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Paper Title:- Design and Development of Hybrid Two-wheeler

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Abstract
Automobiles currently possess certain drawbacks, including higher fuel costs per mile traveled, increased pollution levels, and reduced overall efficiency. Our project aims to harness the cleanest and most efficient technology available.
In our endeavor, we're developing a hybrid electric vehicle (HEV) model that seamlessly integrates an electric motor and battery with a traditional internal combustion engine (typically gasoline-based) found in conventional cars. This innovative approach allows us to achieve approximately double the fuel efficiency compared to a standard gasoline-only vehicle.
The HEV functions by combining two distinct power systems: the traditional gasoline engine and an electric motor. The rear-wheel drive can be powered by either the electric system or the gasoline system, depending on various factors such as driving conditions and compatibility. As a result, both technologies coexist in this "HYBRID VEHICLE." When the vehicle operates on electric power alone, it runs without emissions, providing an eco-friendly driving option.
HEVs represent an exciting advancement in automotive technology. While they are not entirely emissions-free due to the continued presence of the gasoline engine, they significantly reduce fuel consumption and environmental impact, making them a more sustainable and eco-conscious choice compared to conventional vehicles. The option to recharge the batteries using a household power source is enticing.
The motor driver or controller controls the throttle on both the IC engine and the HUB motor. A cost-benefit analysis of the equipment is performed. It is about the production of scooters. The hybrid scooter is the product of the power combination.
Our project's hybrid electric vehicle model combines a conventional car's internal combustion engine with the battery and electric motor of an electric vehicle, resulting in double the fuel economy of a conventional vehicle. It is a hybrid of two systems, notably gasoline and electricity. Rear wheel drive is powered by either a gasoline or an electric system, depending on compatibility. In this "HYBRID VEHICLE," both technologies will be applied correctly.

Using an electric car is both free and environmentally friendly. It's enticing to be able to recharge the batteries using a household power source. The throttle on both the IC engine and the HUB motor is controlled by the motor driver/controller.

CHAPTER-1

INTRODUCTION

One of the greatest technologies of all time is the internal combustion engine. Traditional ICE cars offer strong performance and a lengthy operational range. They have, however, caused and continue to pose major difficulties in terms of low fuel economy, environmental pollution, and human life. One of the most essential aims of contemporary design is to reduce fuel consumption and pollutants. The hybridization of a convectional combustion engine vehicle with an advanced electric motor drive may considerably improve overall efficiency and achieve improved fuel economy while emitting less pollution. Given India's urbanization, a well-organized and fuel-efficient scooter must be conceived and constructed.
The design and development of hybrid two-wheelers represents an innovative approach to modern transportation that combines the benefits of both conventional internal combustion engine (ICE) motorcycles and electric motorcycles. Hybrid two-wheelers are vehicles that utilize a combination of a traditional gasoline engine and an electric motor to provide propulsion. This concept aims to address some of the key challenges in the automotive industry, including environmental sustainability, energy efficiency, and reducing emissions.
Key features and considerations in the design and development of hybrid two-wheelers include:

1. Dual Power Sources: Hybrid two-wheelers typically feature an internal combustion engine, usually fueled by gasoline, in combination with an electric motor and a battery pack. This dual power source system allows for flexibility in operation, with the option to use either the gasoline engine, electric motor, or both.
2. Energy Efficiency: Hybrid motorcycles are designed to optimize energy usage, allowing the vehicle to run on electric power during low-speed or urban commuting, which is more energy-efficient and eco-friendly. The gasoline engine can be engaged for higher speeds or when additional power is needed.
3. Regenerative Braking: Many hybrid two-wheelers incorporate regenerative braking systems that capture energy during braking and convert it into electricity to recharge the battery, thus improving overall energy efficiency.

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4. Environmental Benefits: The integration of electric power reduces emissions and dependence on fossil fuels, making hybrid two-wheelers more environmentally friendly. They contribute to reduced air pollution and can play a part in the fight against climate change.
5. Range Extension: The electric motor in hybrid two-wheelers provides an extended range compared to traditional ICE motorcycles. Riders can enjoy the benefits of electric power while having the assurance of a gasoline engine for longer journeys.
6. Charging Infrastructure: Hybrid motorcycles often come with plug-in capabilities to recharge the battery, and this requires an accessible charging infrastructure. Ensuring a robust charging network is a crucial aspect of hybrid two-wheeler development.
7. Weight and Space Considerations: Engineers must carefully design the integration of the two power sources while keeping the vehicle's weight and size manageable for practical use.
8. Rider Experience: Hybrid two-wheelers aim to provide a seamless and enjoyable riding experience by offering smooth transitions between the electric and gasoline power modes.

The design and development of hybrid two-wheelers is a testament to the industry's commitment to sustainability and innovation. These vehicles offer a compelling solution for those looking to reduce their environmental footprint while enjoying the convenience and freedom of two-wheel transportation. As technology advances and environmental concerns grow, we can expect continued progress in the field of hybrid motorcycle development.

CHAPTER-2

LITERATURE REVIEW

1. Design and Fabrication of Hybrid Two-Wheeler by Prashanna Rangan R et al. (2017): - Studied about how availability of fuel source is depleting day by day. He studied that the hybrid two-wheeler can be used in 3 types of configurations such as fuel mode, electric mode and dual mode. The vehicle operates in fuel mode, and after energy is saved from the dynamo, it switches to electric mode. The motor drives the vehicle, and the vehicle's speed is controlled by rheostats. In dual mode, the engine and motor drive the vehicle in case of heavy load carrying and fast travel.
2. Design and Fabrication of Hybrid Two-Wheeler by Shubham Jalamkar et al.(2015): - Studied the importance of hybrid two-wheeler in case of city driving at slow speeds or driving in hills or high speeds on highways electric motor provides additional power to assist the engine. Also discussed the topic of centrifugal clutch (A clutch is an integral part of a machine that links the driving shaft to a driven shaft allowing the driven shaft to be started or stopped at any time).
3. Design and Fabrication of Hybrid Vehicle by Shoaib Anvar Hussain Multani et al. (2020): - studied the greenhouse effect caused by many gasoline vehicles. Also designed parts of two wheelers which include suspension, rear wheel, bottom rear wheel clamp, main frame, and handle. Also calculated the torque generated after adding the electric motor and finding out the mileage of the two-wheeler before and after installing the electric motor and measured the add on weight of the two-wheeler.
4. Design and Fabrication of Hybrid Two-Wheeler by Inzamam Ul Haq Rizvi et al. (2020): - Studied the importance of hybrid engine and understood the disadvantages of using petrol and diesel engine in our day-to-day life which not only pollutes the environment but creates shortage of fossil fuels which in results increase the prices of petrol and diesel.
5. Design and Fabrication of Hybrid Electric Bike by Y.Ashok Kumar Reddy et al. (2019): - Studied and calculated many factors like Rolling Resistance, Grade Resistance, Acceleration Force, Total Tractive Effort, Wheel Motor Torque, Charging Time Calculations. These factors give us a good insight of the hybrid two-wheeler and help in comparison of an ICE engine and hybris engine.
6. Design and Fabrication of Hybrid Two-Wheeler by N.Boopalan et al. (2014): - Studied The hybrid electric vehicle combines a conventional vehicle's internal combustion engine with an electric vehicle's battery and electric motor. The result is twice the fuel economy of a conventional vehicle in heavy traffic and inside the city where there's no opportunity to move quickly. If the vehicle is operated by an IC engine, then more fuel is wasted due to variation in acceleration. During low load operation, the vehicle can easily be operated by means of battery instead of by engine. When high

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torque is required, the vehicle can be changed to IC engine mode.

CHAPTER-3

THEORY

Hybrid two-wheelers combine the features of traditional internal combustion engine (ICE) motorcycles or scooters with electric propulsion systems. These vehicles use a combination of a gasoline engine and an electric motor to provide improved fuel efficiency, reduced emissions, and often a quieter operation. Here's a comprehensive overview of hybrid two-wheelers:

Hybrid Technology:

Combination of Power Sources: Hybrid two-wheelers integrate an internal combustion engine (usually running on gasoline) with an electric motor and a battery pack. This allows the vehicle to operate using either the conventional engine, the electric motor, or a combination of both.

Working Mechanism:

Electric Assist: During low-speed or stop-and-go situations, the electric motor powers the vehicle. This reduces the load on the internal combustion engine and enhances fuel efficiency. The internal combustion engine typically engages during higher speeds or when additional power is needed.

Fuel Efficiency:

Optimized Fuel Consumption: The hybrid system allows for optimized fuel consumption, especially in urban commuting scenarios where the electric motor can handle low-speed driving and traffic conditions.

Reduced Emissions:

Environmentally Friendly: Hybrid two-wheelers contribute to reduced emissions and lower environmental impact compared to traditional motorcycles or scooters. The electric mode produces zero emissions, and even in hybrid mode, emissions are significantly lower than in conventional ICE vehicles.

Regenerative Braking:

Energy Recovery: Like hybrid cars, hybrid two-wheelers often incorporate regenerative braking systems. When braking or decelerating, the electric motor acts as a generator, converting kinetic energy into electrical energy, which is then stored in the battery for later use.

Battery Technology:

Lithium-Ion Batteries: Hybrid two-wheelers typically use advanced lithium-ion battery technology for energy storage. These batteries are lightweight, have a high energy density, and can endure numerous charge-discharge cycles.

Government Incentives:

Financial Benefits: Many governments offer incentives, tax breaks, or subsidies for the purchase of hybrid and electric vehicles. This can make hybrid two-wheelers more financially attractive to consumers, encouraging the adoption of cleaner transportation options.

Cost Considerations:

Initial Cost: Hybrid two-wheelers may have a higher upfront cost compared to traditional motorcycles or scooters. However, the potential savings on fuel, maintenance, and possible government incentives can make them cost-effective over the long term.

Noise Reduction:

Quiet Operation: In electric mode, hybrid two-wheelers operate quietly, contributing to a reduction in noise pollution, particularly in urban areas.

Charging Infrastructure:

Flexibility: Hybrid two-wheelers offer the flexibility of using both electric and conventional fuel, eliminating concerns about range limitations and charging infrastructure.

Urban Mobility:

Ideal for City Commuting: Hybrid two-wheelers are well-suited for urban commuting, where frequent stops and lower speeds are common. The electric mode allows for efficient and environmentally friendly operation in congested city traffic.

Hybrid two-wheelers represent a promising advancement in the realm of sustainable transportation, combining the benefits of internal combustion engines and electric propulsion to provide an efficient and eco-friendly mode of personal mobility. As technology continues to advance, the appeal and viability of hybrid two-wheelers are likely to increase, contributing to a greener and more sustainable future for urban transportation

Parallel Hybrid and Series Hybrid are two common configurations for hybrid vehicles, which combine both an internal combustion engine (ICE) and an electric motor to improve fuel efficiency and reduce emissions. These configurations differ in how the ICE and electric motor work together to propel the vehicle.

1. Parallel Hybrid:

- In a parallel hybrid vehicle, both the internal combustion engine (ICE) and the electric motor are mechanically connected to the wheels and can work simultaneously to drive the vehicle. The key characteristics of a parallel hybrid are:
  - Both the ICE and electric motor can provide power to the wheels independently or together, depending on the driving conditions and power requirements.
  - This configuration allows for greater flexibility, as the vehicle can run on the ICE, electric motor, or both.
  - Parallel hybrids are generally more suitable for highway driving, as both power sources can contribute to propulsion, offering better performance at higher speeds.
  - A common example of a parallel hybrid is the Toyota Prius, where the gasoline engine and electric motor can work together or separately to optimize fuel efficiency.

2. Series Hybrid:

- In a series hybrid vehicle, the internal combustion engine (ICE does not directly drive the wheels. Instead, it serves as a generator to produce electricity, which is then used to power an electric motor that propels the vehicle. The key characteristics of a series hybrid are:
  - The ICE is primarily used as a generator to recharge the battery or directly power the electric motor, but it is not mechanically connected to the wheels.
  - The electric motor is responsible for driving the wheels, while the ICE's primary role is to generate electricity.

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- Series hybrids are often more efficient in city or stop-and-go traffic, where the electric motor can work effectively at low speeds, and the ICE operates at a more constant, optimized speed to generate electricity.
- An example of a series hybrid is the Chevrolet Volt, where the gasoline engine functions primarily as a generator to recharge the battery, allowing for extended all-electric driving in certain conditions.

Each hybrid configuration has its own set of advantages and trade-offs, and the choice between parallel and series hybrid depends on the specific design goals, driving conditions, and intended usage of the vehicle. Some modern hybrid vehicles even use a combination of both configurations to maximize efficiency and performance.

CHAPTER-4

METHODOLOGY

Technical aspects of hybrid two-wheelers encompass a range of components and systems that collaborate to achieve the integration of both internal combustion engine (ICE) and electric propulsion technologies. Here are the key technical aspects of hybrid two-wheelers:

Powertrain Integration:

Internal Combustion Engine (ICE): The hybrid two-wheeler typically incorporates a traditional internal combustion engine, usually running on gasoline, to provide the primary source of power.

Electric Motor: Complementing the ICE is an electric motor, powered by a battery pack. The electric motor can operate independently or in conjunction with the internal combustion engine.

Battery Technology:

Lithium-Ion Batteries: Hybrid two-wheelers commonly utilize lithium-ion battery technology due to its high energy density, lightweight nature, and suitability for automotive applications. These batteries store and provide electric power to the motor.

Energy Management System:

An advanced energy management system coordinates the power delivery from both the internal combustion engine and the electric motor. It optimizes the use of each power source based on driving conditions, user demand, and efficiency considerations.

Regenerative Braking System:

A regenerative braking system captures kinetic energy during braking or deceleration, converting it into electrical energy. This recovered energy is then fed back into the battery for later use, contributing to overall energy efficiency.

Controller and Electronics:

Sophisticated electronic control units (ECUs) manage the operation of the hybrid system. These controllers govern the power split between the internal combustion engine and electric motor, ensuring seamless transitions between different driving modes.

Transmission System:

The transmission system in hybrid two-wheelers is designed to accommodate the dual power sources. Some hybrids use a continuously variable transmission (CVT) to efficiently

manage power delivery from both the internal combustion engine and the electric motor.

Auxiliary Systems:

Start-Stop System: Many hybrid two-wheelers incorporate start-stop systems, shutting off the internal combustion engine during idle or when the vehicle is stationary to conserve fuel.

Electric-only Mode: Hybrid two-wheelers often have the capability to operate solely on electric power, particularly at lower speeds, providing a quiet and emission-free mode for urban commuting.

Charging System:

Hybrid two-wheelers may feature a charging system for the battery pack. This system can recharge the battery during certain conditions, such as regenerative braking or when the internal combustion engine is running, ensuring the availability of electric power.

Weight Distribution and Frame Design:

The integration of hybrid components, including the battery pack and electric motor, requires careful consideration of weight distribution and frame design to maintain the stability and handling characteristics of the two-wheeler.

User Interface and Display:

Modern hybrid two-wheelers come equipped with user interfaces and displays that provide real-time information on the operating mode, battery status, energy flow, and other relevant data. This helps riders make informed decisions to optimize efficiency.

Safety Features:

Safety features specific to hybrid two-wheelers may include systems to prevent electric shock, secure battery enclosures, and fail-safes to ensure safe operation during hybrid mode transitions.

Maintenance Considerations:

Hybrid two-wheelers may have unique maintenance considerations, such as periodic checks on the battery health, electric motor, and associated control systems. Training for maintenance personnel is crucial to ensure proper servicing.

The successful integration of these technical aspects contributes to the overall efficiency, performance, and sustainability of hybrid two-wheelers, offering users a versatile and environmentally friendly mode of transportation. As technology continues to advance, ongoing research and development in these technical areas will likely lead to further improvements in hybrid two-wheeler design and functionality.

In this project we are going to use both energy electric motor and I.C engine in single run. We are going to use parallel hybrid method in our project. As we know vehicle need maximum torque at initial stage to bring vehicle in motion. After that vehicle only needs high rpm and less torque to maintain the speed and to increase speed of vehicle. The initial torque is the biggest barrier for the electric vehicle and due to this there is decrement in efficiency.

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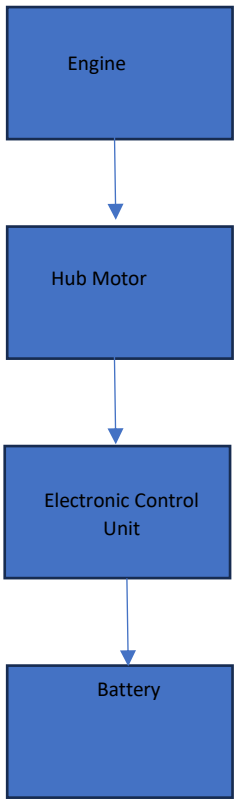
DESIGN

Our objective of work is to make two-wheeler hybrid vehicle which will run by both gasoline and battery. The main objective of our project is to increase mileage and reduce pollution.

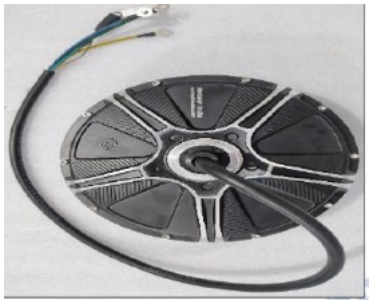
Fabrication:
Fabrication is the process of building up components in complete or sub-assembly
Charging process of battery is modelled as flow chart shown below:



System proposes a solution by retrofitting existing scooters into hybrid electric which runs on IC engine. Here scooter with engine capacity of 125cc petrol IC engine is used. Also the rear wheel gets an electric hub motor. It becomes a conventional engine powering at the rear wheel and electric motor driving wheel.
Conventional engine is pretty inefficient during start-stop traffic. The engine uses a lot of fuel during such situation and reduce mileage significantly. By using economy mode for these in which scooter will start and run on rear wheeled electric motor.
Hub mounted electric motor works during crossing traffic and does not need the fuel. Electric motor is much more efficient as they do not draw any power from battery while waiting in traffic and idling.
Second drive mode is power mode. In this case scooter will start and run on conventional IC engine which is coupled with rear wheel. This mode can be used for required condition when batteries are completely drained or if there is any problem in motor.

TECHNICAL DESCRIPTION

- Motor:
  - This is basically a hub motor with power of 1.5Kw where this motor is fitted at rear of the vehicle and controlled with help of motor drive controller. It is a brushless motor. The size fitment of wheel is 10inch. Speed of motor is an economy level which is 60kmph.



- Controller:
  - Controller which is used for motor speed and conversion of electric drive to petrol drive with compatible voltage of 48V distributed through this motor drive

- Battery:
  - This is lithium-ion battery with voltage capacity of 48V with motor can run up to 40 to 60 km at constant speed or consumption of energy. Time taken to recharge is 4 to 5 hr
  -
- Throttle:
  - This is common throttle valve which is adjusted with electric motor and petrol engine which is controlled by sine wave controller as per the requirement of fuel energy. Based on this shifting of power transmission is changed with an ease without any huge change just switch key is used for power transmission.

- Fixing of synchronized rear wheel drive

- Establishing sine wave controller or motor drive controller

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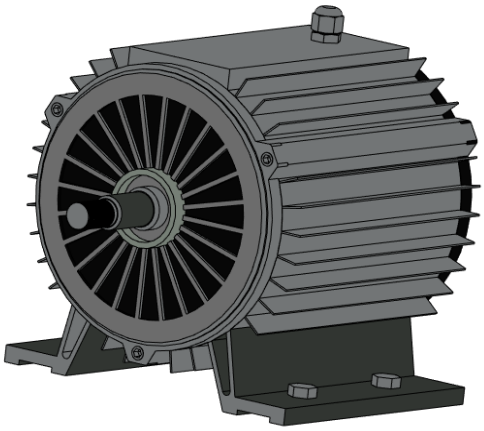
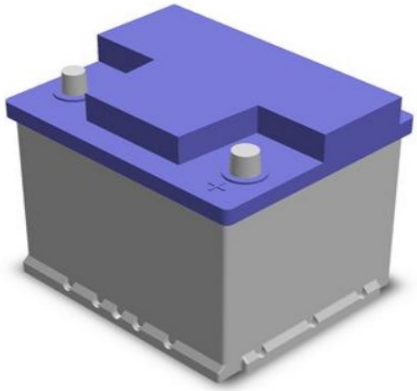
- Installing a lithium battery pack in boot space with charging port

3-D CAD Models of the following components: -

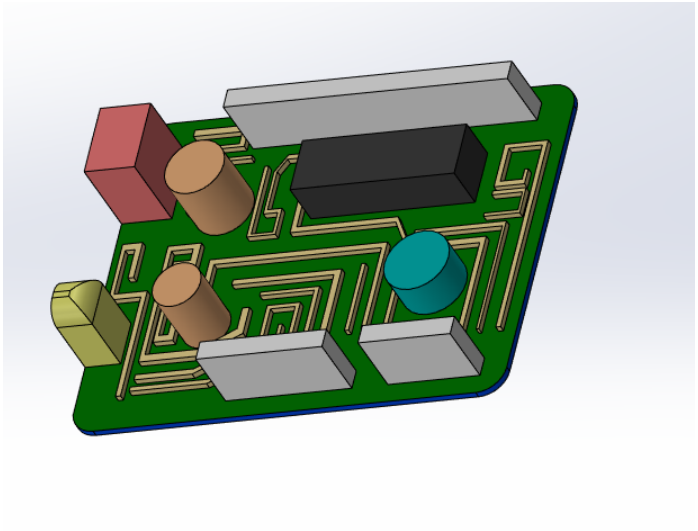
- **Motor:**



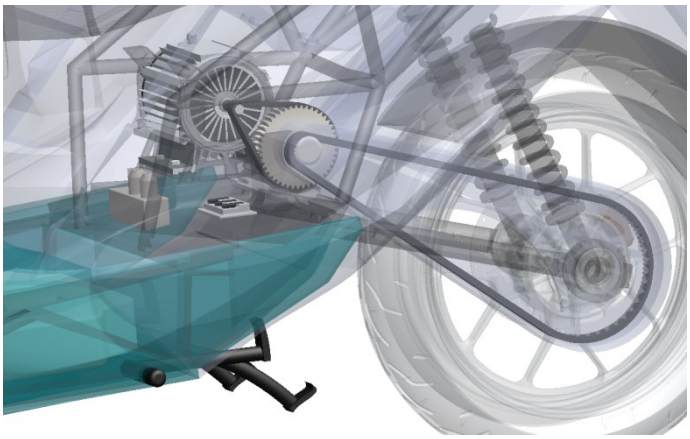
- **Battery:**



- **Controller:**



Schematic Placement of Motor: -



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Schematic Diagram of Hybrid Two-Wheeler: -

CHAPTER-5

RESULT

As the speed of the vehicle increases, it is noted that the ICE in this manufactured hybrid electric vehicle is used to gain propulsion from the rest; the electric motor propulsion is coupled with the ICE propulsion for complete vehicle movement. The overall torque produced by both the ICE and the electric motor is synchronised for each road grade by changing the respective controls.

By properly distributing torque, battery life per total charge may be increased while simultaneously reducing the amount of gasoline required for ICE propulsion.

For the test route chosen, the vehicle in stock state can provide a mileage of 32.5km. This sort of configuration may effectively increase mileage performance by 30%. During the test run, the throttle in relation to the ICE was moderately involved in achieving propulsion. The throttle used to drive the electric motor was made mutually involved with the ICE throttle. Both motor torque and ICE torque were to blame.