

An Intelligent Controller to Increase Power in Parallel Hybrid Electric Vehicle

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ABSTRACT: Parallel Hybrid Electric Vehicles (PHEVs) integrate the internal combustion engine (ICE) into the electric motor to optimize fuel efficiency, reduce emissions and improve the overall performance of the vehicle. To maximize fuel efficiency, lower emissions, and improve overall vehicle performance, Parallel Hybrid Electric Vehicles (PHEVs) combine an electric motor with an internal combustion engine (ICE). Especially while driving in different situations, traditional control systems frequently find it difficult to dynamically balance battery life, power consumption, and fuel economy. This study investigates how intelligent controllers, like fuzzy logic controllers (FLC), can be used to enhance power management in parallel hybrid electric cars. Low, medium, and high driving speeds can be used to keep the internal combustion engine within its efficient working range. Hybrid electric cars combine an electric motor, battery, and internal combustion engine to increase fuel efficiency and minimize pollution. Hybrid electric cars have shown to be a sensible option for guaranteeing higher fuel economy.

Keywords: parallel Hybrid Electric Vehicle, Fuzzy Logic Controller.

1. Introduction

The increased demand for sustainable transportation solutions has led to significant advances in hybrid electric vehicles (HEVs), combining the benefits of both internal combustion engines (ICEs) and electric motors. Parallel hybrid electric vehicles (PHEVs) are being developed as a promising approach, as both the engine and the electric motor can supply electricity simultaneously or independently under the various configurations of hybrid systems. Depending on the operating conditions. To address these challenges, intelligent control systems are increasingly being applied to hybrid vehicles. Advanced controllers such as Fuzzy Logic Controllers (FLCs) provide the opportunity to make decisions to optimize energy management

in real time, improve fuel consumption, minimize emissions, and improve driving comfort. This suggests a dynamic modelling frame for cars with serial hybrid power strands. Each component of the series HEV is constructed individually using the first principal method, confirmed with easily accessible experimental data, and integrated to create linked nonlinear power models. Vehicle models allow for the development of surveillance systems (SCSSs) that optimize the energy flow of drive trains. In simulations, the performance of the vehicle is examined in different operation and driving situations using two different SCs and two drive cycles [1].

The use of thermostatic control technology in relation to moderate HEVs has been modified to increase fuel efficiency when operating in cities.

In this work, parallel mild HEV tests were conducted to evaluate the parameters of hybrid electric drive trains and numerical models of the car were created. Considering the results, the thermostatic control method was modified and used with the automotive model by operating the internal combustion engine (ICE) in areas with high efficiency. This method can improve fuel consumption of parallel mild HEVs. Additionally, battery protection logic is added based on the electrochemical battery model. This is because active battery utilization can damage the battery via a thermostatic tax approach. Simulation studies on driving within the city show that the thermostatic control approach is over 3.5% over traditional methods in terms of vehicle fuel consumption [2]. some driving styles for traditional and hybrid electric vehicles, as well as fuel consumption. Some of the most important social goals are to reduce emissions, improve fuel efficiency, and combine fuel consumption optimization with predicting drive cycles. The U.S. Environmental Protection Agency (EPA) used standard drive cycles to assess the vehicle's fuel economy under laboratory-controlled conditions for a long time. It was also used to evaluate and improve many HEVs (hybrid energy management systems) [3]. When you drive an electric vehicle, the road environment is taken into consideration. With the ongoing movement of transport electrification, the driving cycle has often been recognized as a useful tool to eliminate concerns about optimal structure, evaluation and processing of electric vehicles. This information was integrated with information on the driving environment. Based on the lowest comprehensive parameter changes, traditional microtrip techniques have been improved, improving accuracy and lowering arithmetic load [4]. Because they have an energy storage system that can be handed over, one or more electric machines can consume the latest electricity, hybrid electricity, fuel cell vehicles with less gasoline and less emissions than traditional vehicles. Power assist features, playback brakes, idle supply and engine clamp options are available by including

these devices. Electrical actuators and storage devices can operate in both directions, allowing them to store and use some of the energy generated by the engine and vehicle damage [5]. The development of alternative energy vehicles has always been an important route for the vehicle industry, especially when managing challenges related to global environmental degradation and fuel shortages. From now on, the introduction of alternative transport technologies, which use internal internal combustion engines (ICEs) as the main energy source and battery packs as the sharp energy source for motors [6] [7], will become one of the common solutions to these problems. The purpose of this study is to examine the potential benefits of using parallel HEVs for real drive cycles (Iraqi case studies and standard drive cycles) compared to traditional vehicle models. The actual driving cycle used in this study primarily represents urban activity. Energy storage devices store energy at peak times and provide energy at peak times to maintain the energy balance between storage and microgrids [9][10].

The remainder of this paper discusses the methodology proposed in Section 2. Section 3 describes the results and discussion, followed by the conclusions in Section 4.

2. Proposed Methodology

This proposed work uses fuzzy techniques by transmission. The net strength of the coupler is transmitted to the wheel. The engine and engine drive the wheels simply, resulting in less energy movement and less misfortune afterwards. It acts as an engine and is only low, so in addition to the power required to move the vehicle, the battery needs to be charged.

The proposed system (Figure 1) includes the energy storage components of hybrid electric vehicles gasoline and electricity. The battery stores energy, and the electric motor uses electricity as the towing engine. To create mechanical performance and convert fuel into electrical energy, gasoline must be stored in a tank

and used in the inner engine. System performance was not evaluated under load conditions and

results were published.

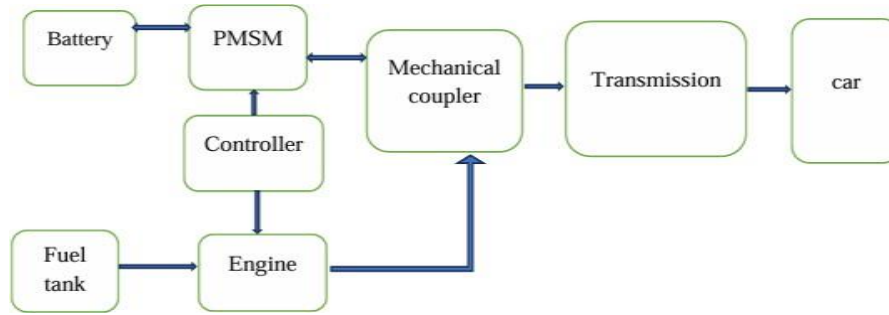


Figure 1: Parallel Hybrid Electric Vehicle Block Diagram

Hybrid electric vehicles, which combine the advantages of both electricity and traditional internal combustion engine vehicles, have been established as a serious road transport problem. By combining two different energy sources, hybrid vehicles use less energy than traditional vehicles and emit less, but they can continue to drive more than all electric vehicles.

2.1 Permanent Magnet Synchronous Motors

The ratio of torque to electrical ratio, weight, efficiency and resistance of permanent magnetic synchronous engines is potentially high. PMSM is often used in applications involving electric vehicles, with modern alternating power drives of various speeds, especially the above advantages.

The steel rotors of permanent magnets (PMSMs) contain permanent magnets used to provide a constant magnetic field. The rotating magnetic field is created by windings of the stator that are linked to alternating currents (like in an asynchronous engine).

2.2. Energy Management System

The design and battery management system limits how much power and battery can be delivered during the operating cycle. Energy is important for controlling the transport of electricity from the engine to the EM. Depending on the battery load condition and performance required, the EM will generate either electricity from ice or the vehicle's active energy. It can be used to drive a car itself or in connection with the engine.

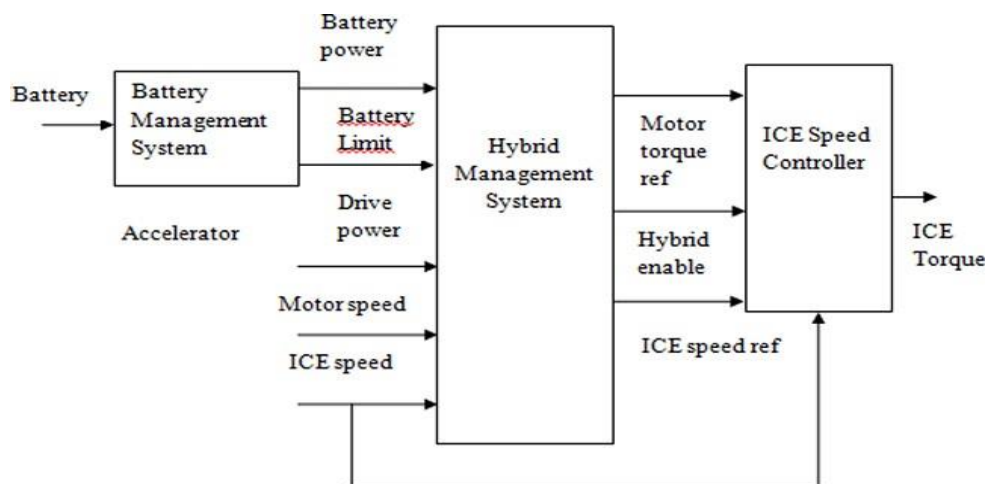


Figure 2 (a): System Block Diagram for Energy Management

2.3 CDC-DC Converter

DC-DC converters control voltage. Additionally, DC-DC converters are used in circuits to load and unload batteries. The engine receives 500V as

soon as the low voltage from the battery is transferred to the DC transmission.

2.4 Motor/Generator

The engine is a long-lasting 50 kW magnetic unit

with a 500 VDC generator. With researched support, this engine has an eight-wave engine. The latest reduction induction engines can run at a top speed of 6000 rpm. The engine has a 30 kw -pmsm generator, two waves, and 500 VDC. 6000 rpm is the highest engine speed you can achieve with vector control. The rear EMF shaft shape of the permanent magnetic synchronous engine is sine wave. It offers excellent torque stability, a high-quality ratio of mass to torque to focus, and the ability to meet the requirements of an electrical extermination system. The better the economy, the more batteries you need, the higher the electric motor performance ratio in determining the total vehicle demand capacity.

2.5 Engine

The engine model contains information on fuel consumption and performance. The EM can replace the torque of the hybrid electrical setup to create the desired acceleration, reducing the engine. Fuel consumption and weight are two of the most important benefits of this motor. When the engine rises at a certain speed, the strength fleet module starts with the supply of engine fuel. The engine choke position is changed to take into account the force requirements. The generator is changed to creation mode and collects the engine with power when the engine exceeds the reference speed. The main goal of PHEV control is to manipulate ice in the most effective environment. This increases the overall efficiency of the drivetrain. Street loads and SOC should be considered when deciding on ice operations.

2.6 Fuzzy Controller

Both the fuzzy controller and the motor generator are linked. The torque of the rotating engine is transmitted to the transmission by a clutch connected to the ICE. To stop torque transmission, the clutch must be activated. The clutch is only a manual gear with an electronic actuator connected and is linked to the office (automatic manual transmission). Once the engine is mounted in this gear, the electric vehicle will begin to move. Fuzzy logic controls are created to determine the

energy flow between the critical energy source (ESS) and the combustion engine (ICE). Four important line parameters, cycle speed, requested torque and brake energy were chosen as the entrance to fully characterize the vehicle.

2.7 Driving Cycle

A driving cycle is a collection of data records that show how a vehicle's speed corresponds to at the time. The vehicle's driving cycle is used to determine fuel consumption and emissions. The driving cycle is also used by software, modelled simulated vehicles to calculate emissions, fuel consumption, and the functionality of batteries, gears and other components. NEDC was developed to mimic typical automobile use in Europe.

2.7.1 The New European Driving Cycle

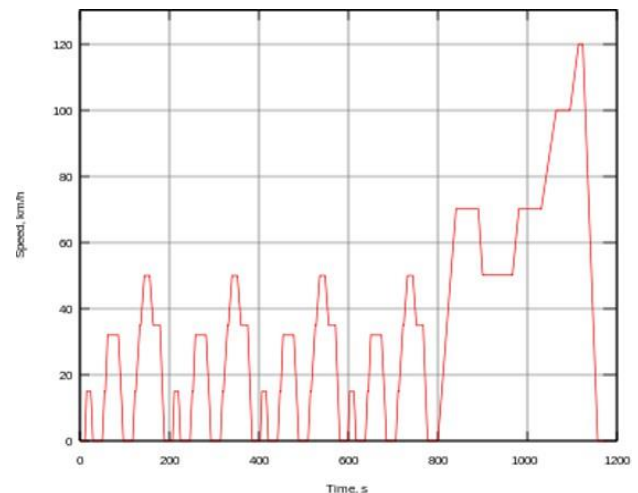


Figure 2(b): *New European Driving Cycle.*

This cycle is used to assess fuel economy and emissions of European cities' street and highways (NEDC) vehicles. It is often used in automotive simulation software to mimic European drive cycles. The ECDC Cycle is a change of the NEDC Cycle developed to mimic high-speed travel. The most important parameters are the duration of 1180, a distance of 11.03 km, and an average speed (km/h) of 33.6.

2.8 LiFePO4

Especially in parallel hybrid electric vehicles (PHEVs), hybrid electric vehicles (HEVs), battery selection plays a critical role in determining the

performance, efficiency and durability of the vehicle. Lithium iron phosphate (LifePO4) batteries are a popular choice for PHEVs due to their superior properties compared to other battery foods such as nickel metal hydride (NIMH) and traditional lithium ion (Li ion). LifePO4 batteries are known for their excellent thermal stability and are less susceptible to thermal outliers, making them safer in high performance applications such as PHEVs. LifePO4 batteries can withstand more duty cycles than many other lithium-ion chemistry. This is extremely important for the life of your PHEV battery system. High energy efficiency is high during loading and during the unloading process. LifePo4 batteries are typically used in these applications, so you need to constantly monitor your charging status (SOC), voltage, and health to ensure efficient operation and protect your battery from potential damage.

3. Result and Discussion

This MATLAB/Simulink's most important subsystem is the internal combustion engine, battery and electric motor, and hybrid electric vehicles that reduce emissions and fuel consumption.

The battery is used to save energy, and the electric motor acts as a foot engine. To generate mechanical performance and electrical energy from gasoline, the fuel must be stored in a tank and burned in a combustion engine. These models use differential movement equations to explain how the components of a vehicle are transformed. Mathematical models that predict the value of collision injuries can also take into account passengers in the vehicle. This is a procedure that requires elimination and minimization of effects that are deemed unimportant when creating a suitable model. The modelled quantities are expressed as functions that depend on individual programmable variables. Normal and partial differential equations are often used to simulate nonlinear physical systems.

3.1 Motor and Engine Power Waves

To improve acceleration, the engine provides

torque to the engine and draws energy from the battery. If high performance applications remain for a long period of time, you need to increase the engine speed. The engine and engine power wave shapes are shown in the previous diagram. At speeds between 0 and 15 mph, the engine and engine can produce up to 2100 W or 2500 W.

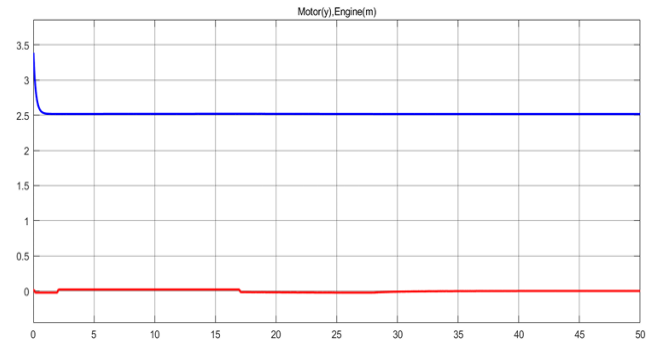


Figure 3(a): Motor and Engine Power Waves

3.2 Shaft Speed (RPM) For Motor and Engine

The engine is set to 2200 rpm and the engine is set to 500 rpm. The car reaches 15 mph in 20 seconds. The car is converted to an electric vehicle with the same half breaks trapped in the diagram below.

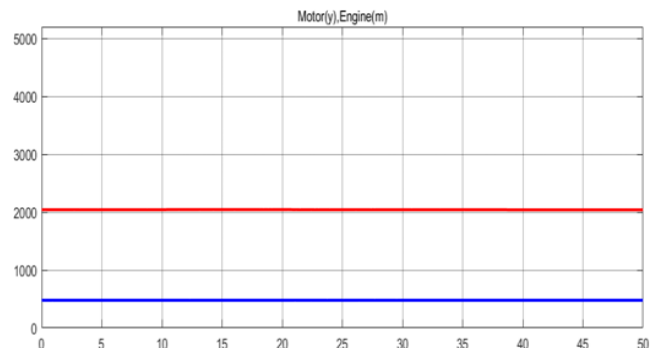


Figure 3(b): Shaft Speed for Motor and Engine

3.3 Total Electrical Loss

The Hybrid technology prevents maximum potential by optimizing ice functionality with existing controllers.

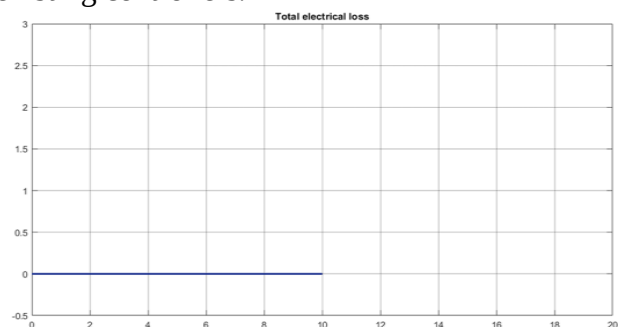


Figure 3(c): Electrical Loss

3.4 Vehicle Velocity

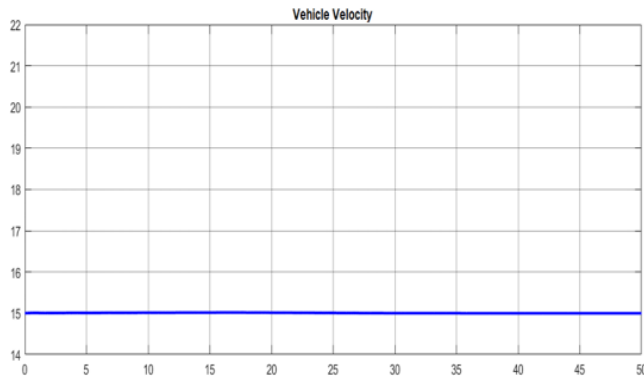


Figure 3(d): Vehicle Velocity

The vehicle economy was compared to Highway fuel consumption tests, urban dynamometer timetables, and new European driving cycles. Existing controllers optimize ICE functionality, so the full potential of hybrid technology has not been achieved. For parallel hybrid vehicles, this study recommends an ANFIS controller to improve battery power. With NEDC, simulations of low- performance vehicles are performed at maximum speeds of 90 km/h over a distance of 50 km/h. The results of the NEDC drive Cycles simulation are shown in Figure 3 (d).

3.5 Fuel Consumption

Calculate NEDC fuel economy estimates using four repeated urban drive cycles and one extra driving cycle. In a parallel hybrid drive system, an electric motor helps the engine turn the wheels. This configuration is further divided into medium, full, plug-in hybrids based on engine power and battery specifications. Evaluate the performance of this hybrid electric vehicle on a standard drive cycle.

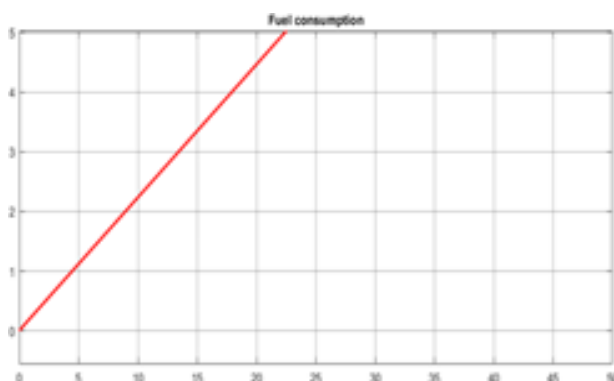


Figure 3(e): Fuel Consumption

4. Conclusion

Modelling and control of hybrid electric vehicles (HEVs) is important to optimize the key factors to reduce fuel economy, energy consumption and environmental impact. By integrating the combustion engine (ICE) and electric motor (EM), the HEV uses the strength of both power sources, allowing efficient operation under a variety of operating conditions. Through precise mathematical modelling of vehicle dynamics, drivetrain behaviour and battery power sources, simulate and predict HEV behaviour in a variety of scenarios. As a result, HEVs can balance fuel efficiency, reduced emissions and improved operating areas, contributing to a more sustainable transportation system. In summary, the combination of advanced modeling and advanced control technology plays a key role in maximizing fuel economy in hybrid electric vehicles. As the automotive industry continues to change towards greener technologies, optimizing HEV performance in these ways remains a central focus for achieving more energy-efficient, environmentally friendly transportation solutions.

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