VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"Jnana Sangama", Machhe, Belagavi, Karnataka-590018

An Project Report

On

"ENHANCEMENT OF ELECTRIC VEHICLE INTO HYBRIDELECTRIC VEHICLE"

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

In

Electrical & Electronics Engineering

Submitted By

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Under the guidance of

INTERNAL GUIDE **External Guide**

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
(B.E (E&E) Program Accredited by NBA, New Delhi, Validity from 01.06.2021 to 30.06.2024)

GSSS INSTITUTE OF ENGINEERING & TECHNOLOGY FOR WOMEN
(Affiliated to VTU, Belagavi, Approved by AICTE, New Delhi & Govt. of Karnataka)
K.R.S ROAD, METAGALLI, MYSURU-570016, KARNATAKA
Accredited with Grade "A" by NAAC

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Geetha Shishu Shikshana Sangha (R)

GSSS INSTITUTE OF ENGINEERING & TECHNOLOGY FOR WOMEN

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CERTIFICATE

Certified that the 7th Semester Project titled **"ENHANCEMENT OF ELECTRIC VEHICLE INTO HYBRID ELECTRIC VEHICLE"** is a bonafide work carried out by **Aishwarya S R(4GW20EE400), Gayathri V(4GW20EE401), Monika M V(4GW20EE403), Tara devi L N(4GW20EE404)** in partial fulfillment for the award of degree of bachelor of engineering in **Department of Electrical & Electronics Engineering** of the Visvesvaraya Technological University, Belagavi, during the year 2022-2023. The Project report has been approved as it satisfies the academic requirements with respect to the Project work prescribed for Bachelor of Engineering Degree.

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CONTENTS

LIST OF FIGURES

CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION

Electric vehicles (EVs) are vehicles that use one or more electric motors for propulsion instead of an internal combustion engine (ICE) that is typically found in gasoline or diesel-powered vehicles. EVs are powered by rechargeable batteries, which can be charged from an external power source such as an electrical outlet or a charging station. EVs have several advantages over traditional vehicles. For one, they produce no tailpipe emissions, which means they do not emit harmful pollutants like carbon monoxide, nitrogen oxides, and particulate matter. This makes them much cleaner and more environmentally friendly than conventional vehicles. Additionally, EVs are generally quieter and have lower operating costs than gasoline-powered vehicles, as they require less maintenance and have lower fuel costs. There are two main types of EVs: battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). BEVs rely solely on electric power and have no ICE, while PHEVs have both an electric motor and an ICE, which can be used to power the vehicle when the battery is depleted. One of the major challenges facing the widespread adoption of EVs is the limited driving range offered by current battery technology. However, advances in battery technology and the growing availability of charging infrastructure are helping to overcome this challenge and make EVs a more viable option for consumers. Overall, the use of EVs is seen as an important step towards reducing greenhouse gas emissions and combating climate change, as well as promoting energy independence and reducing dependence on fossil fuels.

- Enhancement of an existing electric vehicle can refer to a variety of modifications or upgrades that can be made to improve its performance, range, efficiency, or overall functionality. Here are some examples of common enhancements that can be made to electric vehicles:
- Battery upgrade: One of the most significant limitations of electric vehicles is their range, which is determined by the size and capacity of their battery. Upgrading the battery to a higher-capacity one can improve the vehicle's range and performance.
- Performance tuning: Electric vehicles can also be tuned for better performance by adjusting the motor and controller settings. This can increase the vehicle's acceleration, top speed, and overall responsiveness.

- Regenerative braking**:** Regenerative braking is a feature that converts some of the kinetic energy lost during braking into electrical energy, which can be stored in the vehicle's battery. Installing regenerative braking can increase the vehicle's efficiency and range.
- Aerodynamic upgrades: Reducing the drag coefficient of an electric vehicle can also improve its range and efficiency. This can be achieved by installing aerodynamic modifications like a spoiler, diffuser, or wheel covers.
- Charging upgrades: Installing a faster or more powerful charging system can reduce the time it takes to recharge the vehicle's battery, making it more convenient to use.
- Software upgrades: Upgrading the vehicle's software can improve its performance, efficiency, and overall functionality. This can include updates to the vehicle's operating system, user interface, or connected services.

Overall, enhancements to electric vehicles can help to address some of the limitations that have traditionally made them less attractive to consumers, such as range anxiety and long charging times. By improving the vehicle's performance, range, and efficiency, these enhancements can help to make electric vehicles more practical and appealing for everyday use. An electric vehicle (EV) uses only an electric motor and a battery for propulsion, while a hybrid vehicle (HV) combines an internal combustion engine with an electric motor and battery. The idea behind a hybrid vehicle is to use the electric motor for low-speed, stop-and-go driving, and the internal combustion engine for higher speed or longer distance driving. Enhancing an electric vehicle into a hybrid vehicle involves adding an internal combustion engine to the vehicle's powertrain. This engine can be used to charge the battery, providing additional range and reducing the need for frequent charging. The electric motor can still be used for low-speed driving and regenerative braking, but the internal combustion engine can take over when the battery runs low or when higher speeds are needed.There are two types of hybrid electric vehicles: series hybrid and parallel hybrid. In a series hybrid, the internal combustion engine is used solely to charge the battery, and the electric motor powers the wheels. In a parallel hybrid, both the electric motor and internal combustion engine can power the wheels simultaneously, providing additional power and torque. Hybrid electric vehicles offer several advantages over pure electric vehicles, including increased range, reduced charging time, and improved performance. They also produce fewer emissions than conventional gas-powered vehicles and can save drivers money on fuel costs over time.

However, hybrid electric vehicles are more complex and expensive than pure electric vehicles, and they still rely on fossil fuels for power, which limits their environmental benefits. As battery technology continues to improve, it's likely that pure electric vehicles will become more practical and affordable, reducing the need for hybrid technology.

Fig. 1.1 Hybrid Electric Vehicle

1.2 OBJECTIVES:

- Enhancement of Electric Vehicle into Hybrid Vehicle using IC Engine.
- A switching circuit used to switch from IC Engine to the electric power and vice versa.

1.3 SCOPE OF THE PROJECT:

- By converting electrical vehicle to hybrid vehicle we can increase the efficiency.
- It can switch over from electrical to IC engine .
- Fuel consumption will be reduced

CHAPTER-2

LITERATURE SURVEY

1) M. Kebriaei, A. H. Niasar and B. Asaei, "Hybrid electric vehicles: An overview

This paper proposed that 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 composition engine, electric machines and power electronic equipment. In this paper, an overview of HEVs is presented. In fact, we aim to introduce the HEVs and present their history, advantages, disadvantages, classification, vehicle types, energy management strategies and some other related information. The methodology used in this paper is descriptive, library and analytical. The descriptive aspect of this paper is based on identification and definitions and its required materials and information have been complied using related scientific papers.

2) V. Keseev, "Efficiency Improvement of Electric and Hybrid Vehicles by Better Utilization of Inertia,"

This paper proposed that the global climate changes require the setting of high and hard to attain environmental goals and every technological improvement is a step towards achieving them. Transport is one of the biggest polluters. Electric and hybrid cars together with renewable energy sources have the potential to ameliorate the transport ecology, but they still have shortcomings that can be improved. An analysis of the functioning of modern electric and hybrid vehicles, concerning inertia utilization, has been done. The conclusion is that the inertia is not used properly and thus the energy or fuel consumptions deteriorate. The proposed solution has the potential to significantly improve the energy and fuel consumptions of electric and hybrid vehicles, and their operating costs, to extend the expensive battery lives and the run per battery charge of electric vehicles.

3) N. Higuchi and H. Shimada, "Efficiency enhancement of a new two-motor hybrid system,"

This paper proposed that a new two-motor hybrid system is developed to maximize powertrain efficiency. Efficiency of the system is drastically enhanced without any driving performance sacrifices by switching driving modes from "Hybrid Drive" to "EV (Electric vehicle) Drive" or "Engine Drive" according to the driving condition, along with the application of a series hybrid based system to make full use of high flexibility of engine operating points. Basic concepts of the maximization of powertrain efficiency including an applied system configuration and control technologies are discussed in this paper. Along with this system, a high capacity Li-ion battery and an on-board charger are installed in 2014 Honda Accord Plug-In to add practical plug-in HEV capabilities. Superior fuel economy is achieved with values of 46 MPG (Miles Per Gallon) in CS (Charge Sustaining) mode, 115 MPGe (Miles Per Gallon equivalent) in CD (Charge Depleting) mode and 13miles of AER (All Electric Range). MPGe is a unit of fuel economy for the alternate fuel vehicles such as plug-in hybrid electric vehicles or electric vehicles. The ratings are calculated by converting used electric energy into equivalent amount of gasoline.

4) **T. K. G. V, R. Bejgam, S. Sunkari, S. B. Keshipeddi, M. R. Rangaraju and V. Dunde, "A Brief Study on Hybrid Electric Vehicles,"**

This paper proposed that a new era has been visualizing a significant growth in the usage of automobiles, consequently the requirement of fuels to run them has also increased. This caused a drastic shift in the pollution levels and also caused the prices of these fuels to fluctuate at a high rate. This caused the automobile engineers to design the hybrid vehicles. The hybrid vehicles have the characteristics of both conventional internal combustion engines that use fuel as source of energy and also electric motors that move the car. In broader sense the hybrid vehicles are capable of working by fuel and also electrical energy that is stored in the batteries of the vehicle. The design of hybrid vehicles has transformed the automobile industry. The hybrid vehicles are being standardized to achieve the same standards to that of non-hybrid vehicles to have a good fuel efficiency. The other non-conventional vehicles that run on electricity have few disadvantages like imperfect and limited charging points which can be overcame by hybrid vehicles. The authorities have also been implementing a separate infrastructure for the mobility of hybrid vehicles in later days. The hybrid vehicles are categorized based on the energy converters being implemented in the vehicles. In this paper, the authors have explained about the various hybrid vehicles, types and applications of hybrid vehicles.

5) **H. S. Matharu, V. Girase, D. B. Pardeshi and P. William, "Design and Deployment of Hybrid Electric Vehicle,"**

This article discusses hybrid electric vehicle technologies. Nowadays, pollution has risen significantly, and as a result of CO2 emissions, there is a significant influence on the earth's atmosphere. As a consequence, human lives will be impacted. To address these issues, there is a one-stop solution for increasing manufacturing, usage, and development of hybrid electric vehicles that will power the vehicle partly or entirely. The advantages of regenerative braking have been discussed in this article. While braking, a portion of the electricity is returned to the battery, and the battery is charged during regenerative braking.

6) **A. Millner, N. Judson, B. Ren, E. Johnson and W. Ross, "Enhanced plug-in hybrid electric vehicles,"**

This paper proposed that a Plug-in hybrid electric vehicles (PHEVs) have the potential to reduce fossil fuel use, decrease pollution, and allow renewable energy sources for transportation, but their lithium ion battery subsystems are presently too expensive. Three enhancements to PHEVs are proposed here that can improve the economics. First, the incorporation of location information into the car's energy management algorithm allows predictive control to reduce fuel consumption through prior knowledge of the upcoming route and energy required. Second, the use of the vehicle battery while parked, offsetting the short peaks in commercial-scale facility electrical demand to reduce demand charges, can provide additional revenue to pay for the battery. Third, the battery cycle life must be maximized to avoid high replacement costs; a model of battery wear out for lithium ion batteries is presented and is used to confirm that the above strategies are compatible with long battery life.

7) **V. Nandurkar and V. Virulkar, "Modelling and Simulation of Electric and Hybrid Electric Vehicles,"**

This paper discusses the modelling and simulation of electric and hybrid vehicles. Modelling method for electric and hybrid vehicle is discussed with powertrain components. Genetic Algorithm is used as optimization strategy for optimization of powertrain components and control system for fuel economy and reduction of the emission. The ADVISOR software developed by NREL is used for carrying out the simulation. The simulation results demonstrate that optimal selection of parameters and a decision can be made for satisfactory solution in conformity with statutory requirements for emission of electric and hybrid electric vehicle in this paper.

8) **T. K. G. V, R. Bejgam, S. Sunkari, S. B. Keshipeddi, M. R. Rangaraju and V. Dunde, "A Brief Study on Hybrid Electric Vehicles,".**

The new era has been visualizing a significant growth in the usage of automobiles, consequently the requirement of fuels to run them has also increased. This caused a drastic shift in the pollution levels and also caused the prices of these fuels to fluctuate at a high rate. This caused the automobile engineers to design the hybrid vehicles. The hybrid vehicles have the characteristics of both conventional internal combustion engines that use fuel as source of energy and also electric motors that move the car. In broader sense the hybrid vehicles are capable of working by fuel and also electrical energy that is stored in the batteries of the vehicle. The design of hybrid vehicles has transformed the automobile industry. The hybrid vehicles are being standardized to achieve the same standards to that of non-hybrid vehicles to have a good fuel efficiency. The other non-conventional vehicles that run on electricity have few disadvantages like imperfect and limited charging points which can be overcame by hybrid vehicles. The authorities have also been implementing a separate infrastructure for the mobility of hybrid vehicles in later days. The hybrid vehicles are categorized based on the energy converters being implemented in the vehicles. In this paper, the authors have explained about the various hybrid vehicles, types and applications of hybrid vehicles.

9) N. Matanov and A. Zahov, "Developments and Challenges for Electric Vehicle Charging Infrastructure,".

As the number of used electric vehicles increases, questions and problems arise regarding the infrastructure for their charging. This report provides an overview of the charging stations types and their saturation mainly in the EU and BG. Data on several criteria are presented: number of electric vehicles per charging station, number of charging stations and charging stations per 100km of highway. In addition, the main problems in the charging station infrastructure development for a large number of electric vehicles have been defined. Finally, the areas in which specialists work to solve problems related to the development and management of charging infrastructure are prese.

CHAPTER-3

ELECTRIC VEHICLE

3.1 ABOUT ELECTRIC VEHICLE

Electric vehicles, also known as EVs, are a type of vehicle that runs on electricity instead of traditional fuels like gasoline or diesel. They are powered by an electric motor and a battery that stores energy. EVs are gaining popularity as a more environmentally friendly and sustainable mode of transportation, as they produce zero emissions and are typically more energy-efficient than traditional combustion engine vehicles. EVs can be charged at home, at public charging stations, or using fast charging stations. With advancements in technology and infrastructure, electric vehicles are becoming more accessible and affordable for consumers. The growing demand for EVs is driving innovation in the automotive industry and transforming the way we think about transportation.

Electric vehicles, or EVs, have emerged as a promising alternative to traditional fossil fuel-powered vehicles. Unlike gasoline and diesel vehicles, EVs are powered by an electric motor that is powered by a battery. EVs are more energy-efficient than conventional vehicles, as they do not have an internal combustion engine that generates heat and mechanical energy. Instead, they convert electrical energy stored in a battery into mechanical energy that propels the vehicle forward.

One of the main advantages of EVs is their lower environmental impact compared to traditional vehicles. EVs produce no emissions, which means that they do not contribute to air pollution, smog, or greenhouse gas emissions. This makes them a more environmentally sustainable choice for transportation, especially in urban areas where air quality is a significant concern.Another advantage of EVs is their lower operating costs. While the initial purchase price of an EV can be higher than that of a traditional vehicle, the cost of charging an EV is typically much lower than the cost of filling up a gas tank. In addition, EVs require less maintenance than traditional vehicles, as they have fewer moving parts and do not require oil changes or other routine maintenance tasks.

Despite these advantages, EVs face several challenges to widespread adoption. One of the main challenges is the limited range of many EVs, which can make them impractical for long-distance travel. However, this is gradually changing, as newer EV models are being developed with longer ranges and faster charging times.Another challenge is the limited availability of charging infrastructure. While there are now thousands of public charging stations across the United States, many areas still have limited charging options, which can make it difficult for EV owners to charge their vehicles when they are away from home.

Despite these challenges, the market for EVs is growing rapidly, driven by advances in technology, government incentives, and changing consumer preferences. As more people recognize the environmental and economic benefits of EVs, demand for these vehicles is likely to continue to grow, which will help to drive further innovation and investment in this important sector.

3.2 History and Evolution of Electric Vehicles

Electric vehicles have a long and storied history that dates back to the early days of the automobile industry. In fact, the first cars were electric, rather than gasoline-powered. The first electric car was built in 1837 by Scottish inventor Robert Anderson, who used non-rechargeable batteries to power a small electric motor. However, it wasn't until the late 1800s and early 1900s that electric cars became more widely available, thanks to advancements in battery technology and the development of electric starter motors, which made it easier to start gasoline engines.

During the early years of the automobile industry, electric cars were a popular choice for urban transportation, especially among women, who preferred their quiet, clean operation and ease of use. However, the rise of gasoline-powered cars, which were cheaper and had longer ranges, eventually led to the decline of electric cars, which were seen as impractical and expensive.In the 1960s and 1970s, interest in electric vehicles began to grow again, as concerns about air pollution and energy independence led to renewed interest in alternative forms of transportation. This led to the development of several experimental electric vehicles, including the Henney Kilowatt and the Lunar Rover, which was powered by an electric motor and solar panels.During the 1990s, several major automakers began to develop electric vehicles for commercial use.

BLOCK DIAGRAM :

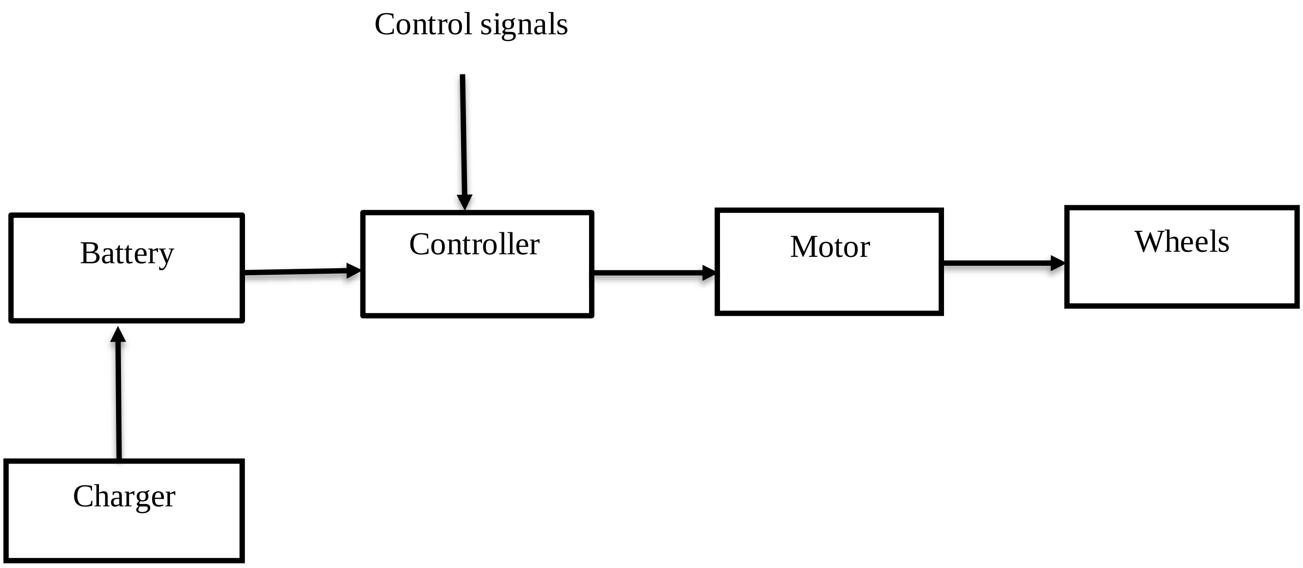

Fig.3.1Block Diagram

3.3 WORKING:

Most electric motorcycles and scooters today are powered by rechargeable lithium ion bateries, though some early models used nickel-metal hydride batteries. All electric scooters and motorcycles provide for recharging by plugging into ordinary wall outlets, usually taking about eight hours to recharge (i.e. overnight). The electricity is stored on board in a rechargeable battery, which drives one or more electric motors. Electric scooters (as distinct from motorcycles) have a step-through frame. The battery pack, which provides a source of electrical power. The most commonly available and affordable batteries are lead-acid flooded type. Next are the AGM (Absorption Glass Mat) sealed maintenance free batteries, a little more powerful and expensive. Then there are the more exotic batteries like Ni-MH and Li-ion; more difficult to find but light and longer lasting, maintenance free, and much more expensive. The new lithium batteries are showing some promise for EVs in the near future .

The charger which restores energy to the batteries (which may be mounted within the vehicle or at a special charging station at some fixed location).

The power controller, which regulates the flow of energy between the battery and the electric motor(s), controlled by an electronic throttle.One or more electric motors are present and their mechanical attachment to the driveline.

Power conductors connecting the battery, controller, and motor(s) along with the accessory aquipment to power auxiliary equipment such as power brakes and heating system. Control circuitry and equipment to allow control and interlocking of the various components and instrumentation specific to the operation and maintenance of the conversion of the system.

Fig.3.2 Electric Vehicle

3.4 Breaking system :

The braking system in an electric vehicle (EV) works differently than in a traditional gasoline-powered vehicle. While the basic function of slowing down or stopping the vehicle is the same, the way it is achieved is different.In an EV, there are two types of braking systems: regenerative braking and mechanical braking.

Regenerative Braking:

Regenerative braking is the primary method of braking in an EV. It works by using the electric motor to slow down the vehicle and convert the kinetic energy of the moving vehicle into electrical energy, which is then stored in the battery. This is accomplished by reversing the electric motor, turning it into a generator that produces electrical energy. The energy generated from the slowing vehicle is then fed back into the battery, increasing the vehicle's overall range.

Regenerative braking is more efficient than traditional mechanical braking since it recovers energy that would otherwise be lost during the braking process. However, it is not as effective at high speeds or when the battery is fully charged.

Mechanical Braking:

Mechanical braking is used when regenerative braking alone is not sufficient to slow down or stop the vehicle. This can happen at higher speeds, during emergency braking situations, or when the battery is fully charged.Mechanical braking works in the same way as in traditional gasoline-powered vehicles. When the driver presses the brake pedal, a hydraulic system applies pressure to the brake pads, which then press against the rotors or drums attached to the wheels, slowing down or stopping the vehicle.In some EVs, the driver can choose between regenerative braking or mechanical braking by selecting different modes or settings. This allows the driver to tailor the braking performance to their driving preferences and the driving conditions.

Despite the many benefits of electric vehicles (EVs), there are still some drawbacks that may make them less suitable for certain drivers or situations. Here are some of the main drawbacks of EVs:

- Limited Range: EVs typically have a limited driving range compared to gasoline-powered vehicles, which can cause drivers to worry about running out of battery power while on the road. While the range is improving with advances in battery technology, long-distance travel may still require more planning and longer charging times.
- Charging Time: While home charging is convenient, public charging stations can take longer to charge the battery than it would take to refuel a gasoline vehicle. This can be a challenge for drivers who need to quickly recharge their vehicle.
- Higher Upfront Cost: EVs are often more expensive to purchase than gasoline vehicles due to the cost of batteries and other electric components. However, this cost is offset by lower operating costs over the lifetime of the vehicle.
- Limited Availability of Charging Infrastructure: While the availability of charging infrastructure is improving, it is not yet as widespread as gasoline refueling stations. This can be a concern for drivers who need to travel longer distances or who live in areas with limited charging options.
- Potential for Range Anxiety: Drivers of EVs may experience "range anxiety," or the fear of running out of battery power before reaching a charging station. This can cause stress and may limit the usefulness of an EV for certain drivers.

3.5 Performance of electric vehicle:

The performance of an electric vehicle (EV) can be enhanced in several ways. Here are some common ways to improve the performance of an electric vehicle:

Battery technology: One of the most important factors that affect the performance of an electric vehicle is the battery technology. The range of the vehicle and the time it takes to charge depend on the battery technology. Improving the energy density of the batteries and reducing the charging time can significantly enhance the performance of an electric vehicle.

Motor and power electronics: The motor and power electronics play a crucial role in the performance of an electric vehicle. Upgrading the motor and power electronics can improve the acceleration, top speed, and overall performance of the vehicle.

Lightweight materials: The weight of the vehicle affects its efficiency and performance. Using lightweight materials such as carbon fiber and aluminum can reduce the weight of the vehicle and improve its performance.

Aerodynamics: The aerodynamics of the vehicle can affect its range and efficiency. Designing the vehicle to be more aerodynamic can reduce wind resistance and improve its performance.

Regenerative braking: Regenerative braking can capture the kinetic energy of the vehicle during braking and convert it into electrical energy to recharge the batteries. This can improve the range and efficiency of the vehicle.

Overall, improving the battery technology, motor and power electronics, using lightweight materials, designing the vehicle for better aerodynamics, and implementing regenerative braking can all contribute to enhancing the performance of an electric vehicle.

3.6 User experience of electric vehicle

Electric vehicles (EVs) have become increasingly popular in recent years due to their many benefits, including lower emissions, lower operating costs, and a quieter ride. Here are some common user experiences associated with owning and operating an EV:

Quiet Ride: One of the most noticeable differences between an electric vehicle and a traditional gasoline-powered vehicle is the quiet ride. EVs produce little to no engine noise, providing a peaceful driving experience.

Instant Torque: EVs have instant torque, meaning that they can accelerate quickly and smoothly, providing a fun and exciting driving experience.

Range Anxiety: One of the biggest concerns for EV drivers is range anxiety, or the fear of running out of battery power while driving. While the range of EVs has increased significantly in recent years, it is important for drivers to plan their routes and charging stops accordingly.

Charging: EV owners will need to have access to charging infrastructure, either at home or at public charging stations. Depending on the type of charger used, charging times can range from a few hours to several hours.

Cost Savings: EV owners can save money on fuel costs, as electricity is often cheaper than gasoline. Additionally, EVs require less maintenance than traditional cars, leading to potential long-term cost savings.

Environmental Benefits: EVs produce fewer emissions than gasoline-powered vehicles, which can lead to a cleaner environment and reduced carbon footprint.Overall, the user experience of an electric vehicle can be very positive, but it is important to understand the unique aspects of owning and operating an EV, such as range anxiety and charging requirements. As the infrastructure for charging stations continues to expand and battery technology improves, the benefits of owning an electric vehicle will likely only continue to grow.

3.7 Hardware Components :

- **Electrical Motor** Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors powered by DC elicity via an inverter/switching power supply which produces an AC/bidirectional electric emFent to drive each phase of the motor via a clos ed loop controller. The controller times mutation (hence rpm) and creates current waveforms(hence torque). This context alternating current does not imply but does include a sinusoidal waveform, with nimal restriction on waveform; it must be periodic, and its frequency will determine motor and the waveform does affect how smooth the generated torque is as well as the motors efficiency at transforming electrical to mechanical energy. In a well-designed PMSM the air pp magnetic flux is spatial sinusoidal and the phase commutation currents are sinusoidal, ery degree out of phase.The motor structural elements of a brushless motor system is typically permanent magnet synchronous motor, but can also be a switched reluctance motor, or induction motor.

Fig. 3.3 Motor

Specifications :

Motor type	Brush non gear hub motor
Wattage	301-400W
Design	Brushless
Voltage	48V

- **Battery:**

Fig. 3.4 Lead Acid Battery

The lead-acid battery was invented in 1859 by French physicist Gaston Planté and is the oldest ope of rechargeable battery. Despite having a very low energy-to-weight ratio and a low agy to volume ratio, its ability to supply high surge currents means that the cells have a elatively large power-to-weight ratio. These features, along with their low cost, makes it active for use in motor vehicles to provide the high current required by automobile starter motor.They are inexpensive compared to newer technologies, lead-acid batteries are widely used when surge current is not important and other designs could provide higher energy ities. Large-format lead-acid designs are widely used for storage in backup power supplies el phone towers, high-availability settings like hospitals, and stand-alone power systems. For these roles, modified versions of the standard cell may be used to improve storage times redoce maintenance requirements. Gel-cells and absorbed glass-ma: batteries are common these roles, collectively known as VRLA (valve-regulated lead-acid) batteries.

Specifications:

Product type	Lead acid battery
Nominal voltage	12V
Length	151mm
Width	65mm
Height	93mm
Capacity	7.2AH
Maximum current	2,1A

- **Electric bike throttle:**

Fig.3.5 Throttle

Electric bike throttle operates in a very similar way many motorcycles (or scooters) operate. As soon as you engage the throttle button, the motor is powered on and it propels your eBike forward.Most electric bike throttles can be adjusted to different power outputs, allowing riders to choose how much power exactly do they need.This is also very useful at saving the battery and prolonging the range. However, when you're battling the hills, full power is often the best throttle mode to use.While some throttles offer a level-type mode to choose the power output, others work in a pressure-sensitive mode. This means, the further you press the button, the more power you will receive on your eBike wheels.When you aren't using an eBike - the motor stays in the "idle" mode until you are ready to take advantage of its features.This also helps save the battery and ensure that the motor doesn't run at all times - which would relatively lessen the range of each

- **Controller:**

A controller is used to connect all electrical components of an e-bike together. Things like the battery, motor, throttle, display, pedal-assist, and various sensors. The controller basically acts as the "heart" for the e-bike.It takes energy from the battery and directs it to the motor. By twisting the throttle, the user can regulate the power that is being sent to the controller, this, in turn, controls the speed of the e-bike.As a rule, all controllers have a sealed protective box, as they are placed open on a bicycle, however, some controllers are mounted inside of the frame and hidden away.

1.GREAT HEAT DISSIPATION: The 24v brushless motor controller shell is made of aluminium alloy with groove design, which can protect the inner circuit due to good heat dissipation feature to avoid thermal overloading.

2.SENSITIVE SPEED CONTROL: This Ebike Controller is a brushless motor controller, it can provide steady speed and sensitive control of braking and direction changes.

3.DURABLE TO USE: The wires and interfaces are durable, and ensure low malfunction of long time use.

4.EASY INSTALLATION: The interfaces have instruction labels on them for your easy installation. Suitable for electric bicycles, scooter, etc.

Fig.3.6 Controller

Specifications: 48V,1000W

Charger:

The charger for an electric two-wheeler is a device that is used to charge the battery of the vehicle. The charger is typically a rectangular or box-shaped device that plugs into a standard electrical outlet.The charger is connected to the battery of the two-wheeler via a cable with a connector at the end that fits into a charging port on the vehicle. The charging port is usually located near the battery on the vehicle and is designed to fit the specific type of connector on the charger.The charger converts the AC (alternating current) electricity from the outlet to DC (direct current) electricity that can be stored in the battery of the two-wheeler. The charger also regulates the amount of electricity that is sent to the battery, ensuring that it is charged safely and efficiently.

Fig.3.7 Charger

Specifications :48V-20h

CHAPTER - 4
HYBRID VEHICLE

A hybrid electric vehicle (HEV) is a type of vehicle that combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system. The electric system in an HEV is used to supplement the power generated by the ICE, improving fuel efficiency and reducing emissions' use a variety of techniques to optimize fuel economy and minimize emissions. For example, the electric motor can provide additional torque to assist the ICE during acceleration, and can also act as a generator to recharge the battery during deceleration or braking. The ICE can also be turned off when the vehicle is stopped, and the electric motor used to power the vehicle in slow-moving traffic. HEVs come in several configurations, with the most common being the parallel hybrid, which uses both the ICE and electric motor to drive the wheels, and the series hybrid, which uses the ICE to generate electricity that powers the electric motor. There are also plug-in hybrid electric vehicles (PHEVs), which can be charged from an external power source and have a larger battery that allows them to operate in electric-only mode for a limited distance. Overall, HEVs are a popular choice for environmentally conscious consumers who want to reduce their fuel consumption and carbon footprint without sacrificing the convenience and performance of a conventional vehicle.

4.1 Hybrid Electric Vehicles History

The competition between vehicles powered by electric and those powered by an internal combustion engine (ICE) is not a new scenario; this antagonism dates back to as early as the beginning of the 19th century. Between 1890 and 1905 ICEs, electric vehic1es (EV s), and steam powered cars 5 were all marketed in the United Kingdom and United States. EV s were the market leader in the United States at this time; mainly due to the works of electricity pioneers such as Edison and Tesla. The limiting range of EVs was not a big problem as the roads linking the cities were not particularly adequate forvehic1e transportation. It was evident that the use of batteries in automobiles was going to pose limitations in range and utility of EV s. Due to the energy advantages of petrol powered vehic1es over battery operation, petrol became the dominate energy source over the next 100 years, and is still leading the way today. At the time many automotive companies designed direct ICE vehic1es, but some tried to combine the advantages of the electric vehic1e with those of an ICE vehic1e by creating a hybrid of the two.

The first ever REV was built in 1898, and there were several automotive companies who were selling REV s in the early 1900s. The production of HEV s did not last the course of time due to significant problems with them. Henry For initiated the mass production of combustion enginevehic1es; making them widely available and affordable within the $455 to $911 price range (H» 375€ to 750€ with prices taken from the current American dollar to Euro conversion rate). In contrast, the price of the less efficient EV s continued to rise. During 1912, an electric roadster sold for $1,732 (1 ,425€), whilst gasoline car sold for $547 (450€) as illustrated by About Inventors. Another problem was the requirement for a smooth coordination between the engine and the motor, which was not possible due to the use of only mechanical controls. Since these early attempts, there has been a rise in the concern for global warming, a continual rise in fuel prices, and the threat of oil reserves dry in gup altogether. This handled to interest in more efficient and environrnentally means of transport again, particularly in the area of HEV. With advances in battery technologies and onboard computer systems, the option of a plausible HEV has become reality, and a number of models from the likes of Honda (Civic and Insight) and Toyota (Prius) have been available now since 2000. There have been a number of prospective designs and REV shave been growing ever since the inclusion of them onto the world market in 2000.

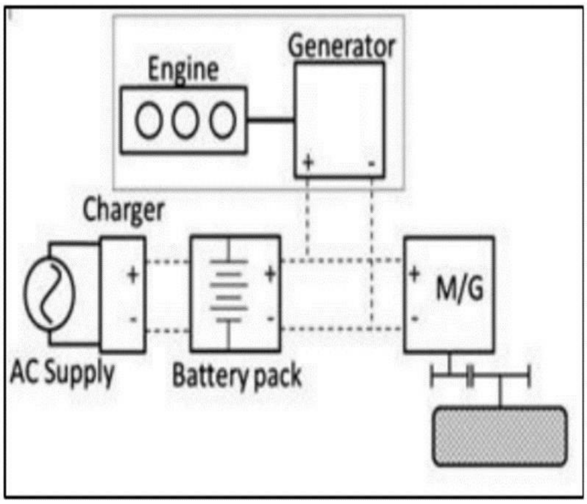

Fig: 4.1 Series Plug In Hybrid Electric Vehicle

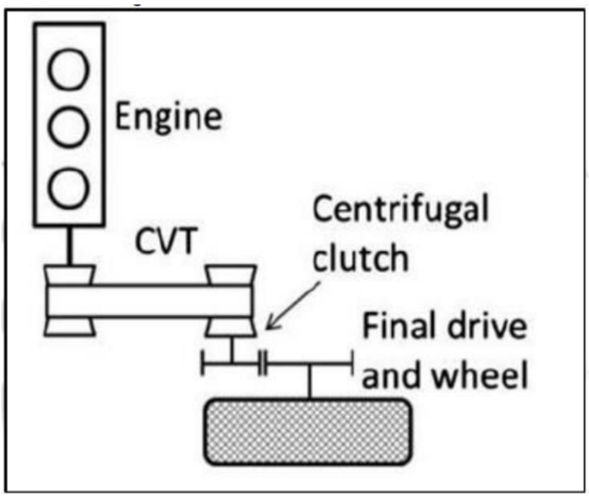

Fig: 4.2 Conventional Vehicle

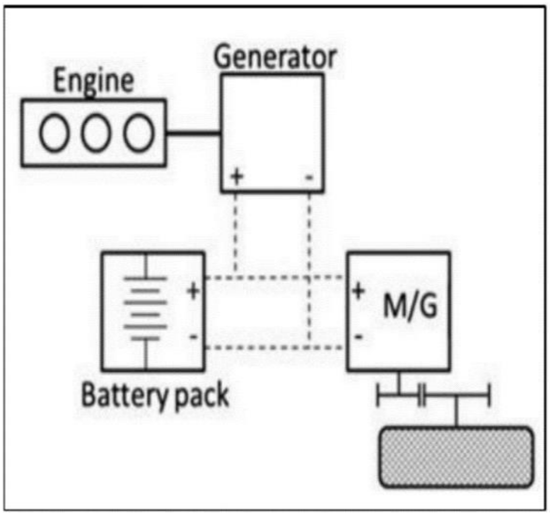

Fig: 4.3 Series Hybrid Electric Vehicle

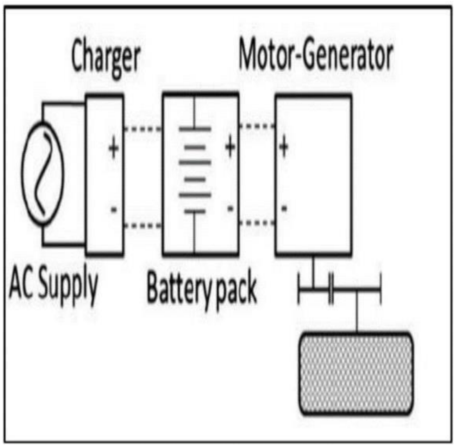

Fig: 4.4 Pure Electric Vehicle

A hybrid-electric-vehicle is an automobile which relies not only on gasoline but also on electric power source. In HEV, the battery supplies power during slow-speed conditions. While on highways or gradient scale, the IC engine drives he vehicle alone. Hybrid electric vehicles consists of an electric hub-motor, inverter, battery as electric drive source and an IC engine with transmission connected as latter drive. It is to achieve better fuel efficiency and reduce toxic emissions. It has great advantages over the previous used IC engine that is driven only from gasoline. This hybrid combination makes the vehicle dynamic in nature and provides its owner a better fuel economy and lesser environmental impact over conventional automobiles. The basic design consists of a dc power source battery. The battery is connected to inverter that is fed to a BLDC motor that works on AC. The motor is attached to the front wheel of the two wheeler vehicle. As the motor rotates the connected wheel also rotates, thus, leading to whole vehicle motion. At slow speeds this driving-mode is selected. The next part comprises of an IC engine. This is connected to the transmission and thus, the vehicle moves. A conventional gasoline powered two wheeler is modified with attachable hybrid electric kit. In which, a BLDC hub-motor is fixed at the front wheel of the vehicle. Along with the rear wheel of the vehicle is powered by the IC engine which is available as the stock custom. Four lead-acid batteries are connected in series connection in order to sum up the total voltage output to the requirement of the electric motor. Batteries are connected to the motor by which the power will be transferred via a controller which receive the varying volt from 1-4 V from the throttle which is placed on the left handlebar of the vehicle. The apparent in the right handle bar. The throttle placed on the left handle bar is actually a thumb throttle used to increase or decrease the voltage supply to the electric hub-motor in turn increasing or decreasing the vehicle speed respectively. Charging of those batteries can be done via the direct plug-in option or the regenerative braking way. Regenerative braking is possible when the vehicle is only running on the IC engine and the electric motor is rotating idling. Regenerative braking charges the batteries when the magnetic flux is produced in the motor during the vehicle running on IC engine.

4.2 BLOCK DIAGRAM

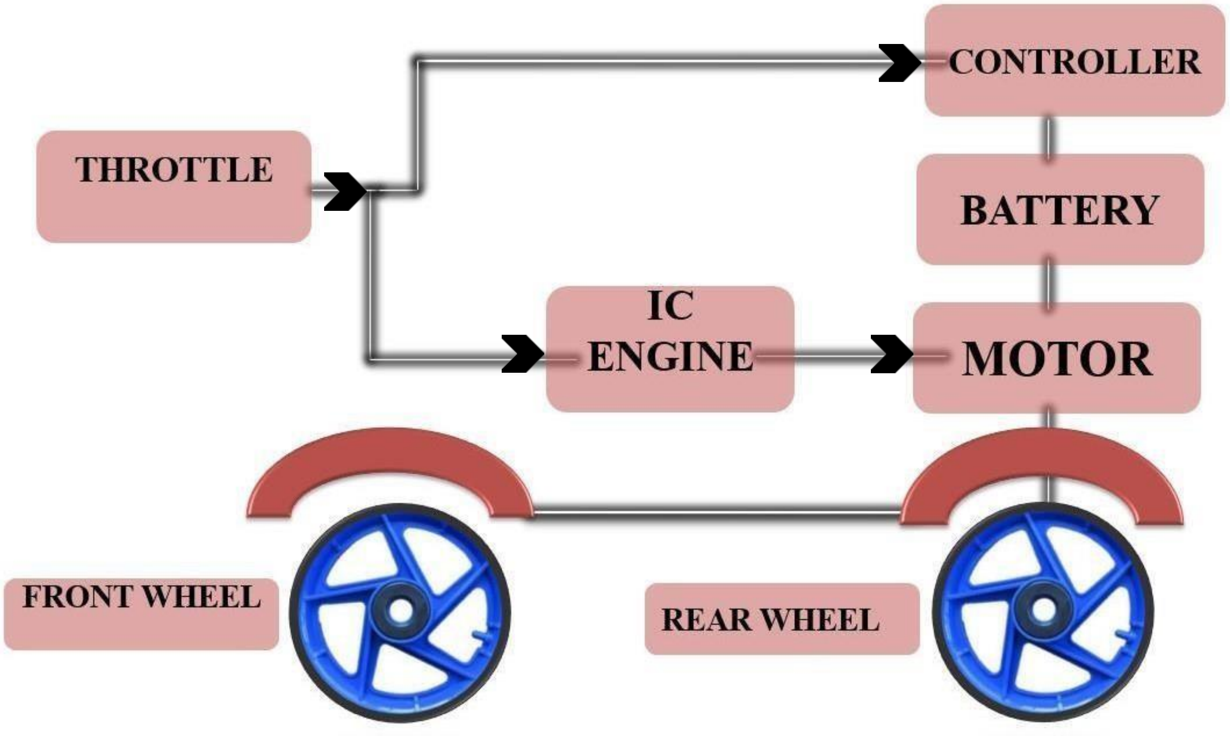

Fig: 4.5 Block Diagram Of Hybrid Vehicle

4.3 METHODOLOGY

The motor is attached to the rear wheel of the two-wheeler vehicle. Now the vehicle rim starts to spin over the axis body for rotation of wheel. As the motor rotates the attached wheel rotates too, leading to vehicle motion. In petrol mode engine will supply the power to the rear wheel and it energize the ignition coil and operate the motor. The rider can control the speed by means of accelerator handle. In this mode BLDC motor will be in ideal position. This mode can be activatedwhen we require high power.

4.4 WORKING PRINCIPLE

Fully electric mode: Batteries in this mode feed the electric motor through the power electronics (inverter) which controls the electric current and turn direct current into an alternative current. The motor is completely detached from the ICE when it is electrically driven. The power produced by motor is finally transmitted by a transmission system to the wheels. The latter mechanism is quite similar to that of the conventional cars, except that the transmission ratio remains constant. This is rooted in the fact that electric vehicles do not require multi-speed transmission, because the electric motor produces a consistent amount of torque at any given RPM while the internal combustion engine requires multiple gears with definite ratios for power output. It is noteworthy that ICEs only generate efficient power at certain RPM ranges. However, EV manufacturers calculate gear ratios to maximize effectively for the electric motor without having to switch through gears. There is resistance between the electrons of the atoms moving in the wires between the e1ectric motor and the battery, and through the electric motor itself.

Produced magnetic fields incur friction in the metal laminations making up the magnetic circuit with the electric motor. There is mechanical friction between every mechanical moving part of the system, including, chains and bearings. As mentioned previously the by-product of friction is heat, and the higher the frictional force the greater the resultant heat. The consequence of the sum of the frictional losses, determines the overall efficiency of the vehicle. The efficiency of HEVs is greater than that of conventional vehicles in the respect that REV scan reclaim energy which would once have been lost through regenerative braking. The inertia of the vehic1e is the fundamental factor in being able to reclaim the energy back in to the batteries. Instead of using the full potential of the brakes of the vehicle, REVs allows the linkages back to the electric motor such as the drive shafts, and chain transfer the torque from the wheels back to the electric motor shaft. Electric motors can transfer electrical energy into mechanical energy and back again, and in both cases can be achieved very efficiently. The way in which electricity is reproduced is through the magnets on the shaft of the motor moving past the electric coils of the stator in the motor, passing the magnetic fields of the magnets through the coils. Electrical energy is then fed back into the battery, in tum charging up the hybrid battery pack. There are two forms of regenerative braking which are parallel regenerative breaking and series regenerative breaking; this is not related to parallel and series configured REV. The forms are dependent on how many wheels are being used to reclaim the energy. The most common approach in vehicles is that the back wheels are the only wheels reclaiming energy. Energy is still lost in this case through the front whee1s as before through minor heat dissipation, unless they are somehow connected back to the electric motor. The other key determinant factor is the battery state-of-charge (SOC) and how hard the energy is being driven back into the battery.

4.5 HARDWARE COMPONENTS

1. BLDC Motor
2. Motor controller
3. Batteries
4. IC Engine
5. Electric charging cable

1. BLDC motor

Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors powered by DC electricity via an inverter/switching power supply which produces an AC/bi-directional electric current to drive each phase of the motor via a closed loop controller. The controller times commutation (hence rpm) and creates current waveforms (hence torque).

In this context alternating current does not imply but does include a sinusoidal waveform, with minimal restriction on waveform; it must be periodic, and its frequency will determine motor rpm, and the waveform does affect how smooth the generated torque is as well as the motors efficiencyat transforming electrical to mechanical energy. In a well-designed PMSM the air gap magnetic flux is spatial sinusoidal and the phase commutation currents are sinusoidal, ninety degrees out ofphase.

The motor structural elements of a brushless motor system is typically permanent magnet synchronous motor, but can also be a switched reluctance motor, or induction motor. Brushless motors may be implemented as stepper motors as well; however, the term "stepper motor" tends to be used for motors with a radically different design and controlled with an open loop (hence the controller cannot detect when the stepper does not step due to too high shaft load; there is no shaft position sensor).

Fig: 4.6 250W BLDC Motor

They are frequently stopped with the rotor in a defined angular position while still producing torque. A well design power supply/controller/PMSM can also be held at zero rpm and finite torque. Two key performance parameters of brushless DC motors are the motor constants Kt (torque constant) and Ke (BEMF constant also known as speed constant Kv = 1/Ke

The SI units Kt and Ke are the same.

2. Motor controller

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults .

Fig: 4.7 Motor Controller

Motor controllers can be manually, remotely or automatically operated. They may include only the means for starting and stopping the motor or they may include other functions. An electric motor controller can be classified by the type of motor it is to drive such as permanent magnet, servo, series, separately excited, and alternating current. A motor controller is connected to a power source such as a battery pack or power supply, and control circuitry in the form of analog or digital input signals.

3. Batteries

The lead-acid battery was invented in 1859 by French physicist Gaston Plante and is the oldest type of rechargeable battery. Despite having a very low energy-to weight ratio and a low energy to volume ratio, its ability to supply high surge currents means that the cells have a relatively large power-to-weight ratio. These features, along with their low cost, makes it attractive for use in motor vehicles to provide the high current required by automobile starter motors.

As they are inexpensive compared to newer technologies, lead-acid batteries are widely used even when surge current is not important and other designs could provide higher energy densities.

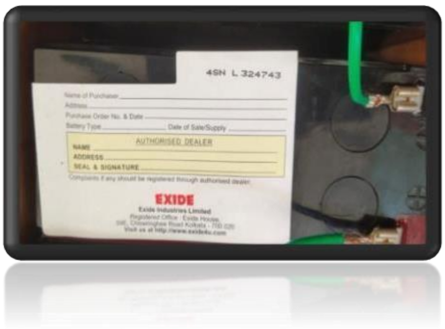

Fig: 4.8 Batteries of 12V 22Ah

Large-format lead-acid designs are widely used for storage in backup power supplies in cell phone towers, high-availability settings like hospitals, and standalone power systems. For these roles, modified versions of the standard cell may be used to improve storage times and reduce maintenance requirements. Geocells and absorbed glass-mat batteries are common in these roles, collectively known as VRLA (valve-regulated lead-acid) batteries.

Product Group	Lead acid battery
Manufacturer	B . B . Battery
Manufacturer number	BP7.2-12
Nominal voltage	12V
Length	151mm
Width	65mm
Height	93mm
Rechargeable	Yes
Battery type	Maintenance free , leak proof.
Capacity	7.2AH

4. IC Engine

IC engine is a heat engine where the combustion of fuel occurs with an oxidizer in a combustion chamber that is an integral part of the working fluid flow circuit.

- Two stroke single cylinder
- 69.9CC
- Maximum power: 3.5bhp@5000RPM
- Fuel capacity: 4L
- Natural Air cooled

Fig: 4.9 Two Stroke IC Engine

The vast majority of vehicles (passenger cars and commercial vehicles) which are sold today are equipped with internal combustion engines. In this article we are going to describe how a Two- stroke internal combustion engine wo rks. An internal combustion engine is classified as a heat engine. It’s called internal because the combustion of the air-fuel mixture occurs inside the engine, in a combustion chamber, and some of the burned gases are part of the new combustion cycle.

A two-stroke (or two-stroke cycle) engine is a type of internal combustion engine that completes a power cycle with two strokes (up and down movements) of the piston during one power cycle, this power cycle being completed in one revolution of the crankshaft. A Two-stroke engine requires four strokes of the piston to complete a power cycle during two crankshaft revolutions. In a two-stroke engine, the end of the combustion stroke and the beginning of the compression stroke happen simultaneously, with the intake and exhaust (or scavenging) functions occurring atthe same time. Two-stroke engines often have a high power-to-weight ratio, power being availablein a narrow range of rotational speeds called the power band. Two-stroke engines have fewer moving parts than four-stroke engines.

5. Electric charger

An EV connector is a cable that connects your bike to the charging point.

- Charger: 48V/3A
- Input AC: 180-240V AC, 50HZ
- Output DC: 58.8V, 3A

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Fig: 4.10 Electric Charger

4.6 BRAKING SYSTEM OF AN HYBRID VEHICLE

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 car down, which assists the use of traditional brakes. In a conventional braking system, a car 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 your car 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 your car model and driving behavior.

HOW DOES REGENERATIVE BRAKING PROVIDE ELECTRICITY?

Regenerative braking turns kinetic energy into electricity by reversing the process that drives the car forward. In electric cars, 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. All you have to do is remove your foot from the accelerator or, in some cases, press the brake pedal to activate regenerative braking. The electric motor not only acts as an electric generator, but it also helps slow your car down because energy is consumed by the wheels as they rotate the shaft in the electric motor.

EXTENDED RANGE POSSIBILITIES FOR EVS

Capturing braking energy and sending it right back to your EV's battery pack can extend your driving range. Estimations show that regenerative braking can potentially add hundreds of miles of electric driving range throughout the year. That means less time spent charging and more time getting where you need to go. When charging stations are still far and few between in many areas, every mile counts. Plus, when you plug into the electric grid less often, you help reduce emissions from coal and gas-powered electricity suppliers.

BETTER FUEL EFFICIENCY FOR HYBRIDS

While hybrids still have internal combustion engines under the hood, they're designed to use their electric motor as much as possible. Regenerative braking helps keep the battery pack charged, so drivers don't have to rely on their engines as often, helping them reduce fuel consumption and save money.

However, the problem is also improving with newer regenerative braking systems. In more recent car models, you may not notice a difference in stopping power at all.The braking system in this HV is using drum brakes. A drum brake is a brake that uses friction caused by a set of shoes or pads that press outward against a rotating cylinder-shaped part called a brake drum. The term drum brake usually means a brake in which shoes press on the inner surface of the drum. When shoes press on the outside of the drum, it is usually called a clasp brake. Where the drum is pinched between two shoes, similar to a conventional disc brake, it is sometimes called a pinch drum brake, though such brakes are relatively rare. When the brakes are applied, brake fluid is forced under pressure from the master cylinder into the wheel cylinder, which in turn pushes the brake shoes into contact with the machined surface on the inside of the drum. This rubbing action reduces the rotation of the brake drum, which is coupled to the wheel. Hence the speed of the vehicle is reduced. When the pressure is released, return springs pull the shoes back to their rest position.

4.7 COMPONENTS OF BRAKING SYSTEM

- backing plate
- brake drum
- shoe
- wheel cylinder
- various springs and pins.

1. Backing plate

The backing plate provides a base for the other components. The back plate also increases the rigidity of whole set-up, supports, protects the housing from foreign materials like dust, debris andalso absorbs the torque reactions that is why back plate is also termed as "Torque Plate. Since all braking operations exert pressure on the backing plate, it must be strong and wear-resistant. Levers for emergency or parking brakes, and automatic brake-shoe adjuster were also added in recent years.

2. Brake drum

The brake drum is generally made of a special type of cast iron that is heat conductive and wear- resistant. It rotates with the wheel and axle. When a driver applies the brakes, the lining pushes radially against the inner surface of the drum, and the ensuing friction slows or stops rotation of the wheel and axle, and thus the vehicle. This friction generates substantial heat.

3. Brake Shoes

Brake shoes are typically made of two pieces of steel welded together. The friction material is either riveted to the lining table or attached with adhesive. The crescent-shaped piece is called the Web and contains holes and slots in different shapes for return springs, hold-down hardware, parking brake linkage and self adjusting components. All the application force of the wheel cylinder is applied through the web to the lining table and brake lining. The edge of the lining tablegenerally has three “V"-shaped notches or tabs on each side called nibs. The nibs rest against the support pads of the backing plate to which the shoes are installed. Each brake assembly has two shoes, a primary and secondary. The primary shoe is located toward the front of the vehicle.

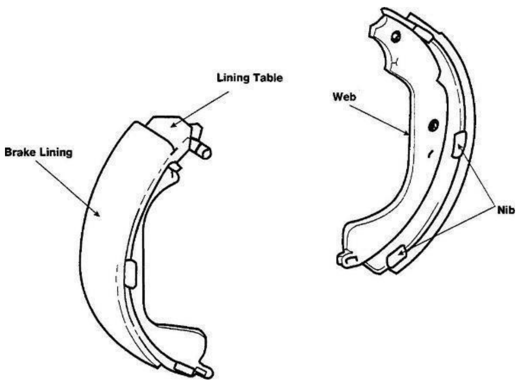

Fig: 4.11 Brake Shoe Assemlby

4. Wheel cylinder

One wheel cylinder operates the brake on each wheel. Two pistons operate the shoes, one at each end of the wheel cylinder. The leading shoe (closest to the front of the vehicle) is known as the primary shoe. The trailing shoe is known as the secondary shoe. Hydraulic pressure from the master cylinder acts on the piston cup, pushing the pistons toward the shoes, forcing them against the drum. When the driver releases the brakes, the brake shoe springs restore the shoes to their original (disengaged) position. The parts of the wheel cylinder are shown to the right.

CHAPTER 5
CONCLUSION

HEV is a vehicle that uses two sources of power- Engine and battery. For low power application battery drive is used whereas for high power application where power requirement is very high engine is used. Engine drive is most efficient at high-speed drive. Thus, HEVs both mode of operation occurs at their maximum efficiency. But in engine low speed operation is not efficient. Its high-speed mode is only efficient. Therefore, it gives twice the mileage given by a normal vehicle. As this hybrid vehicle emits 50% less emission than normal vehicle it plays an important role for reducing pollution to certain extent without compromising with efficiency. Thus, it is most efficient in urban areas mainly in high traffic where engines are least efficient as the energy from engine is being wasted away and creates pollution. The adoption of new development standards is becoming increasingly dependent on creating HEV technologies due to the demands placed on power generation and the need to minimize fossil fuel consumption. The evolution of hybrid electric vehicles already offered solutions to the electric vehicle market. In order to have a lesser dependency on the increased price of fuel and to operate a more environmentally friendly vehicle the technology of HEVs would more than help to satisfy these requirements. The adoption of new development standards is becoming increasingly dependent on creating HEV technologies due to the demands placed on power generation and the need to minimize fossil fuelconsumption.

RESULT AND DISCUSSION

Hybrid electric vehicles (HEVs) combine a internal combustion engine with an electric motor and battery system, providing a more efficient and environmentally friendly alternative to traditional vehicles. The main benefits of HEVs include, Improved fuel efficiency, HEVs use less fuel than traditional vehicles, as the electric motor helps to power the car and reduce the reliance on the gasoline or diesel engine. This leads to lower emissions and savings on fuel costs.

Reduced emissions, HEVs emit less harmful pollutants and greenhouse gases than traditional vehicles, which is better for the environment and human health. Regenerative braking, HEVs use regenerative braking to capture energy normally lost during braking, which is then stored in the battery and used to power the electric motor. This further improves fuel efficiency and reduces emissions. Smooth and quiet driving, The electric motor in an HEV provides a smoother and quieter driving experience compared to traditional vehicles, as it reduces the need for the engine to work as hard. Overall, HEVs provide a practical and efficient alternative to traditional vehicles, offering lower emissions, improved fuel efficiency, and a smoother driving experience.

Fig: 5.1 Hybrid Electric Vehicle

Mode of propulsion	Range in KM	Description
Electric mode	20	For single charge, it can run for around 20km range.
Engine mode	35	35km per litter will be achieved
Combinational mode	55	During combinational mode of operation, that a vehicle can run around 55km.

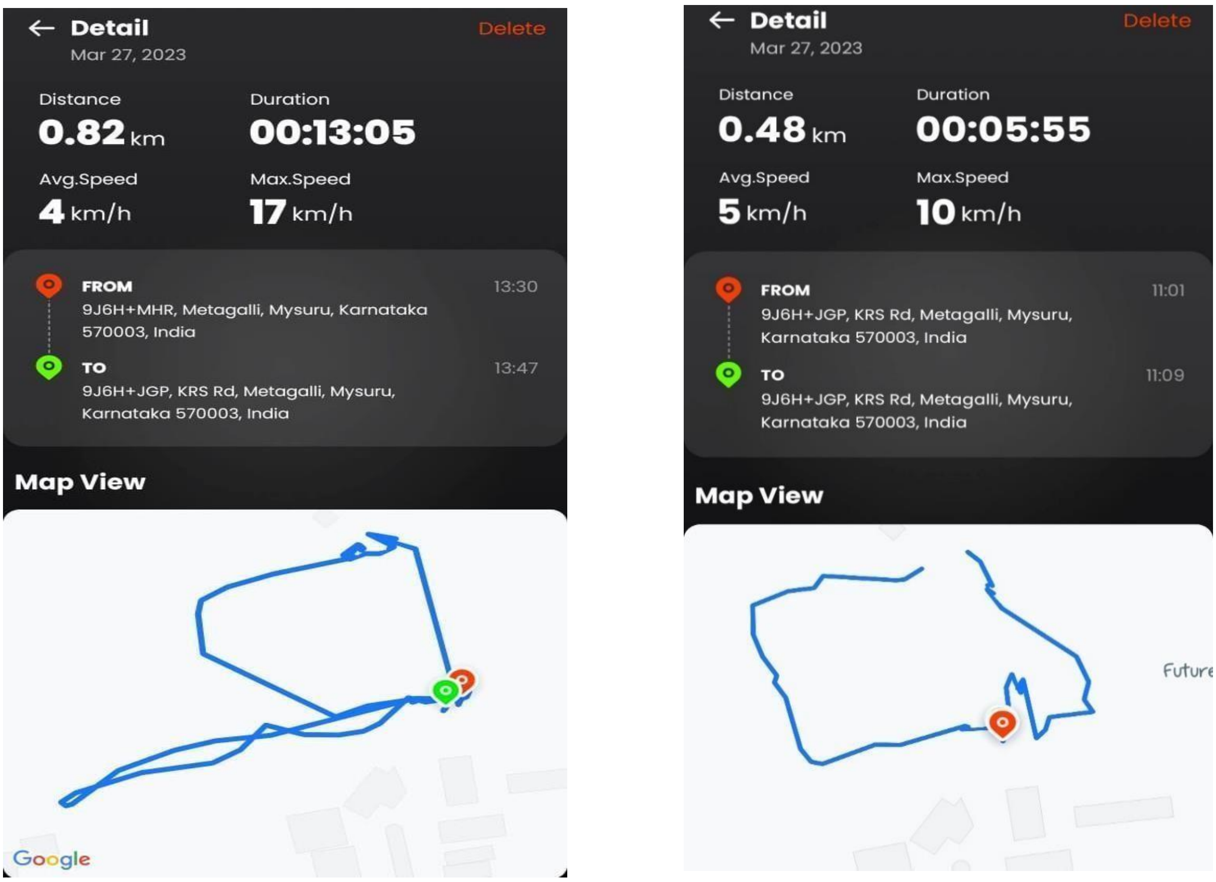

Fig: 5.2 Performance Analysis done By Speedometer App

REFERENCES

[1]. Kartik S Mishra, Shubham V Gadhawe, International Journal of Current Engineering and Technology “Design a nd Development of Solar Hybrid Bicycle” E-ISSN 2277 – 4106, PISSN 2347– 5161, issued on March 2016.

[2]. Sharada Prasad N, K R Nataraj, International Journal of Electrical, Electronics and Data Communication, “DESIGN AND DEVELOPMENT OF HYBRID ELECTRIC TWO WHEELER SUITABLE FOR INDIAN ROAD CONDITIONS” Volume-2, Issue-9, Sept.-2014.

[3]. Basil P Elias, Dino Devassykutty, John George, Akhila K , IOSR Journal of Electrical and Electronics Engineering (IOSR-JEE), “Hybrid Bicycle ” Vol 2-Issued on 02 March 2015.

[4]. N.Boopalan , Marlon Jones Louis , A.K.Nachimuthu, International Journal of Research and Innovation in Engineering Technology, “DESIGN AND FABIRCATION OF HYBRID TWO WHEELER”Volume: 01.

[5]. Mohammed Kebriaei, Abolfazl Halvaei Niasa Department of electrical and computer Universityof Kashan, Iran Hybrid Electric Vehicles: An Overview.

[6]. Mojtaba Shams-Zahraei and Abbas Z. Kouzani School of Engineering Deakin University Geelong, Victoria 3217, Australia A Study on Plug-in Hybrid Electric Vehicles.

[7]. Omonowo D. Momo Electrical & Computer Engineering Department, Prairie View A&M University, Prairie View, TX 77446, Overview of Hybrid Electric Vehicle Technology.