

# Design And Development Of Hybrid Two-Wheeler

Kamatchi Kannan V, Ponnuragan P and Chitra K

**Abstract:** Hybrid Electric Vehicle (HEV) is an advanced vehicle having a feature that operates on battery and inbuilt ignition motor. This motor helps to drive the wheel forward and it also charges the battery system when it is operated as generator. In recent years, the hybrid electric two wheelers have targeted the market due to less CO<sub>2</sub> 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. In HEV, the battery alone can be used at low-speed driving conditions where as the interior fuel based motors are least productive. In case of quickening, long runs or slope climbing, the Internal Combustion (IC) engine gives extra force to drive the motor.

**Index Terms:** Hybrid Electric Vehicle, Internal Combustion Engine, Grounded Low Voltage System, Tractive System, Brushless DC motor, Pulse Width Modulation

## 1 INTRODUCTION

An enormous number of the present autos keep running on oil based items, and oil generation is always diminishing and is evaluated to be exhausted in not so distant future. For more than 100 years, vehicles equipped with normal inward burning engines (ICE) have been present. In recent days, the interest in two-wheels for individual transportation has increased considerably in the past decade with the growth of the total population. This pattern of increase will only escalate as countries, such as China, India, and Mexico, get up to pace. Besides, current vehicles use just 25% of the vitality discharged from oil and rest is squandered into the climate, making the vehicle wasteful just as making a dangerous situation [1]. Regardless of ongoing endeavours to improve eco-friendliness and decrease poisonous outflows in vehicles, discharges have kept on expanding exponentially in the last two decades. In-order to reduce the usage of oil and expanding the effectiveness of two wheeler, an idea of electric vehicle has been developed by researchers. The electric vehicle is uncontaminated and productive under low-speed conditions predominating in gridlocked areas of heavy rush hour. In any case, battery charging is tedious. Oil motor shows its efficiency in high ways at higher speeds and squanders much vitality in urban regions. Another problem linked to the steadily increasing use of individual vehicle is emanation. The impact on the nursery, otherwise referred to as an Earth-wide temperature boost, is a difficult issue that needs to be addressed. Due to the vitality emergency, there has been extended pressure in some parts of the globe. Government offices and organizations have gradually developed strict guidelines for the use and outflows of petrol In any case, the ICE innovation has been developed over the last few years, despite the fact that it will continue to improve with the two / four wheel electronic innovation, it will mainly rely on elective progress to effectively enhance the mileage and reduce outflows. One of the arrangements proposed to handle the emergency of vitality and a dangerous atmospheric devotion was battery-controlled electric vehicles.

Nevertheless, high starting costs, short driving distance, long charging (refueling) time and reduced traveler and load space have shown that battery-controlled EVs are impeded. A half and half vehicle deals with these issues by consolidating the upsides of both frameworks and using both power sources under their effective conditions [2].

## 2 PROPOSED HYBRID ELECTRIC VEHICLE

The figure 1 shows the complete layout of the proposed electric hybrid vehicle.

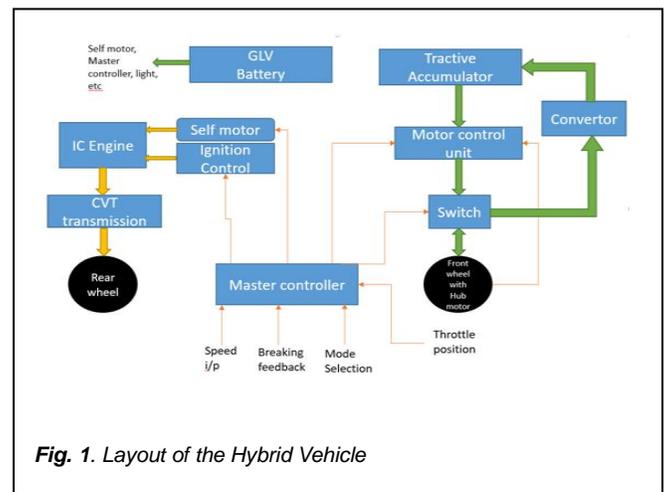


Fig. 1. Layout of the Hybrid Vehicle

The components involved in hybrid vehicle are shown below:

- Grounded Low Voltage System (GLVS) Battery
- Tractive System (TS) accumulator
- Converter
- IC engine
- CVT transmission
- Master controller
- Switch
- Motor control unit
- Self-motor
- Ignition control

### 2.1 GLVS Battery and TS accumulator

The vehicle's TS are defined as any part that is connected to the engine and TS accumulators electrically. The vehicle's GLVS is defined as any electrical part that does not belong to the TS.

- Kamatchi Kannan V is working as Associate Professor / EEE in Bannari Amman Institute of Technology, Sathyamangalam, E-mail: kannan.ped2gmail.com
- Ponnuragan P is working as Associate Professor / EEE in Sri Krishna College of Technology, Coimbatore. E-mail: murugan.pmsm@gmail.com
- Chitra K, is working as Professor / EEE in CMR Institute of Technology, Bangalore, E-mail: chitrapeee@gmail.com

## 2.2 IC Engine

An Internal Combustion Engine (ICE) is a warmth engine where a fuel ignition occurs with an oxidizer (usually air) in an ignition chamber which is a essential part of the operating liquid stream circuit. The development of high-temperature and high-weight gasses delivered by burning in an internal ignition engine applies direct power to some part of the engine. The power is usually connected to cylinders, sharp edges of turbines, rotors or spouts. This power moves the part over a separation, changing concoction vitality into valuable mechanical vitality.

## 2.3 Working of IC Engine

The principal thing it helps to remember in IC engine is the petroleum/diesel motor. Petroleum motor is sparkle start motor though diesel motor is packed start engine. These IC engine are for the most part four stroke motors and subsequently can examine about especially four stroke IC engines. The petroleum engine works in the rule of OTTO cycle. It is a four stroke cycle and it is a blend of gas and air. It is packed in the burning chamber to a predetermined weight proportion. At explicit weight a sparkle is created by methods for flash attachment and the ignition is delivered. This is called control stroke as in this stroke control is made [3]. The steps for the working of oil motor are below:

Procedure 1: Suction of air and fuel blend

Procedure 2: Compressing the blend to foreordained weight proportion

Procedure 3: Power stroke (sparkle lights the fire)

Procedure 4: Expansion stroke/exhaust

The flash fitting is utilized to create a sparkle that is sufficiently varied for the fuel blend to get scorched. Other most famous IC motor is diesel motor. Diesel motor operates based on the diesel cycle guidelines. The primary contrast between the Otto cycle and the diesel cycle is that heat is included in the Otto cycle in a steady volume process while heat expansion occurs in a consistent pressure process in the diesel cycle. Other than that the vital distinction between these two is that the diesel motor doesn't have a carburetor and furthermore a flash attachment. Rather they have a fuel injector framework where it infuses diesel straight forwardly into the ignition chamber. Consequently, these two motors vary by their wellspring of admission. In any case, as a rule these two motors have constructional distinction.

## 3 BRUSHLESS DC MOTOR AND ITS CONTROL UNIT

Brushless DC motor is a type of permanent magnet synchronous motor, wherein its rotors have permanent magnets as well as the trapezoidal shape back EMF. The BLDC motor deploys a DC power supply that is switched on to the motor's stator phase windings using various power devices, wherein the switching sequence is ascertained by virtue of the rotor position. BLDC motor phase current synchronized with back EMF is generally rectangular so that at a constant speed it generates constant torque. Electronic switches replace the brushed DC motor's mechanical commutator, supplying current to the motor windings basically the rotor position is as operative function. This particular type of AC motor is referred to as the brushless DC motor, as in terms of functionalities and performance it resembles the

traditional dc motor with commutators. Controlling brushless DC motors is usually carried out by deploying a three-phase inverter that necessitates rotor position sensor in order to start; additionally to facilitate inverter control through a proper commutation sequence. The respective position sensors may be an absolute position or Hall sensors as well as resolvers. Sensors usually result in raising motor cost and its size too and also one wherein special mechanical arrangements are required in order to facilitate the mounting of sensors. The particular sensors as mentioned earlier specifically Hall sensors are characterized as highly sensitive to temperature and it limits motor operation to about  $75^{\circ}\text{C}$ . Contrastingly, these sensors can affect system reliability and lower it in terms of components and wiring. For certain applications, mounting position sensor may not really be feasible to carry out speed or position control in the motor. Hence during recent times because of varying magnitude and implementation sensor less control of BLDC motor has gained attention from many researchers and experts. [4].

## 3.1 Working of Brushless DC Motor

A brushed DC engine has lasting magnets outwardly of its structure, with a turning armature within. The changeless magnets are known as the stator, which are stationary outwardly. The armature is known as the rotor, which pivots and includes an electromagnet. The rotor turns 180-degrees when an electrical flow is raced to the armature in a brushed DC engine. To go further, the position of the electromagnet must flip. The brushes, as the rotor turns, reach the stator, flipping the attractive field and allowing a 360-degree turn of the rotor. Basically, a brushless DC engine is turned back to the front, removing the brushes requirement for flipping the electromagnetic field. The permanent magnets are on the rotor in brushless DC motors and the electromagnets are on the stator. At that point, a controller charges the stator electromagnet to turn the rotor a full 360-degree. Brushes less DC motor are a type of permanent magnet synchronous machines that possess a rotor position feedback. Controlling brushless motor is carried out by employing the three phase power semiconductor bridge. These motors need rotor position sensors for two main purposes first for initial start-up and then for generating an appropriate commutation sequence that will help power devices in the inverter bridge to get switched ON. On the basis of the rotor position, power device commutation sequence takes places at every 60 degrees. Instead of commutating the armature current using brushes, electronic commutation is utilized. Thus eliminates the issues concerning with the brushes and commutator arrangement, for example, sparking and wearing out of the commutator-brush arrangement, thereby, making a BLDC motor more rugged as compared to a DC motor [5].

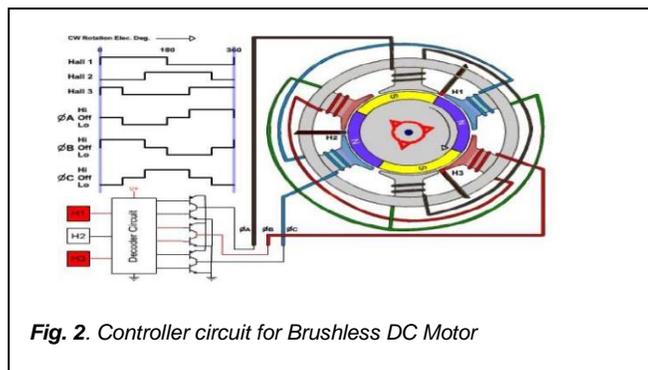


Fig. 2. Controller circuit for Brushless DC Motor

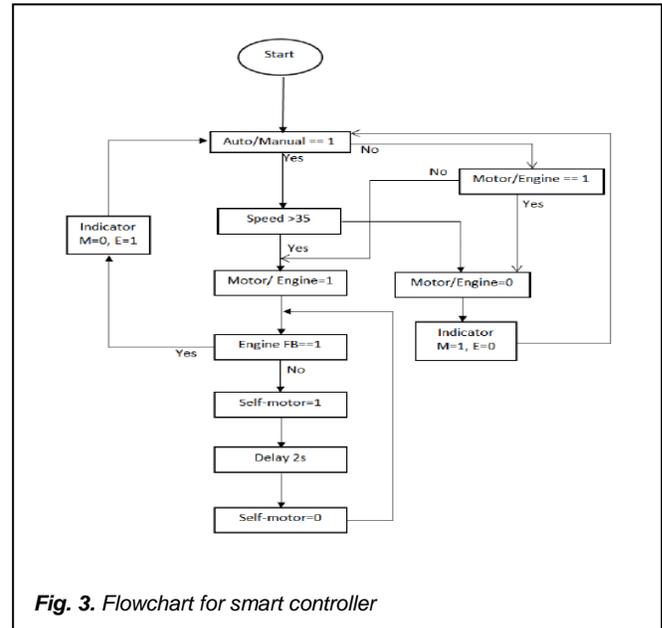
### 3.2 Controlling a BLDC Motor

The Figure 2 is the control unit is implemented by microelectronic systems. This may be implemented using a microcontroller or advanced controller, a PLC or similar other unit. Analog controller is still in use, but feedback signals cannot be processed and controlled appropriately. With this form of control circuits, high-performance control algorithms can be implemented [6]. The outer control loop is also conveniently applied for multiple dynamic demands. To simplify the development of both the control and the power electronic unit, high-performance power integrated circuit, application specific integrated circuits etc. can be utilized. The single integrated circuit can act as a complete pulse width modulation controller. Further, the driver IC can be used for generating the PWM pulses for all the six power switches which is used in a three-phase converter operated as an inverter. There are many similar integrated circuits that are increasingly adding day by day. The speed of the motor can be controlled by Pulse Width Modulation (PWM) technique. The input current flowing through the motor can be varied by means of ON and OFF time of the PWM pulses which in turn, controls the speed of the motor. The desired speed can be attained by a suitable BLDC motor controller. By regulating the dc input voltage, it is possible to control the speed of a brushless dc motor. The change in input voltage proportionally changes the speed. The speed control methods can be open loop or closed loop and the controller with motor is shown in Figure 2. Brushless DC motor systems combine compact yet powerful brushless DC motors with high-performance drivers to deliver excellent energy savings, speed stability, and a wide range of speed controls. With brushless DC motors, it is possible to downsize your application as the motors have slim bodies and provide high power due to permanent magnets being used in the rotor [7], [8], [9]. Among the two speed control methods, the closed loop speed control method is well suited for hybrid vehicles.

## 4 DESIGN AND DEVELOPMENT OF HYBRID SCOOTER

HEV are the vehicles with in excess of two vitality sources are available. The real difficulties for HEV configuration are dealing with different vitality source, exceedingly subject to driving cycles, battery measuring and battery on the board. HEVs take the upsides of electric drive to remunerate the inborn shortcoming of ICE, to be specific staying away from the lingering for expanding the eco-friendliness and decrease emanation amid beginning and speeding tasks. Then to utilize regenerative braking rather than mechanical braking amid deceleration and down incline driving. HEV can address clients issue and has included esteem yet cost is the serious issue. These vehicles are of mind-boggling expense and certain program ought to be upheld by the particular government for promoting HEVs. The HEVs are grouped into two fundamental sorts arrangement and parallel. As of late with presentation of some HEVs offering the highlights of both arrangement and parallel crossovers, the order has been reached out to three sorts arrangement, parallel and arrangement parallel. It is intriguing to take note of that some recently brought HEVs can't be characterized into these three sorts. The aim of this article is to introduce the most effective and less polluting vehicle. The hybrid electric vehicle model combines a conventional vehicle's internal combustion engine

with an electric vehicle's battery and electric motor, resulting in a conventional vehicle's fuel economy twice. The flowchart for smart controller is shown in Figure 3. Usually, hybrids are very fuel effective, some of them receiving as much as 100 km / l. Higher gas mileage also means fewer trips to the gas pump, which is great for your wallet. Hybrid bikes are designed to thrive on city streets. In reality, the majority of people in the town get better gas mileage than the freeway. Depending on the region, when it is time to renew your vehicle registration, they may not be needed to have an emission test. Vehicles may be eligible for tax breaks or loans depending on the region [10], [11].



### 4.1 Vehicle needs to modify

Two propulsions are employed in this system, namely BLDC motor which is mounted on the front wheel that works on HUB motor mechanism and the other is IC engine. The proposed hybrid scooty is shown in Fig. 4 – Fig. 9.





**Fig. 5.** IC Engine propulsion mounting for rear wheel



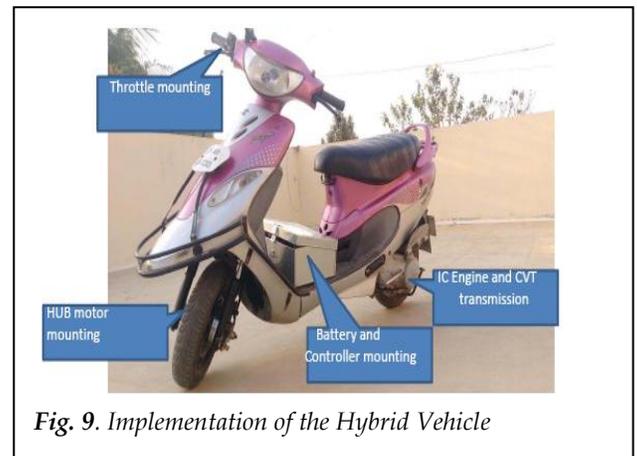
**Fig. 6.** Tractive Accumulator Mounting at Scooty Front Foot place



**Fig. 7.** Single Throttle Assembly for Engine and Motor Speed Control



**Fig. 8.** Vehicle Reversing option Mounting



**Fig. 9.** Implementation of the Hybrid Vehicle

## 5 RESULTS AND DISCUSSION

HEV is a vehicle that utilizes two sources of power one is petrol and the other is battery. The battery drive is used for low-power applications whereas the high-power application requires a very high gasoline engine. At high speed drive, gasoline drive is most efficient. When hybrid vehicles are operated in these two modes, the efficiency obtained is maximum. But operation in low-speed gasoline engine is not effective. Therefore, the HEV provides twice the mileage of a normal vehicle as shown in Table 1. This hybrid vehicle emits 50% less emissions than normal vehicles; it plays an important role in reducing pollution to some extent without compromising efficiency. It is therefore most efficient in urban areas, mainly in high traffic, where gasoline-line engines are less efficient as gasoline energy is wasted away and pollution is created.

**Table 1.** Performance of IC engine and Motor

Mode of Propulsion	Range in KM	Description
Motor Only	75	For a single charge, it can run for around 75km range
IC engine only	50	50km per litre will be achieved
Combinational (motor and IC engine)	150	During Combinational mode of operation, that a vehicle can run around 150km with high fuel economy.

## 6 CONCLUSION

HEV is a vehicle that utilizes two-wheeler which operates on petrol and battery. For low power application battery drive is utilized and for high power application in which control prerequisite is high, hence the gasoline engine has to be utilized. It is observed that, the internal combustion engine is utilized for obtaining the propulsion of the vehicle. Once the desired speed is attained, the BLDC motor is combined with the ICE propulsion for total movement of the vehicle. The total torque achieved by both ICE and electric motors is synchronized for the respective road gradient by varying the controller. By proper distribution of the torque, the battery life per total charge can also be increased by driving the electric motor to minimize the fuel required for ICE propulsion. The throttle involved in driving the electric motor was mutually involved in driving the ICE throttle. Both motor torque and ICE torque were responsible in propelling the vehicle during running condition. Hence, the short battery life issue related to present electric bikes can be solved implementing this technology.

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