Fabrication of Hybrid Two Wheeler with ABS System

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Abstract: The automobile industry concentrating on electric mobility in this period of technical progress, improvement, and Innovation. Instead of employing the traditional power source for propulsion, all of the well-known industries and Entrepreneurs were concentrating on electrification. For these technologies to be commercialized, much more development is still required. The gap between the current fossil fuel technology and low tailpipe emission vehicles can be bridged by hybrid technology. Hybrid electric vehicles combine an electric motor, battery and power system with an internal combustion engine to reduce emissions and better mileage. It offers significant benefits compared to the gasoline engines that relies solely on gasoline for power and results in considerable air pollution.

The integration of Anti- lock Braking System (ABS) in hybrid two- wheelers represents a significant stride towards enhancing safety, stability, and overall performance. The idea is to encapsulate the comprehensive exploration of incorporating ABS technology into hybrid two-wheelers, amalgamating the benefits of hybrid propulsion with advanced braking capabilities. This practical experience deals with an attempt to make a hybrid two-wheeler which runs on both electric and gasoline. The ABS is fitted in the front wheel along with sensor and work accordingly to the control unit which is powered by the battery. The conversion switch is provided in the handle along the battery indicator which is used to convert vehicle to propel either from electric or gasoline. The findings of this practical work contribute valuable insights to the ongoing efforts in the field of sustainable transportation and serve as a foundation for future research and development of hybrid and electric vehicles.

Keywords: Hybrid vehicle; Electric vehicle; ABS; Internal Combustion Engine.

I. INTRODUCTION

Around 93% of today's automobiles run on petroleum-based product, which are estimated to be depleted by 2050. Moreover, current automobiles utilize only 25% of the energy released from petroleum and rest is wasted into the atmosphere. Despite recent efforts to improve fuel efficiency and reduce toxic emissions in cars, emissions have continued to increase steadily in the past two decades. For preservation of gasoline for future and increasing the efficiency of vehicle an electric vehicle can be a major breakthrough. An electric vehicle is pollution free and is efficient at low-speed conditions mainly in high traffic areas. But battery charging is time consuming. Moreover, it cannot provide high power required by drives during high-speed conditions or in slopes of hilly areas. Gasoline engine proves its efficiency at higher speeds in high ways and waste a lot of energy in urban areas. A hybrid vehicle solves these problems by combining the advantages of both the systems and uses both the power sources at their efficient conditions. The objective of this project aims at better utilization of fuel energy and reduces dependence on non-renewable resources using latest technology. The implementation involves development of HEV that uses battery as well as gasoline power for propulsion of vehicle and seamless coordination of ABS making it viable safety enhancement without sacrificing the eco-friendly attributes of hybrid two-wheeler.

A 'gasoline-electric hybrid vehicle' is an automobile which relies not only on gasoline but also on electric power source. In HEV, the battery alone provides power for low- speed driving conditions. During long highways or hill climbing, the gasoline engine drives the vehicle solely. Hybrid electric vehicles comprise of an electric motor, inverter, battery as electric drive and an internal combustion engine with transmission connected as gasoline-based drive. It is to achieve better fuel economy and reduce toxic emissions. HEVs utilize a combination of an internal combustion engine and an electric motor powered by a battery. It has great advantages over the previously used gasoline engine

that is driven solely 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 Anti-lock Braking System (ABS) is a safety feature that prevents wheel lockup during braking, ensuring the vehicle remains stable and responsive to steering inputs. When integrated into a hybrid two-wheeler, ABS operates in conjunction with both the internal combustion engine (ICE) and the electric motor, providing enhanced safety and control during braking maneuvers. The ABS system functions in a hybrid two- wheeler using the components like sensors and control unit, braking system coordination, preventing wheel lock up and enhancing safety and stability. The proposed project focuses on the design, development, and integration of an advanced Anti-lock Braking System (ABS) into a hybrid two-wheeler, aiming to enhance both safety and efficiency in urban commuting. This overview outlines the key aspects of the proposed work, providing a comprehensive understanding of the project's objectives and methodologies. This shows its potential to significantly enhance safety, stability, and energy efficiency. Through meticulous design, integration, and testing processes, the project endeavors to contribute to the advancement of hybrid vehicle technologies, paving the way for safer and more sustainable urban transportation solutions.

II. LITERATURE SURVEY

[1] Kamatchi Kannan V et.al, "Design And Development of Hybrid Two-Wheeler", portraits that in recent years, the hybrid electric two wheelers have targeted the market due to less CO2 emission by the hybrid vehicles. The aim is to reduce the cost and complexity which is involved in the existing hybrid vehicle. This hybrid electric vehicle includes conventional, hybrid, plug-in hybrid and electric variants. The main aim of this paper is to structure and manufacture a hybrid two wheelers such as scooty which can be operated by means of fuel and battery. The integration of both the battery and the fuel makes the vehicle dynamic.

[2] Shoaib Anvar et al, "Design and Fabrication of Hybrid Vehicle", discussed that last 2-3 decades the average temperature of earth increased by 3-4 degree Celsius because of the greenhouse effect. Due to increase in the fuel prices and continuously depletion of natural resources for the fuels causes fuel crises in the modern society. Due to which demand of development of newly energy efficient vehicles increases. The hybrid technology fulfills this requirement by incorporating various combinations of bio-fuels and also by combinations of highly efficient electric drive systems. Along with the same it reduces the emission and cut the fuel cost. This project illustrates an implementation of hybrid technology on a small scale. Project aims at improving the mileage of the car using simple mild parallel hybrid technology with combination of electric motor drive and the petrol engine drive. We have used the straight open kart chassis design.

[3] Balasubramani et al, "Fabrication and Performance Analysis of Hybrid Two-Wheeler", with design and fabrication of hybrid two wheeler system. In recent days availability of fuel source is depleting day by day and also pollution is increasing globally with increased number of vehicle. This leads to the evolution of various alternative fuels and concepts, in that HEV system (hybrid electric vehicle) is one of the effective systems. This project involves the fabrication of two wheeler (HEV) which is driven by both fuel and electric energy with the help of engine and electric motor. The electric motor is the hub motor which drives the front wheel which is driven by the battery and the engine drives the rear wheel. By driving the fabricated two wheeler in engine mode, electric mode and hybrid mode, the performance of the bike is tested and analyzed by comparing with the conventional bikes. This vehicle hugely reduces the pollution, fuel consumption and vital scope in future.

[4] Nikhil M Mane, "Design and Analysis of Antilock Braking System with Fuzzy Controller for Motorcycle", described the Automotive safety applications become more and more common in today's Cars, trucks and also in motorcycles. Vehicle stabilization systems such as anti- lock braking systems (ABS) and electronic stability control are introduced since the late 1970's and have now become almost standard in every passenger car. ABS are mainly applied to two track vehicles, i.e., which have at least four wheels. For single-track (two-wheeled) vehicles such as motorcycles, because the realization

of applications is more challenging due to the extended system dynamics and practical limitations such as space, weight, power requirements, etc. In this work, study of Motorcycle Antilock Braking System (ABS) is discussed. In literature survey study of various controller-based ABS systems are studied which are commercially used in passenger vehicles, trucks, buses, etc. The aim of this work is to design fuzzy logic Based ABS controller for motorcycle in order to obtain desired braking performance to prevent wheel locking considering motorcycle wheel dimensions. The stopping distance, braking torque are calculated analytically and Performance is verified in MATLAB/Simulink Environment.

[5]Chun-Kuei Huang, "Design of a hydraulic anti-lock braking system (ABS) for a motorcycle" paper discussed about the hydraulic anti-lock braking system (ABS) for a motorcycle. The ABS has a hydraulic modulator and an intelligent controller. The hydraulic modulator is analyzed, and then equipped on a scooter for road tests. The intelligent controller controls the hydraulic modulator by estimated vehicle velocity to calculate the slip ratio of the wheels in real time. The performance of the hydraulic modulator and intelligent controller are assessed by the hardware-in-the-loop (HIL) simulations and road tests. In HIL simulation, the ABS is tested for different initial braking velocities on roads with different adhesive coefficients. Furthermore, both HIL simulations and road tests are conducted on a one-phase pavement road and three-phase pavement road.

[6] Piyush Kumar et al, "Design and Development of Hybrid Vehicle using Four Different Sources of Energy", portraits that these days, where there are energy crises and the assets are depleting at a higher rate, there is a necessity for specific innovation that recovers the energy, which gets commonly squandered, and to find new sources of energy. Thus, if there should arise an occurrence of cars one of these valuable innovations are the hybrid vehicles. By the actual name it tends to be surmised that a hybrid vehicle is an extemporization to the conventional gasoline run vehicle joined with the force of an electric engine. In this work, they created a working model of a system that can charge its battery from four different sources.

III.METHODOLOGY

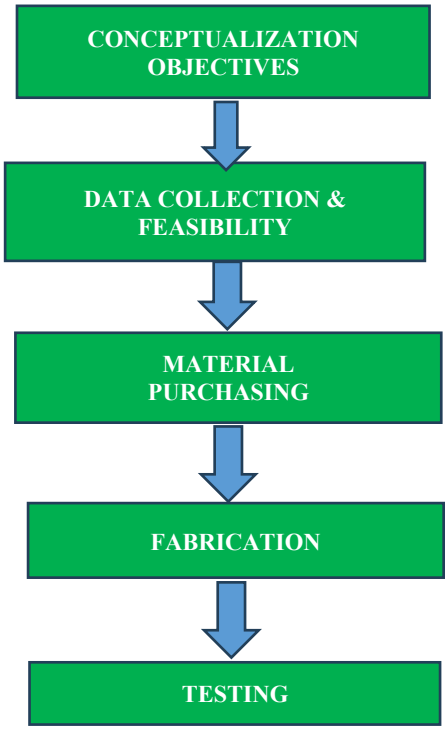

Fig.3.1 Methodology

The practical possibility of the project work has been carried out with concept possibility, feasibility and fabrication as shown in Fig.3.1

IV. COMPONENT DESCRIPTION

The component description serves as a detailed overview of the individual parts that make up the whole. This section will outline the key components, such as the battery, hybrid hub motor, control systems, and the ABS unit, explaining their functions and significance in the hybrid system. The battery's role in energy storage and supply, the hybrid hub motor's contribution to propulsion, the control system's task in managing power distribution, and the ABS unit's importance in ensuring rider safety through controlled braking will be discussed. Each component is integral to the performance, efficiency, and safety of the hybrid two-wheeler, making this section crucial for understanding the vehicle's innovative design.

4.1 Internal Combustion Engine:

Honda Activa vehicle is purchased for the fabrication of Hybrid Vehicle as shown in Fig.3.1. The specifications of the vehicle listed below,

Engine Displacement (cc) - 109cc
Mileage - 55 Kmpl
Engine Type - 4 Stroke, SI Engine
Number of Cylinders -1
Fuel Supply System - Carburetor
Maximum Power - 8 Bhp @ 7500 Rpm
Maximum Torque - 9 Nm @ 5500 Rpm
Wheel Base - 1238mm
Overall Width - 710mm
Overall Length - 1761mm
Overall Height - 1147mm
Ground Clearance - 153mm
Kerb weight – 110 kg

Fig.4.1 Two Wheeler

Fuel tank capacity – 6 Liters
Brake system: Front brake type – Drum • Rear brake type – Drum

4.2 HUB MOTOR

The heart of the hybrid system, the electric hub motor, is responsible for converting electrical energy from the battery into mechanical power. It is chosen for its power-to-weight ratio, efficiency, and regenerative braking capabilities. The motor's torque characteristics and responsiveness are crucial for seamless transitions between electric and internal combustion engine power. The Hub Motor components (Fig.4.2) are motor, shaft, vehicle suspension, stator disc, wheel bearing, rotor, conventional alloy wheel and the other electronics components known as an electronically commutated motor, is a synchronous motor using a direct current (DC) electric power supply. It uses an electronic controller to switch DC currents to the motor windings producing magnetic fields that effectively rotate in space and which the permanent magnet rotor follows. The controller adjusts the phase and amplitude of the DC current pulses to control the speed and torque of the motor. This control system is an alternative to the mechanical commutator (brushes) used in many conventional electric motors. The coils, arranged radially, are made from copper wire coated with blue insulation. The rotor (upper right) has been removed and turned upside-down. The grey ring inside its cup is a permanent magnet. This particular motor is an out runner, with the stator inside the rotor. DC brushless ducted fan. The two coils on the printed circuit board interact with six round permanent magnets in the fan assembly.

4.2.1 Hub Motor Specification
Power (Continuous Power): 1.5kW
Type: DC Brushless Motor
Wheel Size: 10 inch
Speed: 40 – 60km/h
Torque: 30 Nm
Max. Working Temperature: 80 ℃
Waterproof Grade: IP54
Weight: 7 - 8kg
Efficiency:85%

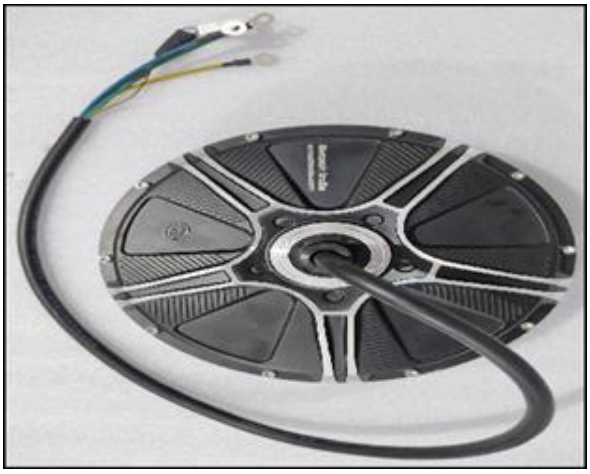

Fig.4.2 Hub Motor

4.3 Lithium-Ion Battery

The battery pack serves as the energy storage unit for the electric motor. Lithium-ion batteries, renowned for their high energy density and quick charging capabilities, are commonly used. The battery's voltage and capacity are selected to meet the power demands of the vehicle, ensuring a balance between range and performance. Advanced Battery Management

Systems (BMS) are integrated for efficient power distribution and thermal management.

Fig.4.3 illustrates the lithium-ion battery which is favored for its extended range, lightweight design, faster charging, durability, high discharge rate, and maintenance convenience, making it ideal for enhancing the vehicle's efficiency and environmental sustainability.

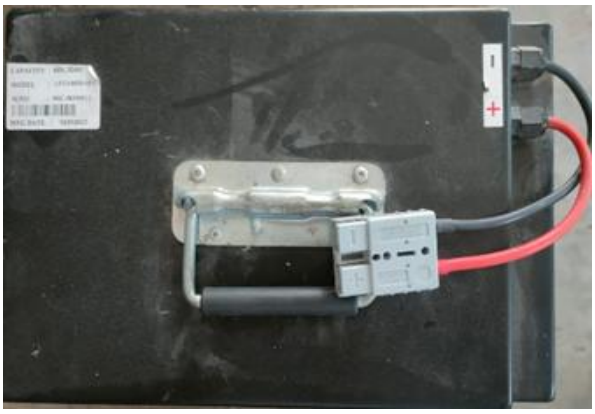

Fig.4.3 Battery

Lithium Ion Battery Specification
Nominal Voltage – 48.1V
True Capacity – 20AH at 0.2C discharge
Watt hr. – 962Wh • Weight – 15 Kg
Battery Dimensions (L*W*H) – 253 mm x 156 mm x 171 mm
Full Charged Voltage – 54.6V
Discharge Cut-off Voltage – 37V
Standard Charging Current – 6A
Max Charging Current – 10A
Max Continuous Discharge Current – 30A
Peak Discharge Current – 60A (for few milli seconds)

4.4 CONTROLLER

A BLDC motor controller regulates the speed and torque of the motor and it can also start, stop, and reverse its rotation. Its major components comprise an armature or rotor made of permanent and in many cases neodymium magnets and a stator with windings that create a magnetic field when energized. The rotor's magnets and stator's windings provide the rotation of the motor. They attract each other with opposite poles and repel each other with the same poles. A similar process takes place in a brushed DC motor. The essential difference is in the method of switching the current applied to the wire windings. In a BDC motor, this is a mechanical process triggered by a commutator with brushes. In a BLDC motor, it happens electronically with the help of transistor switches.

4.4.1 Controller Specification

Compatible Voltage: 48V / 60V
Rated current: 35A
Peak current: 65A
Max Power: 2.1Kw
Waterproof Grade: IP64
Regeneration: Yes
Type: sine wave
Ambient Temperature: 0 to 40 °C
Storage Temperature: -10 to 70 °C
Rated voltage: DC48V/60V
Rated power: 1500W
Rated current: 35A

4.7 HYBRID DUAL THROTTLE

The hybrid dual throttle seamlessly manages and controls both the hub motor and IC engine, optimizing performance and efficiency for a smooth, responsive ride. A hybrid dual throttle system for a two-wheeler is designed to allow the vehicle to operate using both electric power and traditional fuel. This system is particularly beneficial for vehicles equipped with a hub motor, as it can enhance the range and efficiency of the vehicle

Peak Current: 65A

Efficiency: ≥83%

Fig.4.4 Controller

4.5ANTI LOCK BRAKING SYSTEM

The Anti-lock Braking System, is a critical safety feature in motorcycles that prevents the front wheel from locking up during sudden braking scenarios. When a rider applies the brakes forcefully, especially on slippery surfaces, there's a risk of the wheels locking up, causing the bike to skid and potentially leading to an accident. The ABS 28 system is equipped with sensors that continuously monitor the wheel's speed. If a sudden decrease in wheel speed is detected, indicating a potential lock-up, the system sends signals to an Electronic Control Unit (ECU).

4.6 HYDRAULIC BRAKING SYSTEM

The hydraulic brakes work on an oil based actuator. Hydraulic brakes in two-wheelers operate on Pascal's law, which states that pressure applied to a confined fluid is transmitted undiminished in all directions. When the brake pedal is pressed, the master cylinder pressurizes the brake fluid, sending it through hydraulic lines to the wheel cylinders or calipers. This pressure forces the brake pads or shoes against the rotating disc or drum, creating friction to slow down or stop the vehicle.

V. CONSIDERATIONS FOR HYBRID INTEGRATION

5.1 Hub Motor Integration at Rear Wheel

- Mounting and Structural Adaption
- Power Transmission
- Electrical Integration
- Control System
- Battery Placement

5.2 ABS System Integration At Front Disc Wheel

- Disc Brake Upgrade
- ABS Ring and Sensor Installation
- Hydraulic System Modification
- ABS Control Unit
- Testing and Calibration

5.3 OVERALL SYSTEM INTEGRATION

- Safety Considerations
- Aesthetic and Ergonomic Factors

5.4. SCHEMATIC CONNECTION OF WIRING SET

The Wiring connections are made according to the instructions given in the controller manual and prototype block diagram drawn as setup displayed been made. It helps to assemble the parts easily shown in Fig.6.1. Before the assembling and fabrication of the hybridization, the working model

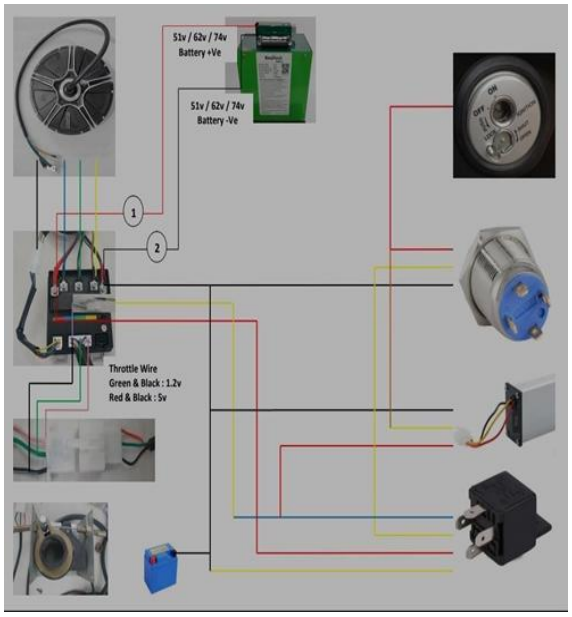

Fig.5.1 Schematic Connection of Wiring Set

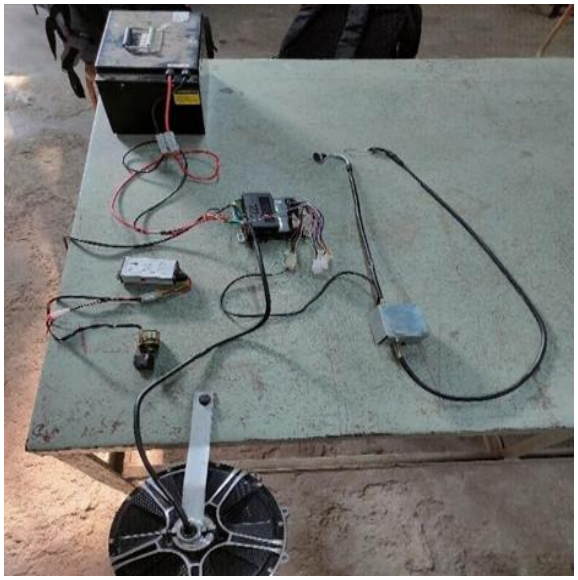

Fig.5.2 Working Model of Electric Vehicle

VI. FABRICATION

In the Fabrication stage, the rear of the two wheeler completely dismantled to fix the EV Hub Motor. The Fig. 6.1 shows the Rear wheel with hub motor assembly and controller. Then The ABS braking system set up in the front wheel of the vehicle as shown in Fig.6.2

Fig.6.1 Hub Motor and Controller Assembly

Fig.6.2 ABS Set up

VII. TESTING OF HYBRID TWO WHEELER

The hybrid two-wheeler project aims to provide a sustainable and efficient mode of transportation by integrating an ABS system. The vehicle operates in two modes: EV mode and Hybrid mode, offering a balance between range and performance. The tested parameters includes.

7.1. Performance Test: The vehicle achieved a top speed of 55 km/h in EV mode and 70 km/h in IC engine.

7.2. Range and Efficiency Test: The vehicle successfully provided a range of 40 km in EV mode until the battery depletes in EV mode and 40 km in IC engine mode until the fuel runs out in IC engine mode on a standard test cycle.

7.3. Load Test: The vehicle maintained stability and performance with the load of 3 passengers.

7.4 Charging Test: The full charging of the vehicle's battery was completed within 3 hours.

7.5 Hybrid Transition Test: The vehicle seamlessly transitioned from EV to petrol engine at 25 km.

The hybrid two-wheeler with ABS system has met the expected performance, range, and efficiency criteria under the test conditions. The vehicle's ability to support the internal combustion engine during acceleration in EV mode demonstrates its potential for enhanced performance.

VIII. CONCLUSION

The project signifies the new hybrid technology for the emission standards and the eco friendliness. It offers both range and mileage for the users for a long runs emitting lesser emissions. The ABS helped to increase the braking efficiency on the wet surfaces and drastically reduced the skidding and lose of stability. More challenges were faced during the fabrication stage on the ABS integration of the front brake system. The wheel speed sensors couldn't match the specified distance between induction plate and disc caliper and finally the ABS system was successfully integrated and tested. Due to troubleshooting in dual throttle system, the throttle responsiveness was not achieved properly and frequent tuning was done to ensure good response .The placement of battery into the vehicle's boot storage has been designed meticulously to maintain vehicle's aesthetic appearance. The hybrid two-wheeler with ABS system has met the expected performance, range, and efficiency criteria under the test conditions. The vehicle's ability to support the internal combustion engine during acceleration in EV mode demonstrates its potential for enhanced performance.

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