Research Article

Modern trends in Electric, Hybrid, Plug-in and Fuel cell vehicle

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Abstract:
The various developments in the field of technology, changes in the auto industry met. Carbon emissions from vehicles play an important role in global warming, thus forcing to produce vehicles with zero carbon emissions or low carbon emissions. Thus, the production of electric vehicles attracts the same attention and many countries have advanced plans for this. This paper described, Electric vehicle, Hybrid electric vehicle, Plug in Hybrid vehicle, Fuel cell hybrid electric vehicle, Range extended electric vehicles, power train, energy management, and features.

Keywords: Electric vehicle, PHEV, FCEV, REV, Battery, Ultra capacitor, Fuel cell, Motor, Energy Management.

1. INTRODUCTION

The transport sector has grown tremendously since the invention of the engine so trade and travel have reached a new level as the country's economic growth has picked up. The engines were manufactured in various capacities for long distance travel and freight transport. Thus, increasing their fuel demand linearly. Excessive use of fossil fuels has caused air pollution and adverse effects on human society. Climate change is an increase in heat loss events eg: acid rain, agricultural production of the country's economy went in the opposite direction. So, it is imperative to find an alternative solution. Increasing the use of green energy would be the best solution. Pollution when driving a vehicle with electric power is very low. So many researchers are continuing to carry out studies such as upgrading the electric vehicle and adapting it to the needs of the people

1.1. HISTORY OF ICE

Excess greenhouse gases increase in the atmosphere when we used in Internal combustion vehicle (ICE) based engine vehicles as shown in figure 1. Uses of fossil fuels supply power to a conventional vehicle but these can also have negative effects such as high fuel price because of high demand, air pollution, economic damage such as increased transportation costs etc., The use of conventional vehicles poses a number of technical challenges, such as complex configurations, low performance, and high maintenance costs. Thus, the automotive industryhas started to give more importance to the electric vehicle

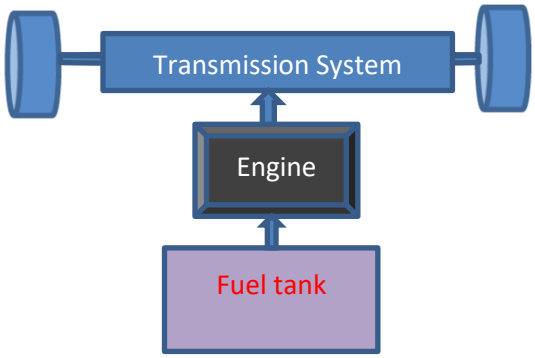


Figure.1. Internal combustion engine-based vehicle

Internal combustion engine-based vehicle is, fueled by the combustion of fossil fuel [1]s. In the conventional vehicle fossil fuel have not been fully converted in to efficient energy. In this type of vehicle 68% to 72% of energy is lost due to friction and exhaust heat. Similarly, due to parasitic and

idle loss cause energy loss from 4% to 7%. Compared to internal combustion engine vehicles, electric vehicles, the energy loss is very low. In electric vehicle fuel efficiency is 95% will be obtained. Even the power conversion loss is 22%, the overall efficiency is 73% possible depends upon type of electric vehicle**.**

2. Electric vehicle:

An electric vehicle is powered by electrical energy derived from a battery. The electric vehicle has numerous benefits such as low power loss, simple configuration, zero emissions, and economical travel etc., The electric vehicle also has fewer parts compared to conventional vehicles, thus reducing friction. Thus, noise caused by the vehicle is very low so that the passengers are able to make the most comfortable journeys on long travel. The maintenance cost of an electric vehicle is very, very low compared to regular vehicle . The electric motor, battery and electric converter are the most important parts of electric vehicles as shown in figure.2. Despite the long-distance travel, the electric vehicle faces many technical challenges, especially when it comes to long distance travel. In this case, the challenge is to provide energy for the vehicle. This is because a once charged battery can only deliver energy for short distance depending on the capacity of the electric motor. The solution can be found by increasing the capacity of the battery. But the cost of capital for that is increasing. In the capital cost of the electric vehicle, twenty to fifty percent of goes to battery. Also, the battery currently in use has a short lifespan. So that the comparatively the electric vehicle has more capital cost investment needed. So people are reluctant to buy an electric vehicle. Many researchers are engaged in a series of research to find the best solution for solving the battery issues.

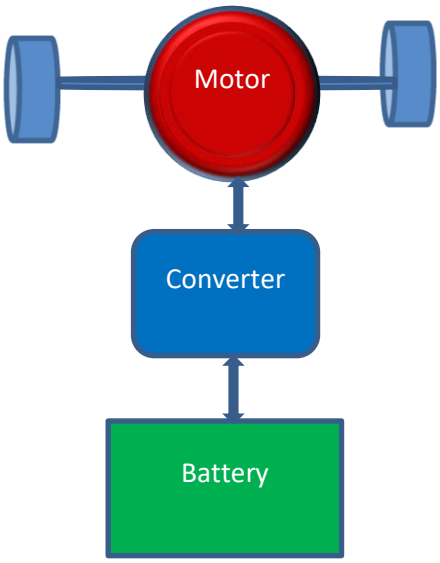


Figure.2. Battery electric vehicle

2.1. Hybrid electric vehicle:

The hybrid vehicle is a combination of the conventional vehicle and the electric vehicle so the hybrid vehicle has the special characteristics and characteristics of the two. Problems with long distance travel in an electric vehicle can be remedied by a hybrid vehicle. Also, people can choose the configuration of the hybrid vehicle depending on the need. The hybrid vehicle is powered by an electric motor and an engine as shown in figure.3. In a hybrid vehicle the engine is connected to the transmission system either directly or through a generator [3][11]. HEV is divided into three types depending on the design of the engine i.) series hybrid vehicle ii.) parallel hybrid vehicle iii.) series- parallel hybrid vehicle.

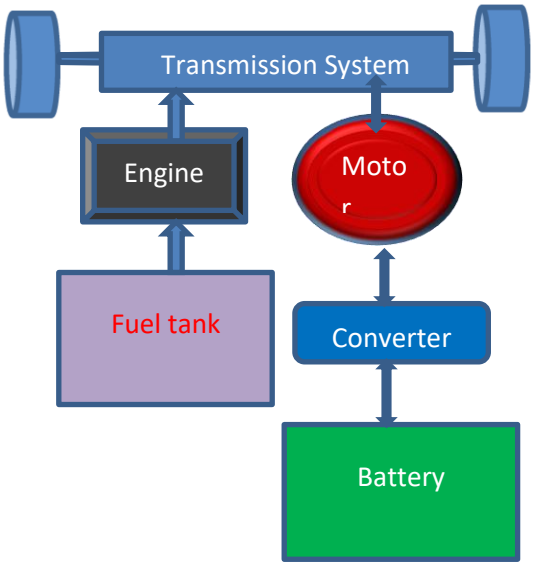


Figure.3. Hybrid Electric Vehicle

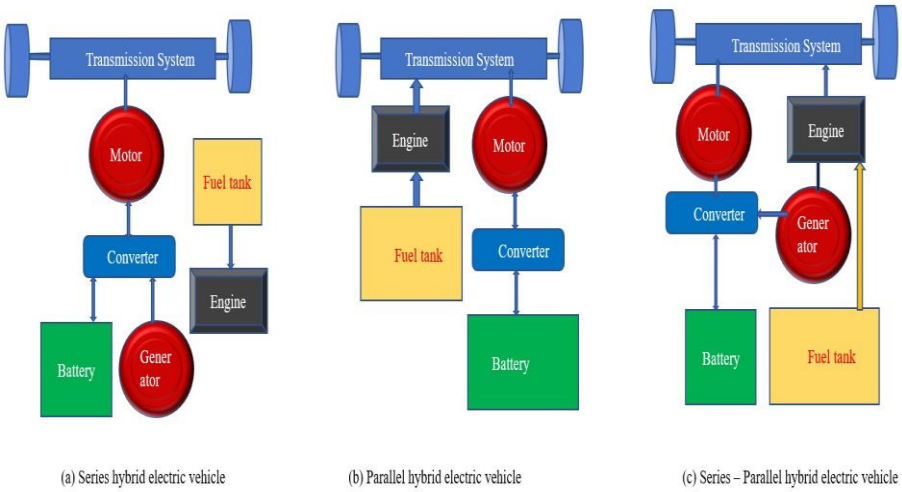
2.2.1. Series hybrid electric vehicle:
In this configuration, the electric motor acts as main propeller, it's providing power when the vehicle is running at moderate speeds. The engine is connected by a generator without being directly connected to the transmission system. The power required to run the generator electricity generation is obtained by the engine. This process greatly reduces losses and allows the engine to produce more power only when needed. The series hybrid electric vehicle as shown in figure 3.(a).

2.2.1. Parallel hybrid electric vehicle:
In this configuration both the electric motor and the engine are directly connected to the transmission structure. so that they can run side by side, providing both the driving force needed for the vehicle [9]. For example, the extra power required when the vehicle is running at the high speed, the electric motor will operate high torque mode to meet demand. so that the vehicle can travel longer distances and reduce air pollution. The series hybrid electric vehicle as shown in figure 3.(b)

2.2.1. Series parallel hybrid electric vehicle:

The energy required at high speeds and completion of long journeys can be met by the structure. In which more than one electric motor is connected They are connected by a series and parallelly connected to the transmission system. Like in the series hybrid electric vehicle the generator generates electricity and stores it to battery. Thus, both the electric motor and the engine are powered depending on the need to run the vehicle [4]. Based on the hybridization further it is classified to Micro hybrid, Mild hybrid, Full hybrid electric vehicle.

The conventional vehicle is loss significant power in start/stop stage only. So, in micro hybrid the electric motor will operate in start/stop on this stage only. The mild hybrid also same like micro hybrid, the electric motor is operating start/stop and addition operate in boost mode i.e., the motor will assist the engine in acceleration mode. The fully hybrid mode, the high range range of electric motor will operate parallel to engine to reduce the fuel consumption. The series hybrid electric vehicle as shown in figure 3.(c)



(a) Series hybrid electric vehicle (b) Parallel hybrid electric vehicle (c) Series – Parallel hybrid electric vehicle

3. Plug -in hybrid electric vehicle:

In hybrid electric vehicle the battery charge through either engine operation or regenerative braking mode only. Significant energy loss occurs when energy is converted into different types at different levels. The best solution for this is to charge the battery directly from the grid [1]. Even though for fully charging the battery take significant time, this method will reduce the fuel energy uses and downsizing the engine. The plug-in hybrid electric vehicle as shown in figure 5.

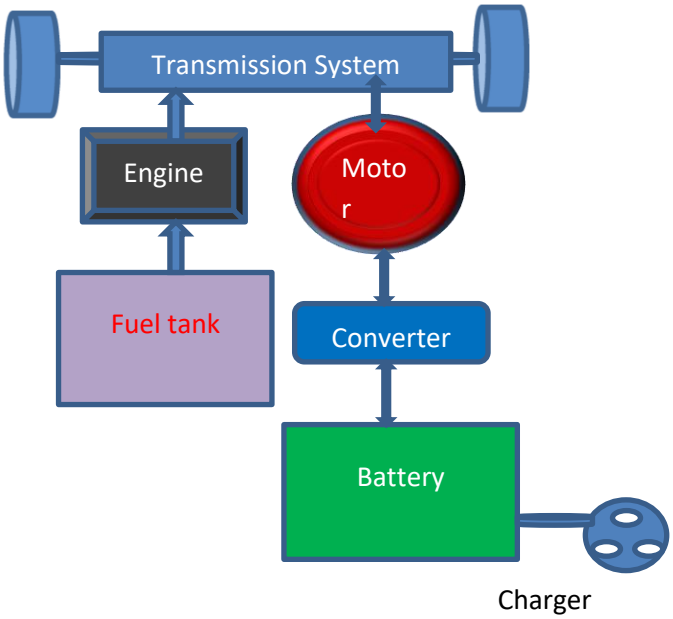


Figure.5. Plug- in Hybrid electric vehicle

4. Fuel cell electric vehicle:

Fuel cells are electrochemical devices to convert chemical energy into electrical energy. Based on hydrogen and oxygen gas reaction fuel cell can generate the electricity as shown in figure 5. Compare to conventional vehicle, it can produce the high-density power, less pollution, fuel flexibility, base load and off-grid applications, economic, and noise free are the features of the system [3].

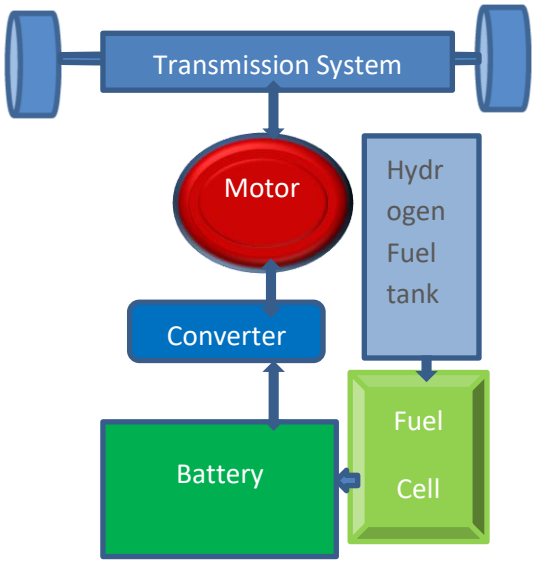


Figure.5. Fuel cell electric vehicle

4. Energy management:

There are two main ways in which the electric vehicle can be made more efficient through energy development [12]. 1.) Sizing of the electric vehicle 2.) using rule base algorithm or optimizing technique.

Their structure of the vehicle can be determined depending on the use of the vehicle. These include travel distance, capital expenditure, maintenance costs, pollution and the number of passengers. Parts are selected in their configuration based on the range of the vehicle [6]. Types of battery, its size, types of electric motor, its number's, transformer capacity, engine range, type of fuel all are decide the configuration of the electric vehicle [7].

Based on real data of the vehicle speed, wind speed, weight, travel distance, the optimizing method applied on the energy storage management system. Based on the data system will predict the driving cycle in well advance by using the optimizing technique. Mainly vehicle operate in idle, acceleration, deacceleration, cruising mode[10]. In the initial stage of vehicle propulsion is not required, but in this stage 1 vehicle in starting condition, if engine is ON mode, the clutch is not engaged with gear but due to engine running energy will happen. Instead of engine, motor will operate in start/stop mode. The stage 2 vehicle will operate in acceleration mode, so high propulsion required, both motor and engine will share the load demand [8]. In case vehicle claim down like hill station, vehicle operate in regenerative mode. The generating power will store in battery [10]. In cursing mode either mostly motor will propel the vehicle.

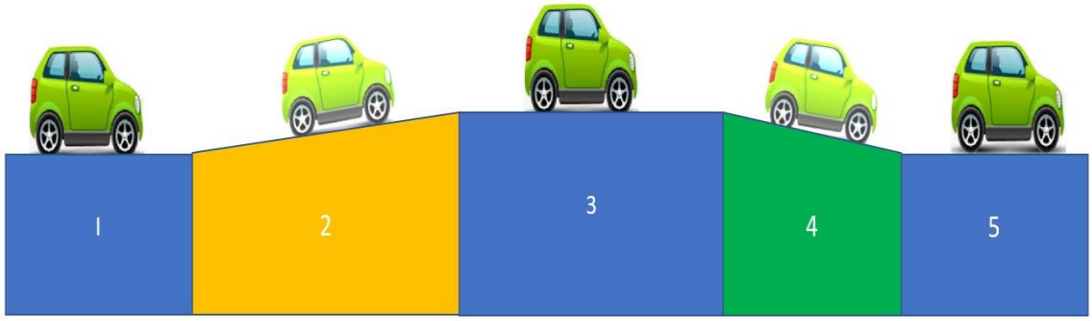


Figure.6. Driving pattern of vehicle

Table 1. Mode of operation of the vehicle

Type of Electric vehicle	Start/Stop (Pure electric Drive)	High acceleration	Cursing (Condition based	Deacceleration (Regenerative Mode)	Idle (Motor assist) **5**

	1	(Electric mode assist) **2**	Engine/Motor assist) **3**	**4**	
ICV	No	No	No	No	No
BEV	Yes	--	No	Yes	Yes
HEV(Micro-HEV)	Yes	No	No	Yes	Yes
HEV(Mild-HEV)	Yes	YES	Yes	Yes	Yes
HEV(FHEV)	Yes	YES	Yes	Yes	Yes
PHEV	Yes	YES	Yes	Yes	Yes
FEV	Yes	No	No	Yes	Yes

Result analysis:

Based on the analysis as shown in table 5, the plug-in hybrid electric vehicle is suitable for long range travel and optimum energy management. Using the Simulink, the system was developed for tested. The rule-based controller is suitable for energy management [13-17]. The fuzzy logic controller is designed based on the SoC of the battery and acceleration of driver input as shown in fig (7,8,9). The speed of the traction motor is controlled based on the fuzzy memberships.

- If (Throttle is Low) or (SoC is Low) then (Motor is Low) (1)
- If (Throttle is Medium) and (SoC is High) then (Motor is Medium) (1)
- If (Throttle is High) and (SoC is High) then (Motor is High) (1)

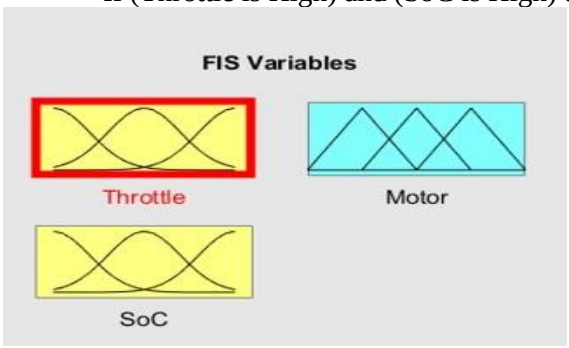


Fig. 7. Fuzzy membership

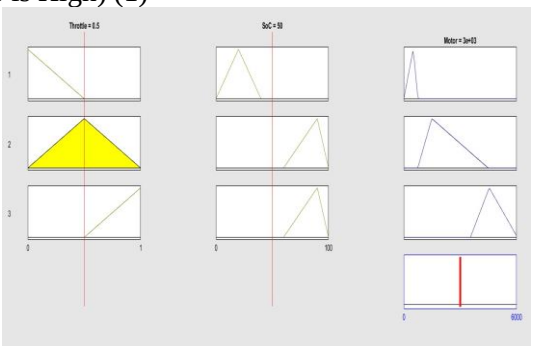


Fig. 8. Fuzzy Logic for various of driving modes

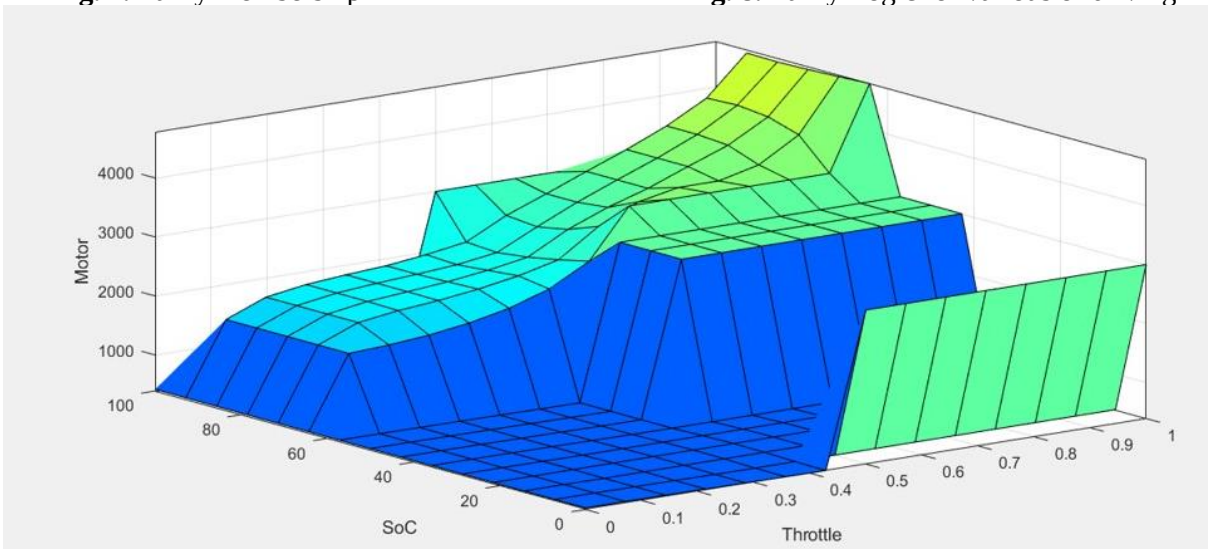


Fig. 9. 3D Fuzzy control rule

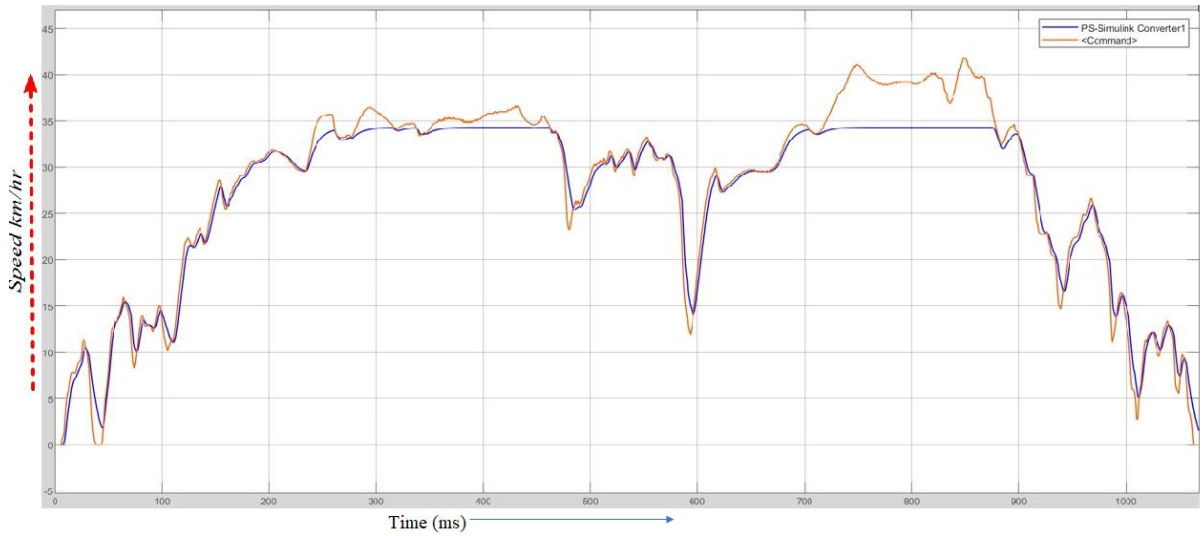


Fig.10. Driving cycle output for plug in hybrid electric vehicle

The power train of the vehicle is controlled by the rule based fuzzy logic controller for obtaining the long driving range. The result shows the linear operation of the vehicle and power train control was verified for the various speed of operation. The USSD driving cycle is selected for testing the performance of PHEV, the result as shown fig 10. The vehicle power train is followed the controller input closely for the various speed of operation.

5. Conclusion:

This article describes the demand utilization and performance of an electric vehicle. Also, different types of electric vehicles have their advantages and disadvantages are described. Challenges and opportunities in this sector have been explored. The performance of the vehicle can be improved by using energy management techniques. The combination of the electrical and mechanical power train system is suitable for the long range of travel. PHEV is the best choice comparing to the all type electric vehicle. Here the rule based fuzzy controller is used for optimizing controlling the power train of the PHEV. The result shows the linear mode of operation for various range of SoC and speed. In the future many upgraded electric vehicles will be brought into the use of the people.

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