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Modelling of SPHEV Technique for Performance Enhancement of Hybrid Electric Vehicle

Sahil

Sahilghalawat990@gmail.com

M. Tech Scholar, Department of Electrical & Electronics Engineering, BRCM CET, Bahal, (Haryana), India

Sandeep Kumar

Sjakhar1989@gmail.com

Assistant Professor, Department of Electrical & Electronics Engineering, BRCM CET, Bahal, (Haryana), India

ABSTRACT

With rising oil prices and environmental concerns, cleaner and more sustainable energy solutions are in demand. Existing transportation contributes significantly to energy consumption and pollutant emissions. This paper analyses hybrid vehicle technology, focusing on Power split configurations with an internal combustion engine and a battery as the power source. Initially, the performance of Series parallel hybrid electric vehicles (SPHEV) is evaluated using batteries with a higher amp-hour capacity. In the advanced state, a converter circuit is used to reduce the battery rating. Various battery charging and discharging circuitry configurations have been observed in various cases. This paper presents a SimPowerSystems and SimDriveline-based multi-domain simulation of a HEV power train. The HEV drivetrain is of the series-parallel variety, similar to that of the Toyota Prius. This HEV is equipped with both an electric motor and an internal combustion engine (ICE) to increase the efficiency of the drive train and decrease air pollution. The Hybrid Management System regulates the reference power of the electric motor by dividing the power demand as a function of the battery and generator's available power. Controlling the generator torque and ICE speed enables the generation of the required amount of power.

Keywords:Electric Vehicles, Hybrid, Fossil Fuels, emission , Electrical Propulsion, Energy Storage Device

INTRODUCTION

Two or more energy converters are utilised by hybrid vehicles to generate propulsion. Each energy converter is supplied by a corresponding on-board energy reservoir. A hybrid electric vehicle (HEV) combines an internal combustion engine and one or more electric motors. The engine converts fossil fuel from the fuel tank into mechanical energy, whereas the electric machine(s) convert electric energy from an electric energy storage system, such as a battery, into mechanical energy. Unlike a combustion engine, an electric machine can typically convert mechanical energy into electric energy by acting as a generator[1]. Adding an electric path to the conventional drivetrain is primarily motivated by the possibility of improved fuel economy. This potential is realised through 1) engine stop-start; 2) operating point shifting; 3) engine downsizing without sacrificing drivability, such as acceleration performance; 4) recuperation of kinetic energy during deceleration; and 5) pure electric zero-emission driving. Electric hybridization has the disadvantages of increased weight, complexity, and cost[2].

There are several hybrid electric drive train topologies, including series, parallel, and combined (or series-parallel) topologies. Within each topology, there exist a number of variants. This HEV drivetrain is of the series-parallel variety, similar to that of the Toyota Prius. This HEV is equipped with both an electric motor and an internal combustion engine (ICE) to increase the efficiency of the drive train and decrease air pollution. It combines the benefits of an electric motor drive (zero emissions and high available power at low speed) and an internal combustion engine (high dynamic performance and low emissions at high speeds)[3-4].

Hybrid Electric Vehicles (HEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) have two power sources: an Internal

Combustion Engine (ICE) and a battery. Power distribution between these two is crucial for minimising fuel consumption without compromising performance.the vehicle's velocity [5]. According to the available literature, numerous power split strategies have been developed and implemented. These strategies differ in terms of optimization type (global or local), computational time, structural complexity, a priori knowledge of driving pattern, and algorithmic efficiency. Researchers and practitioners working on HEVs/PHEVs would find a survey of these available methods very useful.

Another possible method for extending the electric range of a HEV is to enable continuous battery charging while the vehicle is in motion [6]'. The emergence of solar-powered HEVs (PVHEVs) results in the continuous charging of batteries via solar energy, which reduces the use of gasoline and, consequently, the amount of air pollution [7].

Batteries that are both durable and affordable are the primary obstacle for hybrid vehicles. Various HEV battery compositions have been tried in the past, with lithium-ion derivatives producing the best results [8]. In vehicles, there are three levels of battery pack integration: (1) individual battery cells, (2) modules comprised of individual battery cells, and (3) battery packs comprised of modules. The battery must be able to provide high power for short durations and withstand millions of transient shallow cycles over the life of the vehicle. To extend the range and life of a battery, it can be interfaced with an ultracapacitor (UC) that allows for a longer life cycle, higher rate of charge/discharge, and lower internal resistance, resulting in less heat loss and improved reliability. UC increases the efficiency cycle to approximately 90% from 80% [9]. Compared to their individual performances, the hybrid energy storage system (HESS) formed by the combination of battery and UC is more efficient.

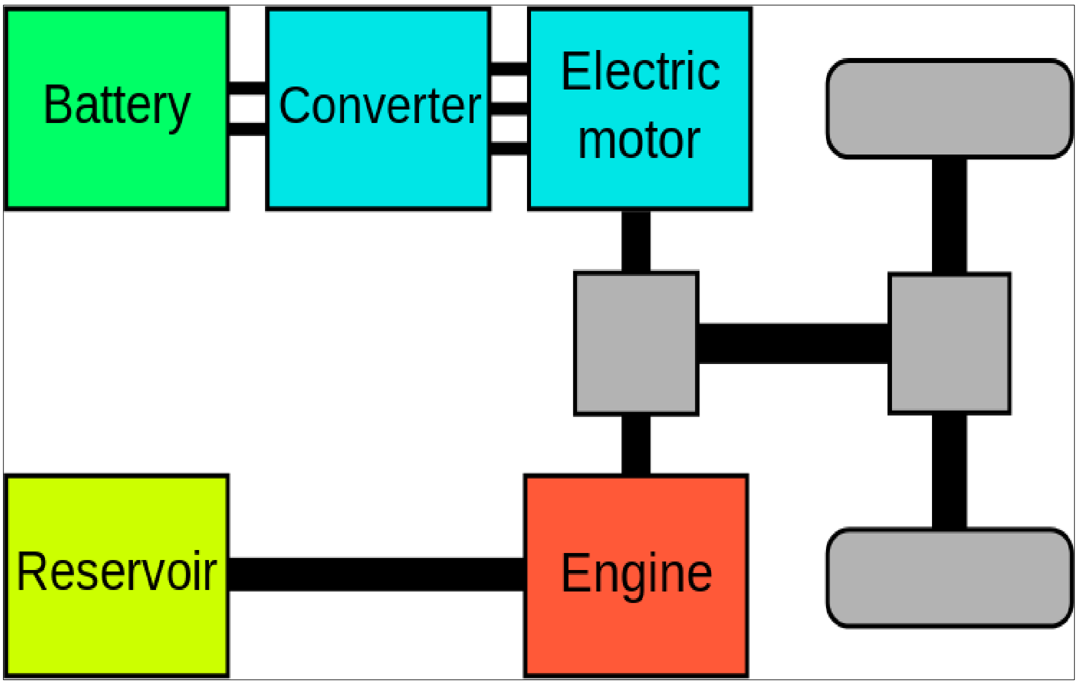

Figure 1 Structure of a parallel hybrid electric vehicle

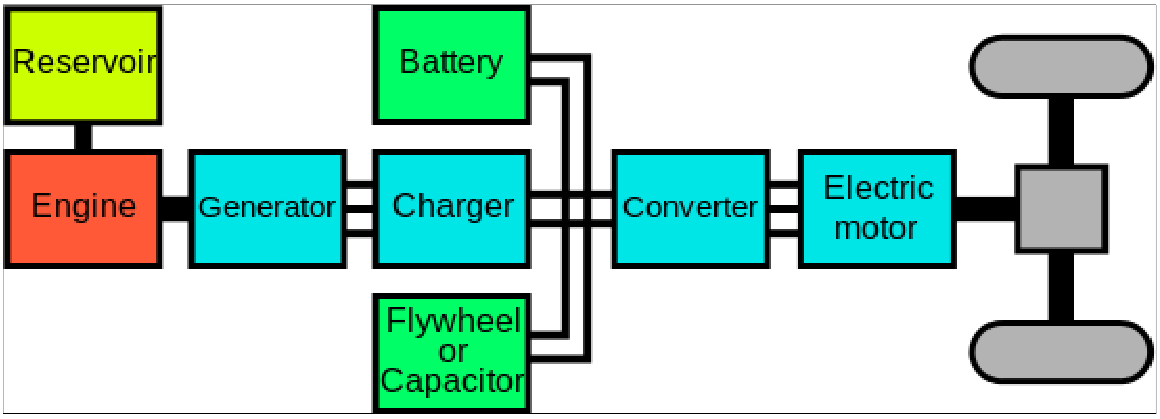

Figure 2. Structure of a series-hybrid vehicle

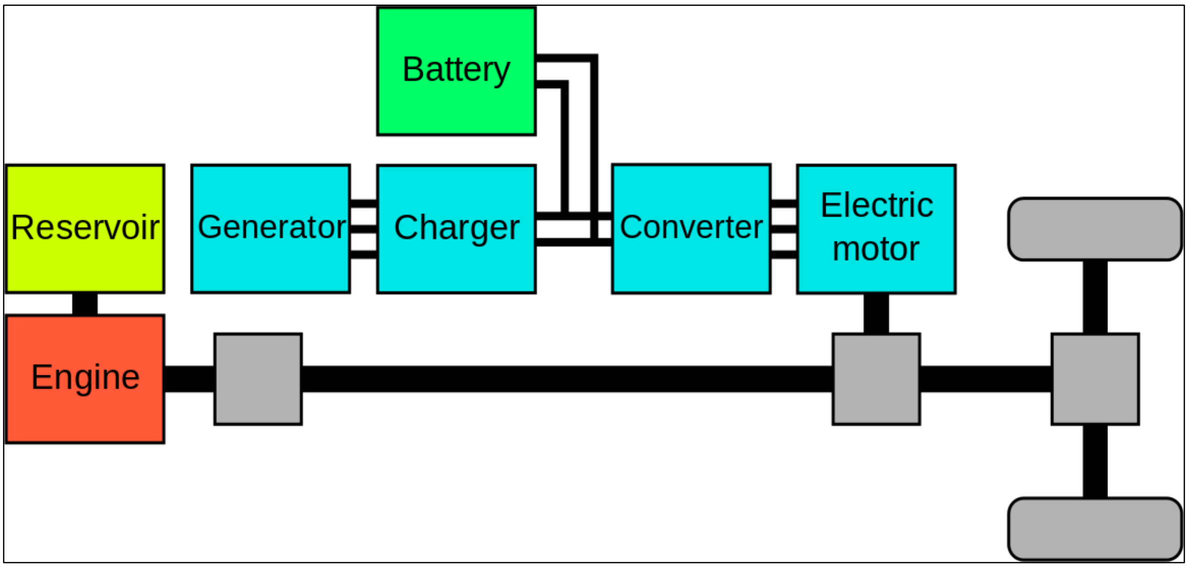

Figure 3. Series Parallel Hybrid combination.

METHODOLOGY

As a result of the current economic downturn, a large number of individuals are in need of fuel-efficient, low-emissions vehicles, and automakers are shifting their production to vehicles that are less harmful to the environment and more eco-friendly to meet consumer demand. Automakers are attempting to promote hybrid vehicles because their environmental friendliness and low emissions make them the best solution for the current state of the world. Module hybrids are gaining prominence, making electric vehicles a real possibility [10].

The Electric Power Research Institute and Daimler Chrysler have tested hybrid module Sprinter vans with a range of 20 to 30 miles (EPRI 2008). Compared to non-module mixtures, module mixtures reduce ozone-depleting substances by 35 to 65 percent and oil by 40 to 80 percent, as determined by their research. General Motors Chevy Volt, a hybrid configuration in which only the electric engine controls the haggles gas engine to recharge the lithium-ion batteries (*Fuel Cells Bulletin 2007*). Travel with Airstream fostered the conception of a vehicle HySeries combines a lithium-particle battery load with a conventional power module framework that operates in constant state, thereby reducing by more than half the size, weight, cost, and complexity of a conventional energy unit framework (*Austinenergy 2008*). The Toyota Prius has been renamed Prius Plus by the California Cars Initiative. The Prius Plus achieves roughly double the fuel economy of the standard Prius and can travel up to 10 miles on electric power alone. The California Air Resources Board estimates that battery-powered electric vehicles emit 67 percent fewer greenhouse gases than gasoline-powered vehicles. Though PHEVs with a 20-mile all-electric range are 62% less expensive than BEVs (*Calcars 2009*).

Argonne national laboratory, United States, a transportation R&D organisation, analysed the impact of module crossover electric vehicles and dismantled standard travel behaviour, new innovation penetration.

Examples and routes for vehicle fills are provided. They analysed the charging patterns of PHEV battery packs, oil consumption reduction, well-to-wheel energy, and ozone-depleting substance emissions. Combining PHEV recreation results with evaluation of movement behaviour from a public study, they developed a concept that disposes of vehicles that travel less than a PHEV's daily electric range, as PHEVs are not practical for these customers. 20 miles is the optimal PHEV range for reducing oil consumption.

In 1997, *Honda Motors* presented a concept hybrid motorcycle at the Tokyo engine show with the primary goals of a 60 percent reduction in CO2 emissions and a 2.5 times improvement in environmental friendliness. In this configuration, the rear tyre is driven by a water-cooled 49 cc gas motor coupled to a DC brushless electric motor. The gas engine provides power for high-speed performance and hill climbing, while the electric engine is locked for low-speed travel.*Biona (2007)* commissioned a study to investigate the fuel consumption and emissions reduction potential of combining hybrid frameworks with two-stroke-controlled vehicles. Carbureted and direct infusion two-cycle motor mixture frameworks were investigated and compared to the effect of utilising four-phase motors. The results indicated that hybridised two-stroke controlled frameworks have the potential to provide significantly greater environmental and fuel savings than the transition to new four-stroke vehicles. He suggested that the development of such technology specifically for two-stroke vehicles should be actively pursued.*Constantine and Kyle (2008)* analysed the life cycle GHG emissions of PHEVs and found that they reduce GHG emissions by 32% compared to conventional vehicles, but only marginally compared to conventional hybrids. While accusing PHEVs of power that has a GHG force equivalent to or greater than our flow system, their results indicate that PHEVs would significantly reduce gas consumption but only marginally reduce life cycle GHGs, when compared to gas electric hybrids or other eco-friendly motor advances. However, with a low-carbon power infrastructure, module hybrids could significantly reduce GHG emissions and oil dependence. The effect of plug-in hybrid electric vehicles (PHEVs) on GHG emissions from the transportation sector will depend on the rate of buyer adoption. Their consideration of low, flow, and high GHG-concentrated power situations enables leaders to consider what a power framework should look like under various appropriation scenarios if PHEVs are sought after as a major source of GHG emissions decreases. Due to the slow turnover of capital in the power sector, a low-carbon framework may necessitate.

It took many years to emerge. Significant reductions in ozone-depleting substance emissions from module half-breeds in the coming decades will necessitate decisions within the next ten years to foster a robust low-carbon energy supply.

RESULTS & DISCUSSIONS

Fig. 4 is a block diagram of a hybrid electric vehicle (HEV) power train, which combines an electrical machine and an internal combustion engine (ICE) to propel the vehicle. The electrical machine functions as a generator when the state of charge (SOC) of the batteries is low and charging is required, and as a motor when torque is required for vehicle propulsion. The neuro-fuzzy method-designed controller controls the engine by adjusting the throttle angle to produce the required torque. Calculating the torque required from an electric motor by subtracting the actual engine output torque from the torque required at any given time.

The battery is a 6.5 Ah, 200 Vdc, 21 kW Nickel-Metal-Hydride battery. The DC/DC converter (boost type) is voltage-regulated. The DC/DC converter adapts the low voltage of the battery (200 V) to the DC bus which feeds the AC motor at a voltage of 500 V.

SIMULATION AND RESULTS IN MATLAB.

The existing graph for our proposed algorithm ANFIS is displayed below. When using the accelerator mode, it should run for roughly one minute. The HEV speed begins at 0 km/h, reaches 73 km/h in 14 seconds, and then decreases to 61 km/h in 16 seconds. ANFIS controller is used to maintain a constant acceleration pedal position until the end of the simulation. Open the "Car" scope in the primary system. Figure 6.1 depicts the stator current after the implementation of ANFIS, which explains what happens when the HEV is in motion.

At t = 0 s, the HEV is stopped and the driver accelerates to 70 percent of maximum speed. So long as the required power is less than 12 kW, the HEV will move using only the battery-powered electric motor. Both the generator and the ICE are powerless.

After applying the ANFIS controller depicted in figure 6.2, rotor current can also be plotted. The motor section implements this controller.

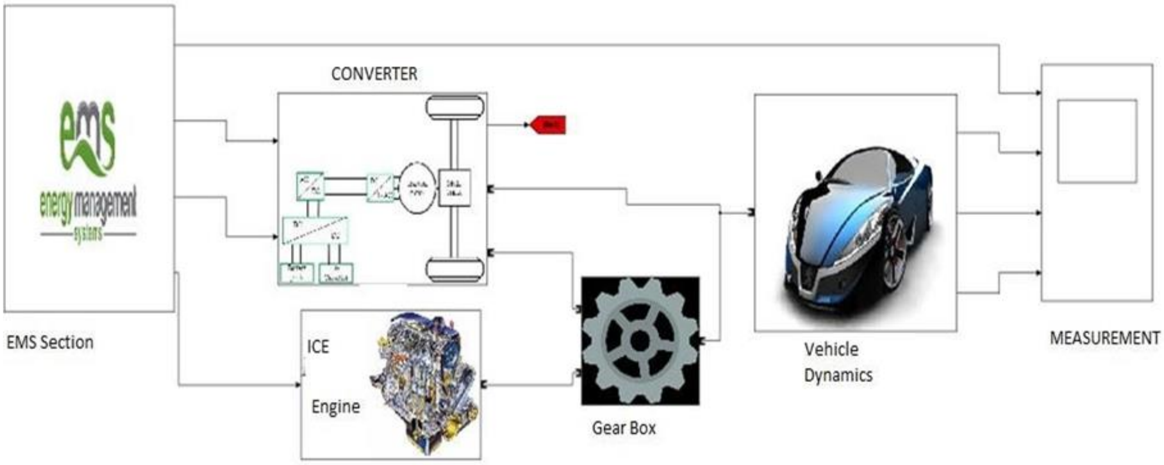

Figure 4. Model of series Parallel HEV

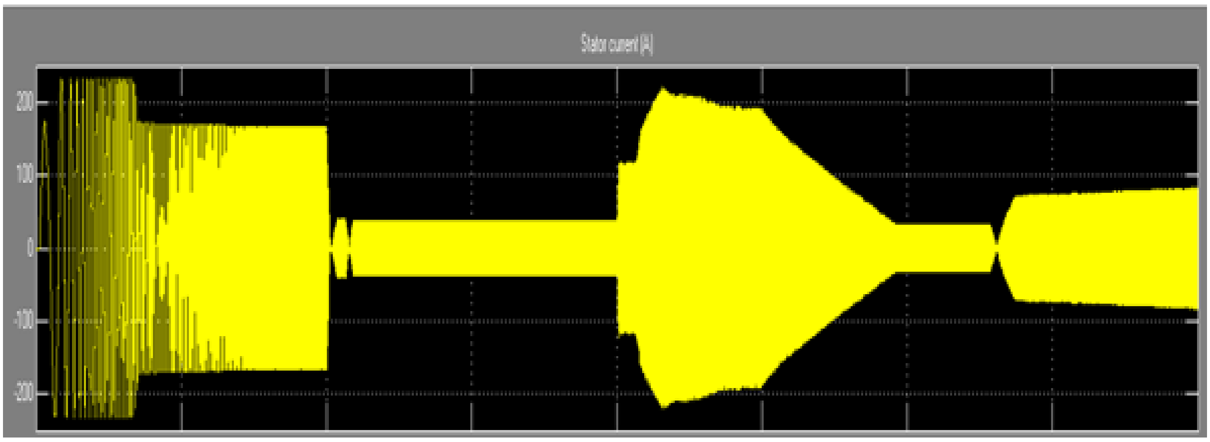

Figure 5. Plot of stator current incorporated with ANFIS

CONCLUSION

A hybrid electric vehicle (HEV) frame designed with a robust controller, i.e. ANFIS, provides superior response in comparison to biological controllers. In the modelling and feedback control of any dynamical system, a controller is required for the plant because it eliminates all disturbances and returns the system to its initial state within a few seconds. To initiate the design of the controller using the ANFIS scheme, a simulink model of the motor plant and a mathematical model of the controller are required, both of which can be used for simulation purposes.

FUTURE SCOPE

Based on translating expert knowledge into a set of ANFIS rules, the aforementioned problem has been discussed. There is no underlying mathematical model, but if more refined rules are implemented, system performance may be enhanced. In addition to incorporating uncertainty and parameter variations, the mathematical model can be improved by employing robust control algorithms to solve the optimization problem.

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