW, 72V, 34.7ah battery is mounted in the car. This battery will save the electrical strength had to energize the hub motor.

4. On-Wheel Charge Mechanism:

An on-wheel rate mechanism is blanketed within the layout. This mechanism, powered by an alternator, prices the battery while the automobile is in movement, in each electric powered and petrol mode.

5. Sensor Integration:

Various sensors are integrated into the motorcycle, inclusive of a temperature sensor to screen the warmth tiers of the vehicle, a GSM module for verbal exchange, and an ESP32 module for Wi-Fi connectivity and manipulate.

6. Smart Switching Mechanism:

The automobile consists of a clever switching mechanism among the Internal Combustion (IC) engine and the electrical motor. This allows for green use of power and extends the variety of the vehicle.

7. Final Testing and Refinement:

The final step involves trying out all of the integrated systems and making necessary refinements to ensure superior overall performance and protection of the hybrid automobile.

Modification of a Conventional Two Wheeler:

- We start through deciding on a suitable two-wheeler that meets our necessities that is Pulsar 150. The present elements are then modified or replaced to accommodate the brand new hybrid gadget. This contains structural modifications to the vehicle body and the elimination of a few parts.

- **Integration of Hub Motor:**

We then procure a 2KW, 72V hub motor and combine it with the front wheel drive of the automobile. This includes mechanical and electric changes to make sure that the motor fits well and features effectively.

- **Battery Installation:**

A 2.5KW 72V 34.7ah battery is then installed in secure and handy vicinity at the automobile. The battery is connected to the hub motor.

- **On-Wheel Charge Mechanism:**

We then deploy an alternator and join it to the on-wheel fee mechanism. This involves both mechanical and electrical modifications. The alternator is configured to fee the battery every time the automobile is in movement.

- **Sensor Integration:**

Various sensors are then hooked up at suitable locations on the motorbike. These sensors are related to the vehicle's electrical system and configured to screen diverse parameters.

- **Smart Switching Mechanism**:

A manage unit is hooked up and programmed to interchange between the IC engine and the electric motor based at the automobile's pace, battery degree, and other factors. This entails each hardware installation and software program programming.

- **Final Testing and Refinement:**

Finally, the bike is thoroughly tested underneath numerous situations to make certain that everyone system are working efficiently. Any necessary adjustments or refinements are made based totally on the consequences of the checks.

5. RESULT

Impressive Range and Speed: The upgraded electric bike showcases remarkable performance, boasting a nearly 100 km range on a single battery charge and maintaining a steady speed of 60 km per hour. These features are crucial for efficient urban transportation, ensuring practical range and speed to meet daily commuting needs.

Versatile Fuel Options: Extensive testing reveals the bike's dual-fuel capability, offering a 45 km range on petrol at speeds ranging from 60 to 80 km/h. This adaptability to various road conditions and user preferences underscores the versatility and dependability of the hybrid vehicle.

On-Wheel Charging Innovation: The integrated on-wheel charging system delivers uninterrupted power directly to vehicle components via a 24V alternator. This innovation optimizes energy transfer, ensuring reliable operation and reducing reliance on external charging infrastructure, thus offering practical value for sustainable urban transport.

Energy-Efficient Braking: Utilizing regenerative braking technology, the vehicle captures energy during deceleration and braking, converting it into electricity to recharge the onboard battery. This energy-saving feature enhances overall efficiency, extending the vehicle's range and reducing energy consumption during urban commuting.

Advanced Sensor Integration: Equipped with a sophisticated sensor array and corresponding display, the hybrid bike utilizes a DC-DC converter with two input and one output channels. This integration enables real-time data tracking and efficient power management, enhancing user experience and optimizing performance under varying conditions.

Enhanced Safety Measures: Prioritizing rider safety, the bike features an anti-theft alert system that detects unauthorized access and alerts the owner. This feature provides peace of mind and safeguards the investment in the hybrid electric bike, addressing common urban bike ownership concerns.

Intelligent Switching Operation: The intelligent switching system seamlessly transitions between IC engine and electric motor modes based on driving conditions and user preference. This automatic variability enhances productivity, improves efficiency, and reduces environmental impact without compromising convenience or performance.

6. CONCLUSION

In conclusion, the evaluation and enhancement of the hybrid electric two-wheeler represent a significant step forward in sustainable transportation technology. Throughout this study, we thoroughly examined the bike's innovative features and performance capabilities, providing valuable insights into its potential for urban commuting. Our main goal was to improve the efficiency, range, and versatility of two-wheeled vehicles by integrating electric propulsion with dual-fuel capability. The results from various tests and analyses reveal key findings and implications for the future of hybrid electric vehicles.

Impressive Mileage and Speed

Achieving nearly 100 kilometers on a single battery charge at a speed of 60 kilometers per hour demonstrates the feasibility of electric propulsion for daily urban commuting. This remarkable mileage shows that electric motors can serve as practical alternatives to traditional fuel-powered bikes, offering extended range without sacrificing performance.

Dual Fuel Capability

The hybrid two-wheeler's ability to operate on both electricity and petrol fuel provides users with flexibility for different travel needs. With a tested range of up to 45 kilometers on petrol fuel at speeds ranging from 60 to 80 kilometers per hour, the vehicle proves its reliability and adaptability under various road conditions and user preferences.

On-Wheel Charging System

Integrating a 24V alternator for an on-wheel charging system represents a significant innovation in power management. This system ensures continuous power supply to the bike's components, minimizing energy loss and optimizing overall performance. Implementing this charging solution enhances the bike's autonomy and reduces reliance on external charging infrastructure.

Regenerative Braking

Successful implementation and testing of regenerative braking technology demonstrate its effectiveness in capturing and utilizing kinetic energy during braking. By converting this energy into electric power to recharge the battery, the bike achieves greater efficiency and extended range, contributing to reduced energy consumption and environmental impact during urban commuting.

Advanced Sensor Integration

The integration of advanced sensors and a DC-DC converter with multiple input and output channels enables real-time data monitoring and efficient power management. This integration enhances the bike's performance across various operating conditions, improving user experience and overall system efficiency.

Enhanced Safety Features

Incorporating an anti-theft alarm system enhances rider safety and protects the bike against unauthorized access. This feature ensures a secure ownership experience, addressing common concerns associated with urban bike usage and ownership.

Smart Switching Operation

Implementing a smart switching mechanism between IC engine and electric motor modes optimizes power management and efficiency. By automatically switching between propulsion modes based on riding conditions, the bike maximizes performance while minimizing environmental impact, highlighting the practical benefits of hybrid technology in urban transportation.

In summary, our study's findings underscore the potential of hybrid electric two-wheelers as sustainable solutions for urban mobility. The combination of electric propulsion, dual-fuel capability, advanced power management systems, and safety features enhances the bike's performance, range, and user experience. These results contribute to the growing knowledge base on hybrid bike technology and pave the way for further advancements in sustainable transportation.

Academic Year: 2023-2024

Project title: **TWIN POWERED HYBRID ELECTRIC BIKE INTEGRATED WITH ON-WHEEL CHARGING**

Type of Project: **Innovative Prototype**

Project Guide: Dr. V. Srinivasa Rao

PROGRAM OUTCOMES			
PO1	Engineering knowledge	PO7	Environment and sustainability
PO2	Problem analysis	PO8	Ethics
PO3	Design/development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project management and finance
PO6	The engineer and society	PO12	Lifelong learning

PROGRAM SPECIFIC OUTCOMES	
PSO1	Provide effective solutions in the fields of Power Electronics and Power Systems using modern computational tools
PSO2	Apply knowledge to solve industrial and societal needs using innovation and development in electrical engineering.

CONCLUSION STATEMENTS

S.NO	DESCRIPTION	ATTAINED CO'S	ATTAINED PO'S &PSO'S
1	These hybrid electric vehicles optimizes energy efficiency and enhances performance through intelligent integration of electric propulsion and internal combustion engine technologies	CO1,CO2, CO3	PO1,PO7,PO9
2	The system is capable of on wheel charging with impressive mileage, speed and Advanced sensor integration.	CO2,CO3	PO3,PO5
3	The system is capable to show information such as location, by incorporating GPS system to detect the coordinate and display it on the Google Maps which enhances the safety.	CO4,CO5	PO3,PO5
4	The dual-fuel functionality of the hybrid -wheeler, enabling operation on both power and petrol fuel, offers customers with flexibility and adaptability to diverse journey requirements.	CO3,CO4	PO3,PO6,PO7
5	A hit implementation and testing of regenerative braking technology show its effectiveness in capturing and utilising kinetic energy during braking.	CO2	PO3,PO5,PO12
6	This great mileage demonstrates the feasibility of electric motors as sensible options to traditional fuel-powered bikes, providing prolonged variety without compromising performance.	CO2	PO2,PO4,PSO1
7	Finally, the prototype is constructed successfully and results are found to be satisfactory.	CO5, CO6	PO9, PO10, PO11, PSO2

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