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Critical Analysis on Usage of Hybrid Power in Assuring Vehicle Stability Through Converting Electric Energy to Mechanical Energy

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Abstract **- The increase of utilization and recovery of efficient energy of regenerative braking is done in hybrid vehicles for distribution strategy and energy transformation through storage systems of hybrid energy with ultra-capacitor and battery. The system of regenerative braking in the hydraulic system of braking has several advantages of recovering kinetic energy and quicker responses that can improve the utilisation of efficient energy of the overall vehicle. The converted energy is stored in the devices of energy storage such as ultra-capacitors, batteries, and even in flywheels that are having ultrahigh speed and it extends the overall range of driving up to 10%. Furthermore, electric vehicles are totally equipped with a hybrid system of braking that is regenerative and hydraulic and the system of regenerative braking is insufficient that can offer the same type of deceleration that is available in the conventional vehicles then the system of hydraulic braking is applied there. Therefore, the analysis on the usage of hybrid power is verified on assuring the vehicle stability by converting electrical energy to mechanical energy.**

Keywords— Regenerative braking, Hydraulic braking system,electro-hydraulic system, Vehicle stability control

Introduction

The usage of hybrid power in electric vehicles includes the technology of regenerative braking. It can cause the wheel in slowing down and convert from electric energy to mechanical energy and also store it back within the battery. Other than that, it also assists the gasoline engine that provides extra power for climbing up to the hills. Furthermore, it totally shuts off the overall engine when the vehicle comes to a stop and then restarts when the accelerator of the vehicle is pressed. This research includes exploring the significance of the hybrid power in assuring the stability of a vehicle and also illustrates the energy transformation in the electric vehicles by the usage of the hybrid power.

Significance of hybrid power in assuring vehicle stability

The system of hybrid power is still the emerging technology that is used for evolving in future by having lower cost and wider technology. In addition, this system is bringing different storage, consumption of several technologies and generation in a single system by improving total benefits that are compared to other systems in a single source. Furthermore, there are several factors that influence the capability of regenerative braking of electric vehicles at lower speed and simulation is carried out for each of the factors for displacement at a lower speed (Heydari et al. 2019). The regenerative system of braking that consists of the ***electro-hydraulic system*** of composite braking has several advantages for recovering kinetic energy and quick response of the vehicle. It also improves the utilisation of efficient energy of the overall vehicle. In the current scenario, the component of energy storage for the system of regenerative braking adopts the system of power supply that is composed of pure batteries. It is having the characteristics of low power, characteristics of undesirable temperature and a shorter life cycle.

The lower specific energy is the main shortcomings for having an ultra-capacitor as one of the energy devices for an electric vehicle. It is totally combined with a battery that is having higher energy that forms the storage system of hybrid energy (Zhao et al. 2019). The ***Vehicle stability control (VSC)*** is the braking control that controls the handling performance of a vehicle. This system improves the handling performance and overall stability of a vehicle and the strategies of VSC are developed for the ***Hybrid electric vehicle (HEVs)***. Furthermore, if a vehicle consists of an anti-braking system and it is also totally designed for having the hybrid powertrain, then the hybrid powertrain will be consisting of several electric motors. It is excluded from the system of an active safety control loop.

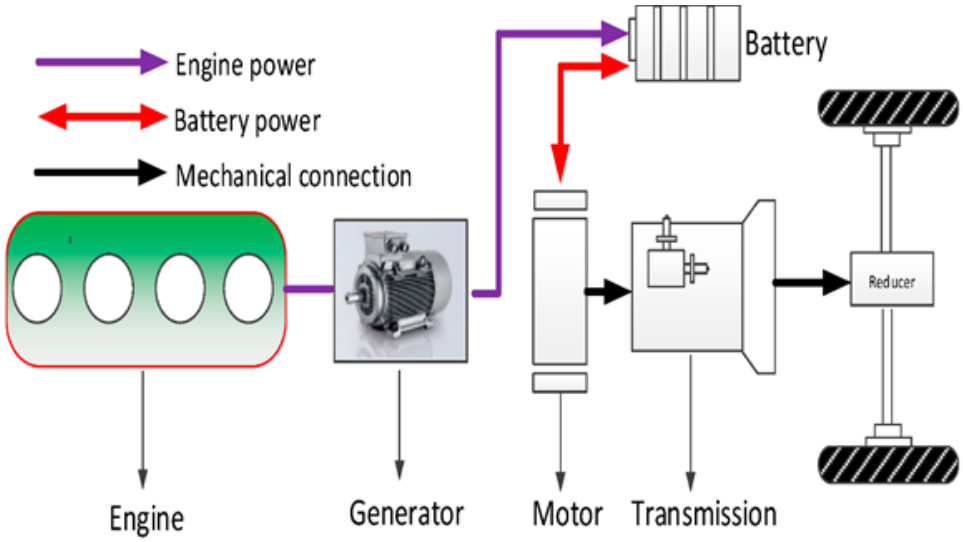

Figure 1: Energy management strategy of hybrid vehicles

(Source: Li *et al.* 2019)

The technology of HEV is providing the improvement of fuel economy and it also enables the HEV for exhausting fewer emissions that are totally compared to vehicles that consist of conventional combustion engines (Li *et al.* 2019). On the other hand, the traction and braking capabilities are totally provided by several electrical machines and they are totally disabled at the time of activation of several safety features. The HES is growing the capacity that is from the systems of an off-grid of fewer kilowatts. It is also designed for the low voltage AC and DC for the huge megawatt systems that are expanding to the medium voltage in the grid-connective systems of voltage. The major drawback of a hybrid vehicle is the capability of energy storage and these energy resources are having high specific power and higher energy that reduces the charging time (Jyotheeswara *et al.* 2018). Electric vehicles based on hybrid technology are totally powered by the engine of internal combustion and the electric motor that uses energy that is stored in batteries. Therefore, the system of HES is a much more promising solution that is sustainable for the power generation of several electric cars.

Energy Transformation in electric vehicles by the usage of hybrid power

The engine of the electric vehicles transforms from the electrical energy to mechanical energy that is through the electromagnetic interactions. The main conductive element that is inside the electric vehicle makes the movement as it enters the overall magnetic field and it also ends up by receiving electric current. The hybrid electric vehicle are having several advantages such as these are environment friendly, having several financial benefits, these are less dependent on the fossil fuels, having the system of regenerative system. The hybrid vehicles also have several disadvantages such as having less power, being more expensive, poor handling performance, maintenance costs are higher, replacement of the battery is costly and many more. Furthermore, there are also advantages regarding DC input voltage that is stable around their nominal value and it also enhances the stability of vehicles on the storage system of hybrid energy (Trovão *et al.* 2017).

HEVs are totally regarded as the critical solutions for enhancing the fuel economy of several automobiles as they might decrease the consumption of fuel and emissions of exhaust. It utilises electrical energy with the advantages of pollution-free and lower costs, while the configuration of the powertrain is the main part of designing the HEVs. The storage system of hybrid energy has a primary energy source that is a Li-ion battery and the secondary source is the Ultra capacitor and these sources deliver the power demand in hybrid vehicles (Itani *et al.* 2017). On the other hand, the energy transformation is totally analysed in the hybrid vehicles and for that, the configurations of single-mode are totally designed for considering the efficiency of energy. In addition, it also analyses the loss of energy conversion and the transmission of mechanical energy from electrical energy. The main purpose of the hybrid vehicles is to propose the controller of an artificial neural network that is for estimating the yaw moment which is required for the stability of dynamics in electric vehicles. The ordinary HEV undertakes the supply of overall energy and also the battery of the vehicle is also treated as the energy buffer. It can easily adjust the overall output power within the engines with several loads by the proper release of the energy and proper absorption of energy.

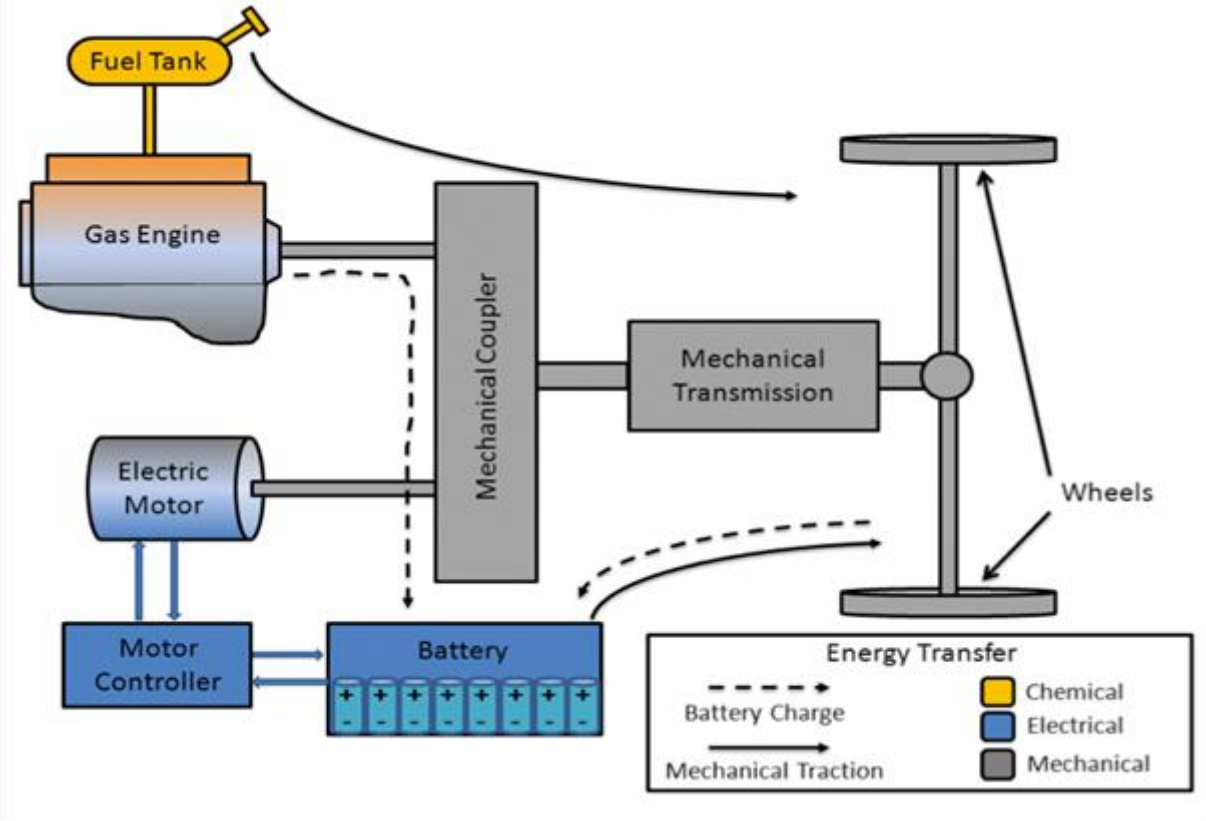

Figure 2: Process of Energy Transformation

(Source: Krithika and Subramani, 2017)

The HEVs are capable of improving the fuel economy, the overall emission for the system of hybrid power and also the control strategies that are much more significant (Krithika and Subramani, 2017). The feedback system of control is also used for regulating the HEV within the fuel cell, super capacitor and batteries while these components are totally implemented with other fuel cells within the hybrid vehicles. The main equivalent relationship between electric energy and fuel is not as constant as the efficient system of HEV is not evaluated after a certain time.

Result and discussion

The important possibilities that are for increasing the energy efficiency regarding the savings of electric vehicles are accumulated within the electric vehicles. It also increases the performance range of the vehicles with the initial resources. The electric and hybrid vehicles ensure the overall improvements in the reduction of emissions and fuel saving. The management of energy for the system of hybrid power consists of battery, ultra capacitor and fuel cell and these are totally dedicated to the electric vehicles (Marzougui *et al.* 2019). The overall change for focusing on the hybrid technology is done by several automobile manufacturers and there are various configurations of hybrid and electric vehicles. The configurations of hybrid vehicles are the electric batteries that are equipped in electric vehicles are called Battery electric vehicles (BEV), hybrid vehicles that combine the conventional propulsion are based on the ICE engines.

Furthermore, the electric propulsion of vehicle motors is powered by super capacitors or batteries called HEV, the electric vehicles are totally equipped with several fuel cells and they are called battery vehicles of fuel cells. However, the combination of elements of energy storage requires the power electronics that are based on converters that are associated with measurement and control instrumentation, known as the storage system of hybrid energy.

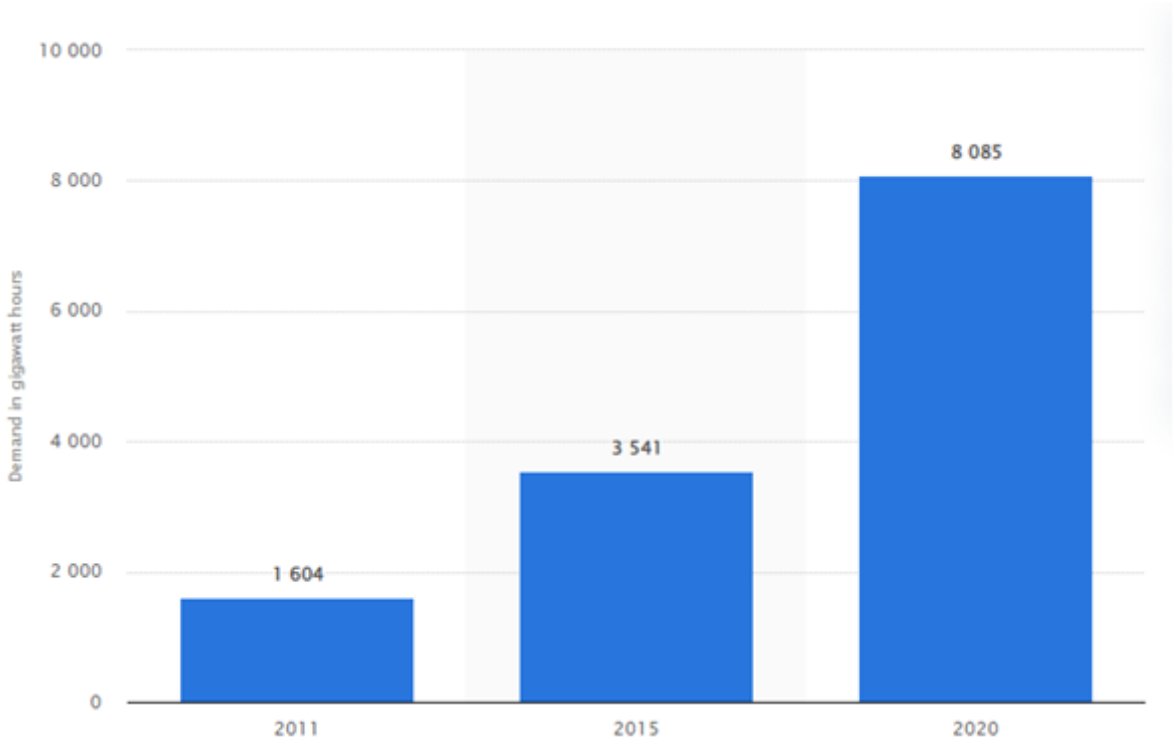

Figure 3: Energy storage demand of Hybrid Electric Vehicles

(Source: Statista, 2021)

The demand for energy storage of the hybrid vehicles was 1604 in the year 2011 and the demand gradually increased day by day with 3541 in the year 2015 (Statista, 2021). In the current scenario, the demand increased up to 8085 in the year 2020. The best thing about hybrid vehicles is this system is having several advantages in both engines that are on internal combustion and in electric vehicles for overcoming the disadvantages. For the enhancement of the performance of hybrid vehicles, the control system is totally utilised for designing the strategies of the power management for hybrid vehicles. The controllers are totally tuned by using the Simulink control for achieving a better balance between the stability of the vehicle and response time.

Based on the high repeatability of the vehicle routing, the strategy of energy management is totally proposed for optimising the hydrogen consumption that ensures the stability within the operation process. The method of incremental conductance provides appropriate initial values that can be simulated steadily and quickly and also it improves the overall performance, ensures the stability and accuracy of the hybrid vehicle (Lü *et al.*2019). Electric vehicles that have two energy sources are known as hybrid vehicles and on these vehicles special batteries, main batteries and capacitors are used as the secondary energy sources.

In addition, these sources are totally designed for providing energy and power to the hybrid vehicles. Energy transformations of HEVs form an idea of reducing the energy losses and the design of HEVs method of powertrain configuration is proposed. The hybrid vehicle improves the fuel economy and also reduces the consumption of fuel and it is the major benefit of several HEVs. The hybrid vehicles aim to save the fuel by running on electricity and for full acceleration or if the batteries are totally discharged the hybrid vehicle has to be run long distance. On the other hand, the strategy of energy management plays an important role for the fuel cell of HEVs and it also affects the performance and efficiency of the energy storage in HEVs (Zhou *et al.* 2017).

Conclusion

Through the overall research, it is concluded that, the vehicle stability of hybrid vehicles is attained by using the driving technique of rear method, regenerative control of braking, and the system of hydraulic braking. Overall performance of controlling vehicle stability is calculated by using Simulink and the results of the Simulink illustrates the regenerative braking and driving performance of hybrid vehicles and they are fully capable of providing stability to the vehicle. Furthermore, the better performance can be only achieved by applying the regenerative method of braking control and driving procedures. HEVs run on both conventional technology of internal combustion engine and an electrical propulsion unit. This energy transformation from electrical energy to mechanical energy within the vehicle is done through electromagnetic interactions and axle electric motors are used in EVs to ensure its stability.

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