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A TWO-WHEELER HYBRID ELECTRIC VEHICLE IS DESIGNED

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ABSTRACT

Introduction: *Efforts to reduce emissions from vehicles used for transportation on public roads are being made by a number of research organisations.*

Aim of the study: *the main aim of the study is toA Two-Wheeler Hybrid Electric Vehicle Is Designed*

Material and method: *The speed-time data will collect by driving the vehicle along a pre-determined route from the starting point to the destination specified on the map.*

Conclusion: *With the electric motor and internal combustion engine (ICE) propulsions working in unison, fuel efficiency improves and battery recharge is required less often (long life per charge).*

1. INTRODUCTION

In addition, fossil fuels are a limited resource that serves several purposes, including but not limited to the production of electricity, industrial activities, and transportation. Therefore, it is crucial to develop either new supplies of fossil fuels to meet the rising market demand, or alternative technologies that allow the vehicle to use less or no fossil fuels at all. Additionally, improved alternative technology on the vehicle is required to fulfil the rigorous emission limits imposed by the pollution control authorities to decrease pollution and global warming. Numerous nations are investigating and proposing various technologies that might help mitigate the present crisis and lessen reliance on traditional fossil fuels. Ethanol, hydrogen-powered cars, and biofuels are only a few examples of the suggested technology. The proposed technologies' potential to replace traditional fossil fuels is a benefit, but they also have their own drawbacks. The primary drawback is that automakers will need to design and create unique power trains for each fuel type. While this is theoretically possible, it would require significant investment from automakers in order to develop the necessary powertrains. Unfortunately, no concrete policies have been proposed by the government to support and sustain such technologies, making it difficult for automakers to mass-produce vehicles powered by alternative fuels.

Efforts to reduce emissions from vehicles used for transportation on public roads are being made by a number of research organisations. The United Nations Environment Programme (UNEP), the

International Energy Agency (IEA), and the International Transport Forum are among the most important of these organisations (ITF). Together, they plan to cut emissions by nearly half by doubling fuel economy by 2050. The transition to fully electric cars is one of the finest solutions proposed and endorsed by these organisations. The zero-emissions and noiselessness of electric cars demonstrate their status as truly eco-friendly transportation. While several automakers are dabbling with the creation of such pure electric vehicles, the challenges they face prohibit them from scaling up to meet market demand. Hybrid electric vehicles are another option that bridge the gap between electric and conventional vehicles (HEV). Taking into account the current state of technology, HEVs appear to be a viable alternative technology that might successfully displace traditional cars that rely on fossil fuels.

1.1 ELECTIRIC VEHICLE

A vehicle can be called an electric vehicle if it uses electric propulsion. Since electric motors are crucial to cars' propulsion systems, they are divided into two categories: battery operated electric vehicles (BEVs) and fuel cell operated electric vehicles (FCEVs), respectively (FLEV).

These early electric propulsions were designed to propel only the largest locomotives across the countryside in the eighteenth century. Applications that required high tractive power were grouped according to the high torque created by these motors and the smooth speed regulating systems. In the middle of the 18th century, an English patent was filed for using electrical current to power locomotives over tracks.

Midway through the eighteenth century, electric motors were successfully applied to tiny passenger vehicles, opening the door to their use as electric automobiles for public transit. When it comes to eco-friendly features like zero emissions, low noise levels, simple controls, and little vibration during operation, these electric automobiles have quickly become a serious alternative to internal combustion engine (ICE) vehicles.

2. LITERATURE REVIEW

Dao et al. (2020)have detailed a dual active bridge converter and series resonant converter-based three-port DC-DC converter with slow and rapid charging options for electric car applications. In order to cut down on both costs and losses, the offered threeport DC-DC converter uses a design that requires fewer passive and active components. The output power of the fast and slow charging ports may be adjusted using a control approach based on phaseshift and frequency modulations. When the converter is in a slow charging mode, the ideal phase shift angle has been derived to reduce the transformer current. To ensure proper converter functioning, a 2.74 kW/dm3 power density, 5-kW SiC-based prototype model has been constructed and tested.

Eckert, Jony et al., (2015). ArtigoCompleto The hybrid electric vehicle (HEV) became an alternative to reduce the fuel consumption. The HEV parallel configuration consists of two separated drive systems, such as the engine/powertrain system and an extra electric motors (EMs) system. The addition of an extra electrical power changes the engine operation point and consequently the fuel consumption. However, there are many ways to introduce this electrical power source as a secondary drive system. In this paper, two parallel HEV configurations are studied in a condition where the conventional engine/powertrain system, coupled to the vehicle front wheels, is the main power source and two different configurations of EMs drive system, coupled to the rear wheels, are auxiliary power sources. The first one consists of two in-wheel motors coupled directly to the vehicle rear wheels and the other one is an EM coupled to a differential system similar to the existent in the conventional vehicle powertrain. The aim of this paper is to simulate and compare the HEV behavior with the conventional vehicle behavior, both of them running in the Brazilian urban drive cycle NBR6601, evaluating differences in performance, fuel consumption and battery discharging when applicable.

Zhongwei, Zhang et al., (2013). Based on the software ADVISOR2002, the simulation modal of the assembly power and vehicle of the Parallel Hybrid Electric Vehicle(PHEV)has been set up. With the control targets for power characteristic and for fuel characteristic, this paper still considers the state of charge meanwhile; this thesis presents a simulation analysis of the PHEV and the influence on vehicle characteristic by component parameters of drivetrain, and studies the parametric choice and proper parametric matching among drivetrain component.

Moore, Haley et al., (2012). The Purdue University EcoMakers team has completed its first year of the EcoCAR 2 Competition, in which the team has designed a Parallel-Through-the-Road Plug-in Hybrid Electric Vehicle that meets the performance requirements of a mid-size sedan for the US market, maintaining capability, utility and consumer satisfaction while minimizing emissions, energy consumption and petroleum use. The team is utilizing a 1.7L 14 CI engine utilizing B20 (20% biodiesel, 80% diesel), a 16.2 kW-hr A123 battery pack, and a Magna E-Drive motor to power the front and rear wheels. This will allow the vehicle to have a charge-depleting range of 75 miles. The first year was focused on the simulation of the vehicle, in which the team completed the controls, packaging and integration, and electrical plans for the vehicle to be used and implemented in years two and three of the competition.

Kumari, Madhwi et al., (2012). Most of the gains in worldwide oil use occur in the transportation sector. Improving the fuel economy of vehicles has a crucial impact on oil supply. So far, the most promising technologies are the Hybrid vehicles and fuel cell vehicles. Recent researches in Hybrid electric vehicles are directed towards developing the energy efficient and cost effective propulsion system. But the performance of automobiles depends not only on the vehicle drive train alone, but also on driving patterns such as journey type, driving behavior, etc. Moreover while designing an HEV configuration, the commonly constraints imposed on optimizing critical component selection are: vehicle range, acceleration, maximum speed, and road grades. All these factors are directly related to diving pattern. This paper is an attempt to look into the various factors affecting design of series Hybrid Electric Vehicle on a typical drive cycle.

Shen, Caiying et al., (2011). As the environmental pollution and energy crises are getting more and more remarkable, hybrid electric vehicles (HEVs) have taken on an accelerated pace in the world. A comprehensive overview of HEVs is presented in this paper, with the emphasis on configurations, main issues, and energy management strategies. Conclusions are discussed finally.

3. METHODOLOGY

The speed-time data will collect by driving the vehicle along a pre-determined route from the starting point to the destination specified on the map. The speed-time curve, power-speed curve (Engine and ICE), ICE alone mode tractive effort, Engine alone mode tractive effort, and Hybrid mode tractive effort must be plotted for the test area chosen for research, which is Mysore city, India, and the designed configuration of hybrid electric vehicle must be analysed for the speed-time curve, power-speed curve (Engine and ICE), ICE alone mode tractive effort, Engine alone mode tractive effort, and Hybrid mode tractive effort.

4. RESULTS

4.1 DESIGN OF TWO-WHEELR HYBRID ELECTRIC VEHICLE

Vehicles that use more than two types of fuel are called "HEVs." The design of a HEV is difficult since it must deal with a number of energy sources that are all extremely variable depending on the vehicle's driving patterns, as well as the sizing and management of its batteries. Hybrid electric vehicles (HEVs) use their electric drive to make up for the ICE's weaknesses, such as the need to idle for increased fuel economy and reduced pollution during starting and speeding operations. However, the high price of HEVs prevents them from being a practical option for most customers. Due to their high price, the government of a given country should back a particular campaign to promote the sale of HEVs. There are two primary types of HEVs, which we call "series" and "parallel." With the recent advent of HEVs that combine the benefits of series and parallel hybrids, the categorization has been expanded to include three types: series, parallel, and series-parallel. It's worth noting that not all recently released HEVs fit neatly into one of these three categories. As a result, we may finally divide these systems into series, parallel, series-parallel, and complicated hybrid systems.

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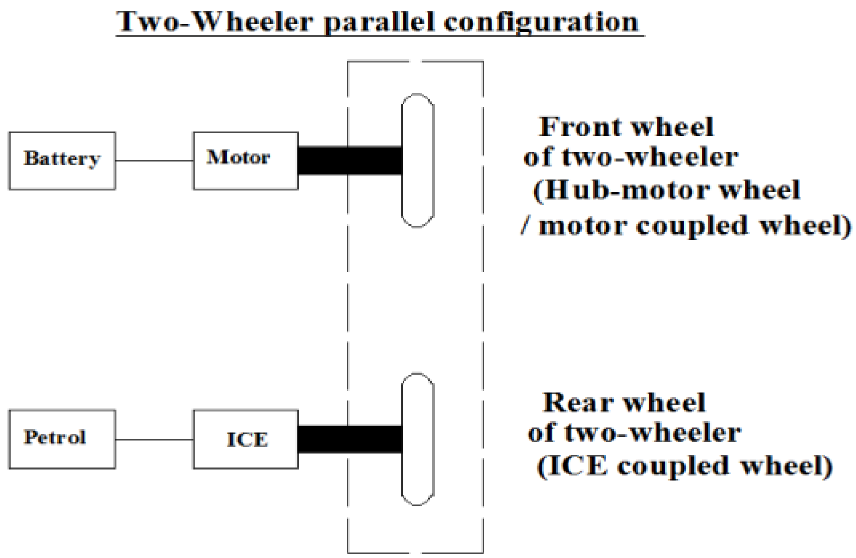

Figure 4.1: Concept of two-wheeler parallel configuration

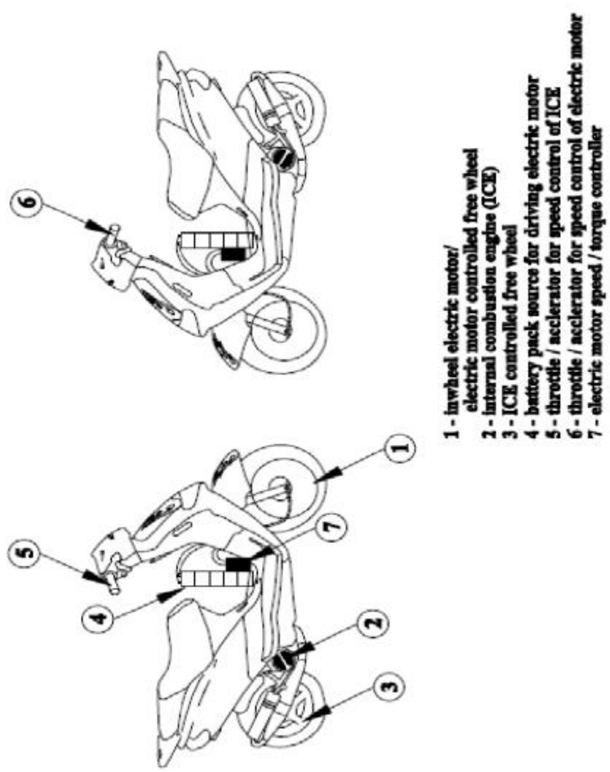

Figure 4.2: Concept of two-wheeler parallel Configuration Scooter

Figure 4.3 shows the Kinetic Honda Y2K, manufactured, two-stroke, continuously variable transmission test vehicle used for the analysis purposes of this work. Table 4.1 displays the details of this ICE-powered motorcycle, including its dimensions and engine type.

Table 4.1: Technical specification of ICE vehicle (Kinetic Honda) considered for design

Engine	Two-Stroke(petrol)
Transmission	Automatic
Enginedisplacement	98cc
Maximumpower	7.7bhp@5600rpm(5.74KW)
Maximum Torque	1.0kgm@5000rpm(9.80665Nm)
Wheelbase	1215mm
Ignition	Electronic
DryWeight	99kg
Battery	12Volts
Frontsuspension	Bottomlinkhydraulicdamper
Raresuspension	Unitswingarm/ hydraulicdamper
Fronttyresize	3.50X 10.4 Pr
Reartyresize	3.50X 10.4 Pr

Figure 4.3: Kinetic Honda Y2K, ICE operated Scooter considered for design

The MATLAB simulation programme is utilised to gather all the design results. The resulting programmes that were created to process the data are included as an appendix. Using the values for air density a = 1.205kg/m3, frontal area Af = 0.7m2, the aerodynamic drag coefficient CD = 0.3, transmission efficiency from engine to drive wheels t,e = 0.9, and transmission efficiency from motor to drive wheels t,m = 0.95, the engine characteristics obtained for maximum speed of 60Kmph on flat road are as shown in the Figure 4.4.

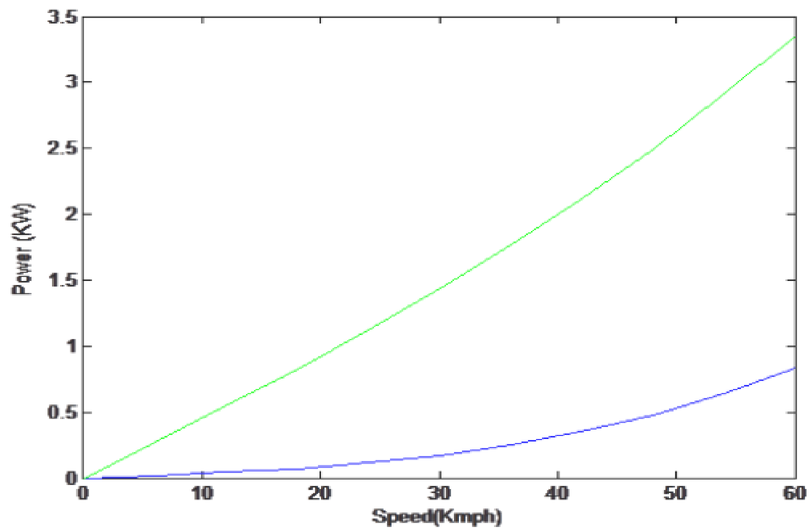

Figure 4.4: Engine power required (Blue: power for overcoming only road resistances, Green: overcoming the acceleration criteria along with road resistances)

Using solely the ICE, the test car took 12 seconds to reach 60Kmph. Figure 4.5 depicts the vehicle's acceleration profile.

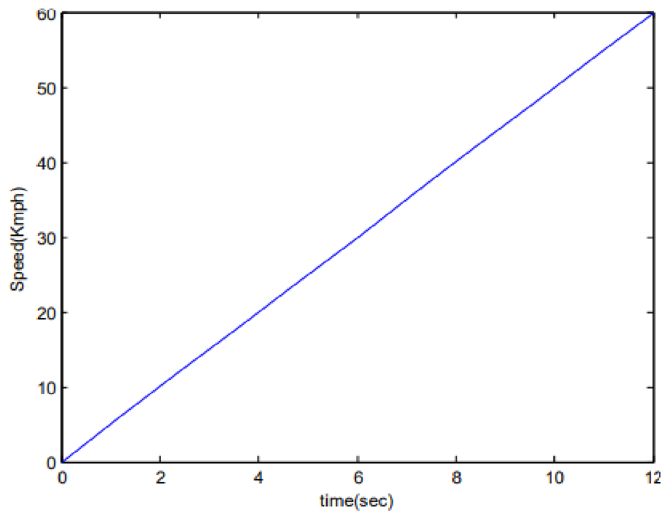

Figure 4.5: Acceleration curve for the vehicle considered

Figure 4.6 depicts the engine power-speed curve derived by using the transmission gear ratio of ig = 1 (because the engine investigated is of the continuously variable transmission type and the analysis is conducted on a level road) and the final wheel gear ratio of i0= 0.9.

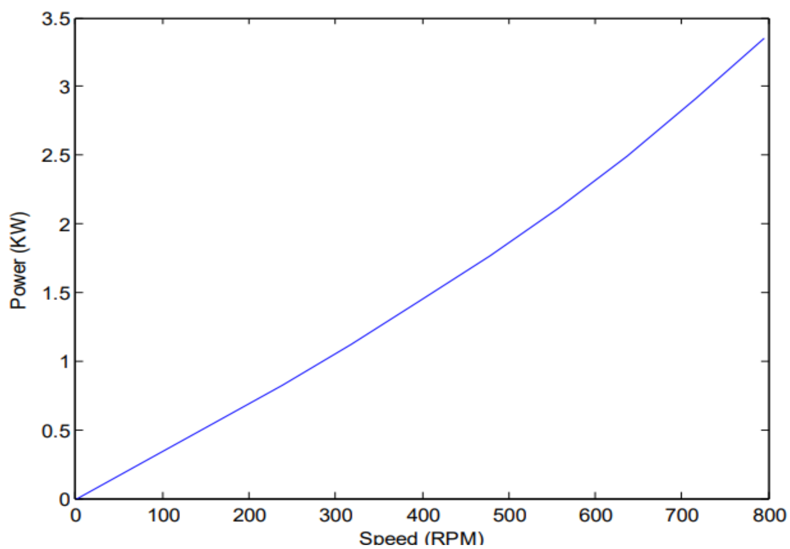

Figure 4.6: Engine power Vs Speed curve

The primary goal of the electric motor in HEV design is to supply maximum power to the drivetrain. Because the vehicle has two power sources, it is challenging to design the motor power directly from the acceleration performance. However, since we can assume or estimate that the engine handles the rolling resistance and aerodynamic drag, we can focus on designing the motor to handle the dynamic load (inertial load in acceleration). If we assume that acceleration is proportional to electric motor output, then we may use the expression.420 to determine which motor will be most effective.

$$\frac{T_m i_{tm} \eta_{tm}}{r_d} = \delta_m M \frac{dV}{dt}$$

Where Tm is motor torque, itm is gear ratio from motor to drive wheel, tm is transmission efficiency, rd is driven wheel radius in metres, m is rotational inertia factor in kilogrammes, and M is mass in kilogrammes.

Using the formula, we can get the motor's maximum allowable power input.

$$T_m = \frac{30 P_m}{\pi n_m}$$

For any given motor, the relationship between its maximum speed and its power rating may be expressed as: (RPM). In table 4.2, we can see the motor's detailed specifications.

Table 4.2: Rating of the motor considered for the design

Type of Motor	Hubmotor
Design of motor	BLDC(BrushlessDC)
Torque	12Nm
Speed	300RPM
Voltage	60Volts(5batterieseachof12V,20Ah)
Efficiency	≥80%
Weight	7Kgs

Figures 4.7, 4.8, and 4.9 depict the speed-torque and speed-power characteristics of the motor under consideration, respectively.

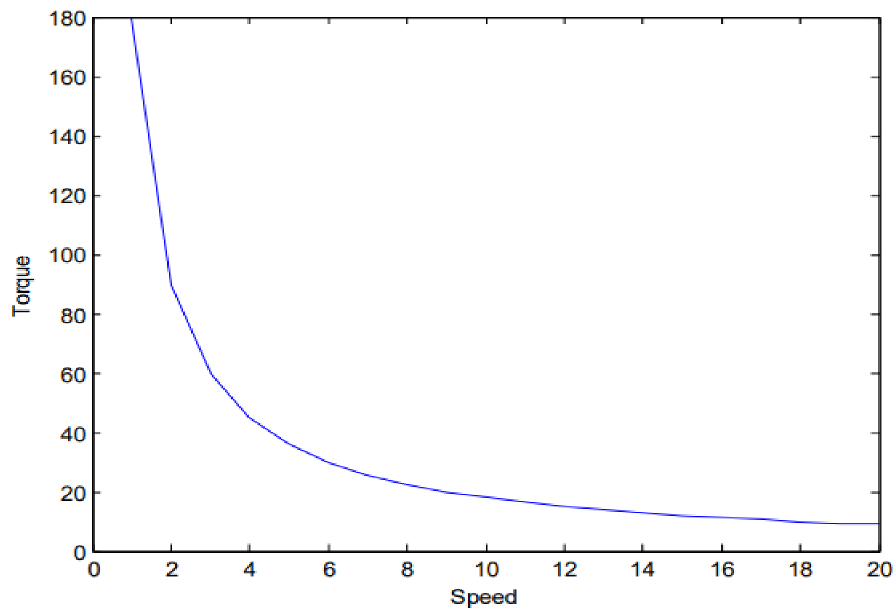

Figure 4.7: Speed-Torque Characteristics

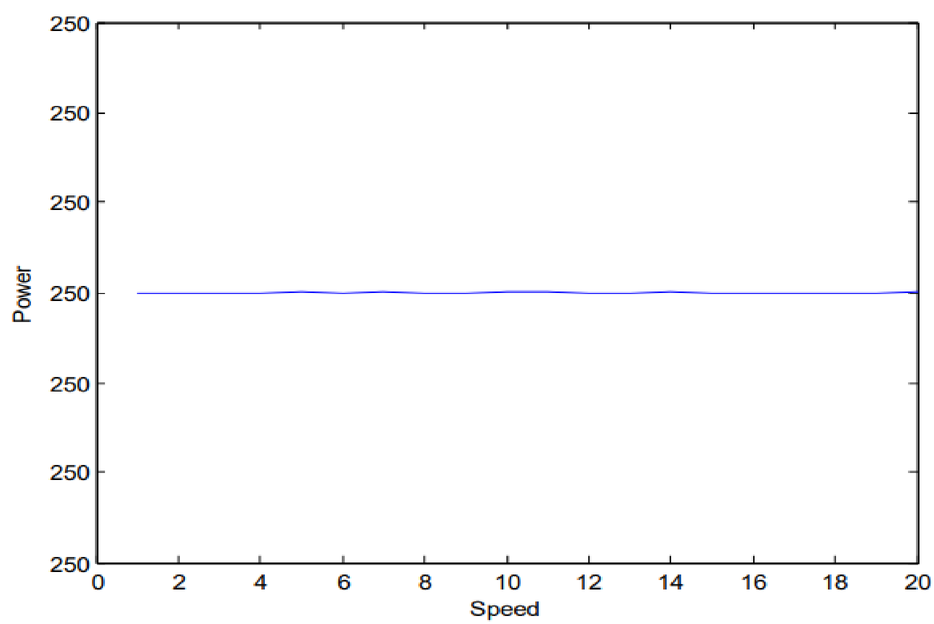

Figure 4.8: Speed-Power characteristics

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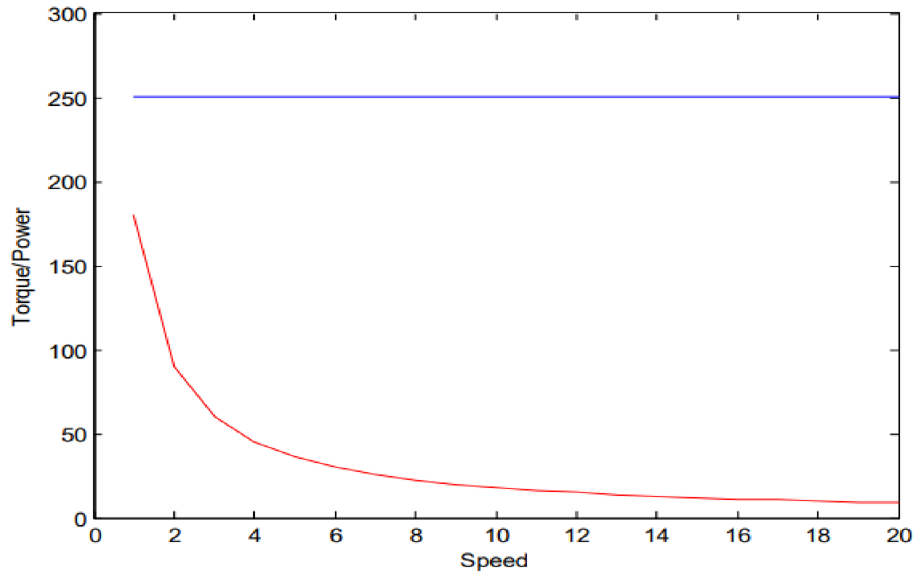

Figure 4.9: Speed-Torque/Power characteristics (Blue: power, Red: Torque curve)

Design principles are created for steering a scooter with each wheel being driven by a distinct mechanism. The vehicle's back wheel will continue to be linked to and driven by an internal combustion engine (ICE), while the front wheel will be replaced by a wheel hub motor powered by five direct current (DC) batteries. Figure 4.10 and Figure 4.11 depict the analytical process of modifying the suspension mechanical arrangements in the front wheel to accommodate the design requirements of holding the motor wheel.

Figure 4.10: Designed vehicle with front wheel as hub motor

Figure 4.11: Mechanical arrangement made for fixing the hub motor as front wheel

Motor speed regulation as illustrated in Figure 4.12 is being interfaced with the motor controller. The motor controller circuit is serving as the link between the throttle and the motor. This application utilises a hub motor from Ampere with a 60V, 250W rating. The motor's controller is an Ampere design, making it ideal for use with the named motor. The accelerator, also known as a throttle, controls the speed of the motor in Figure 4.13 using an ampere-made throttle.

Figure 4.12: motor controller connected to front wheel

Figure 4.13 Left hand Throttle / Accelerator used for controlling the speed of the motor

5. CONCLUSION

With the electric motor and internal combustion engine (ICE) propulsions working in unison, fuel efficiency improves and battery recharge is required less often (long life per charge). If a single car can cut its gas use by 30%, then the entire country may save 40% to 60% only by switching to this sort of vehicle. Batteries have a long life per charge, so you can save money on your electricity cost, too. It's also possible to apply the notion of charging the batteries using internal combustion energy (ICE). This sort of vehicle has the potential to enhance durability and convenience for consumers. Lithium-ion batteries may be charged in a variety of ways, such as by operating the internal combustion engine (ICE) while the vehicle is in motion or by using the solar charging strategy outlined. It is possible to build algorithms to better coordinate the on-and-off times of the electric motor and the internal combustion engine (ICE) with respect to the driving cycle. So, the vehicle's fuel economy may be greatly enhanced. Vehicles optimised for a certain location may be designed with the use of programmes like ELPH, ADVISOR, and SIMULINK / MATLAB. Future three- and four-wheeled vehicles, such as Auto-rickshaws, will benefit from adopting and validating this design technique. In 2002, National Renewable Limited (USA) developed a SIMULINK/MATLAB-based programme they call ADVISOR. It may be used to examine the efficiency of various ICE, Electric, and HEV vehicles across a range of predefined driving cycles and emission types.

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