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Design of Hybrid Electric Vehicles using MATLAB/SIMULINK

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Abstract: **- This research will study the history, evolution, and current situation of hybrid and electric vehicles (HEV). The overuse of number will look at The origin, development, and current state of hybrid and electric vehicles and will be examined in this study (HEV). HEVs have proven to be the most practical solution due to the excessive use of fossil fuels and deteriorating atmospheric conditions. Future innovations that can be implemented into Electric vehicles to make the world greener are also discussed in the paper. Due to advancements in power electronics and motors, as well as fast charging and slow draining, long-lasting batteries, Hybrid vehicles became more cost-effective and efficient. CO2 emissions from automobiles are a significant cause of pollutants in the country. The automotive industry has enormous challenges in reducing greenhouse gas emissions.**

I. INTRODUCTION

Gasoline vehicles have become an essential component of our daily existence, thanks to the advancement of IC & EC engines. For mobility purposes, the bulk of the population now uses fuel-controlled vehicles [1]. Transportation account for 40% of all petroleum-based fuels [2]. In most places throughout the world, public transit is currently one of most common everyday concerns. There was a desire for fuel-efficient and environmentally friendly transportation vehicles due to a variety of reasons, including global petroleum crises and environmental concerns [3]. Electric Automobiles (EV) & Electric Transport System (ETS) have gotten a lot of attention, and they're expected to be the most popular means of transportation in the coming years because of their benefits over conventional vehicles [4]. In this arena, ongoing study efforts are focused on extending the battery bank's life [5], which delivers the benefits of a low-power rated converter and an optimal load profiles for the battery bank. Clegg (1996) [6] suggested that employing regenerative braking of motors (tractive motor) [7] could improve energy efficiency. His findings showed that he had high dynamic performance and stable stability, as well as greater recovered energy. As a result, regenerative braking seems to be appropriate for both hybrid electric and fuel cell electric vehicle [8]. The ability to produce propulsion torque across a wide speed range is a critical requirement for drive systems used in HEVs. Permanent magnet motors (PM) and induction motors are the two most often utilized motor in HEV propulsion (IM) [9]. Electrical energy is provided by the power sources to the DC bus, which then is transformed to motor [10].Electricity and gasoline are the two forms of energy storage systems in a hybrid electric vehicle (HEV). The term "electricity" refers to the fact that energy is stored in a battery (sometimes supplemented by ultra caps), and traction is provided by an electromotor (consequently referred to as motor). A petrol tank and a Combustion Engine (ICE, thereafter known as an engine) are both instances of fuel, as is using a battery pack to transform fuel to electrical energy. The electromotor will now be the main source of traction in this situation. The car in the first situation will own an engine as well as a motor depending on the design [11].

To make a hybrid electric vehicle, materials from an electrical vehicles and a pure gasoline vehicles are merged. Regenerative braking is possible in an hybrid electric vehicle (EV), its M/G is nestled right behind the engine. In hybrids, the M/G is simply connected to the engine. The transmission is next in line. The two torque providers in this system are the M/G in motorized mode, M-mode, and also the petrol engine. M/G and the batteries are electrically connected [12].

1.1 Configurations:

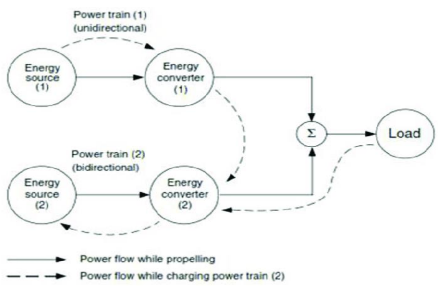

Figure 1: Power flow diagram

The general notion of a hybrids drive train, as well as a hypothetical energy flow path, is depicted in Figure 1. Some of the numerous techniques to combining power flow and driving requirements are as follows:

i. The first power train generates power on its own.
ii. The first power train generates power on its own.
iii. The power train 1 and 2 deliver energy to the system at the same time.
iv. The load provides energy to power train 2. (regenerative braking)
v. Power Train 1 provides power to Power Train 2.
vi. Power train 2 gets both its power and its load via power train 1.
vii. At same time, power train 1 sends power to a load and power train 2.
viii. The power train 1 provides power to power train 2,further power train 2 provides power to power train 1.
ix. power train 1 delivers power to load and load delivers power to power train 2 [13].

1.2 HEV Architecture:
An electric motor, batteries, converters, combustion engine (ICE), fuel tank, and control board are the main components of a HEV. These components can be classified into three groups:
1. Drive trains—physically connect the ICE power source to the electric engine.
2. Energy storage system (ESS)—this type of system focuses on smaller or larger power storage and power capacity.
3. Control system—manages the HESS and instructs the electric systems/ICE [14].

Hybrid electric vehicles include the following:

(a) Hybrid electric vehicles in series
A series hybrid is identical to an electric hybrid car in design (BEV). The petrol engine powers an electric generator rather than driving the wheels directly. The generator simultaneously charges a battery and powers the vehicle's electric generator. When a large amount of power is necessary, the motor draws power from both the batteries and the generator. Series hybrid are also known as elongated electric vehicles (EREVs) because of gasoline engine solely produces power for the motor but never actually drives the wheels (REEVs).
b) Hybrid electric vehicles that run in parallel
A parallel hybrid is powered by an combustion electrical motor connected to a mechanical transmission. The power transfer between both the engines and the motors is altered to ensure that both function at peak efficiency. There is no distinct generator in a parallel hybrid. When the generator's action is necessary, the motor operates as a generator.
c) Hybrid electric vehicles with a series-parallel drivetrain
A solitary internal combustion engine, a solitary electric engine, or even both energy converters can be used to power the vehicle. The engine and motor's power distribution is intended to allow the engine to function as closer to its ideal operational range as feasible [15].

II. METHODOLOGY

The MATLAB core qualities are completed in order with flow of data, starting on the left with the various driving input and concluding on the right with ADAMS model subsystems. The input data ports of each component block are on the left, whereas the data output ports are on the right.

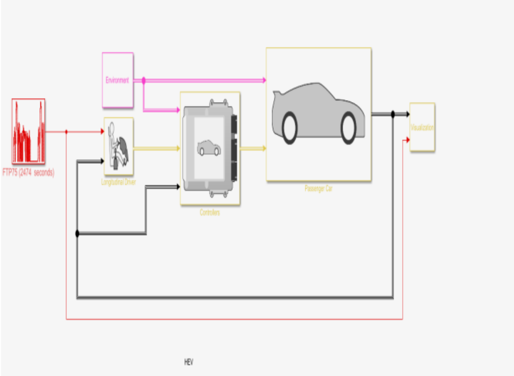

Figure 2: MATAB/simulink model

The data ports then are connected to the relevant component block's input ports. This information is then passed throughout each of the data blocks.

2.1 System of drive cycle
The cycle of driving component comprises tables of standard driving cycles as well as data on vehicle speed over time. Based on current simulation time, the block outputs the anticipated vehicle speed.

2.2 Control of power management
When the vehicle is stationary, the power control controller subsystem is in charge of executing power efficiency and shutting off the engine. A higher output power value indicates that the motor aid mode requires more power, and the subsystem estimates the net power need for the motor/generator.
The vehicle's desired power is determined at any simulation moment as the result of the maximum output given as well as the percent throttle. The output power is calculated by adding the engine and electric motor's peak power outputs as a constant. The motor's logic computations are carried out by the Logical function blocks, after which the motor drives source mode are engaged.
The AND gate generates strongly held data to activate the operating mode when all Boolean are true.

2.3 Motor/Generator
The resultant torque of both the motor/generator usually computed using various table classified by shaft speed, just as the engine model. The engine speed is much like the motor/since generator's the motor/generator shafts are directly connected to the engine's crankshaft. Whether motor/generator sub-system is employed as a generator or a motor is determined by the power conservation controller.
The motorized method indication becomes 1 when the motor is in assistance mode. The needed power estimation, The energy output of the motor is determined by the power controller's calculations. When the required power is substantially greater than the motor's maximum power, the motor outputs the maximum power possible. The braking torque remains unchanged during regenerative braking.

2.4 Transmission system
A 5 speed manual transmission is standard on this model. The vehicle speed determines the gear ratio, which follow a simple logic.
A sequence hybrid vehicle transmission combines two power sources to power a single electricity generation unit (electric motor) that drives the vehicle. In hybrid vehicles, a closed loop is widely used. A gasoline tank serves as the initial energy

source, while a combustion engine attached to a generator serves as the energy transfer (power station). The wants to transmit is connected to a DC power bus through a regulation electronic converter (rectifier). A regulated bidirectional power system connects an elevated battery storage to the DC power network.

2.5 System of batteries

To estimate the battery's energy level, the battery system employed a simple energy calculation that average the produced and expended power over time. The battery subsystem are portrayed in the MATLAB/simulink simulation with their starting level of energy & State of Charge (SOC) set at the beginning of the simulation, and then modified depending solely on the motor/power generator's use or output during the simulation**.**

III. RESULT

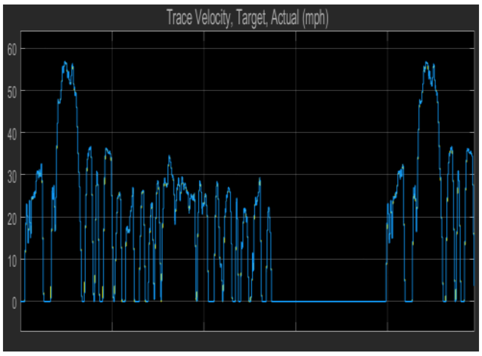

Fig (a): velocity of hybrid electric vehicles

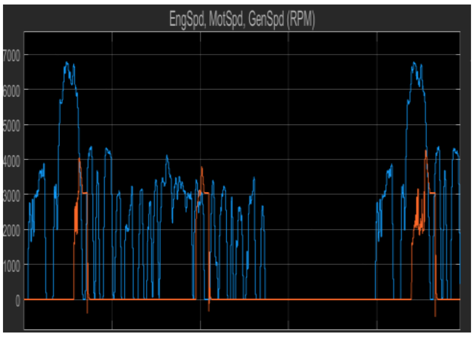

Fig (b): engine speed, generator speed, motor speed

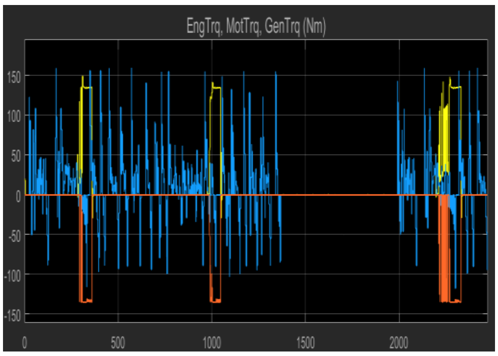

Fig (c): Engine torque, generator torque, motor torque.

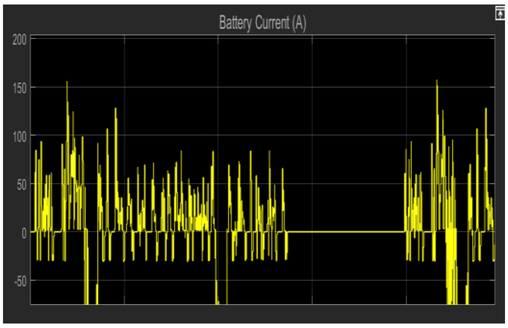

Fig (d): Battery current of a hybrid electric vehicle

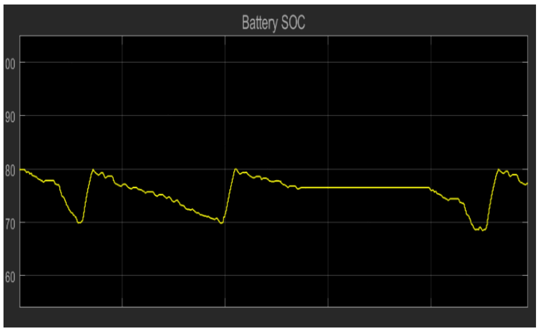

Fig (e): State of charge of a battery

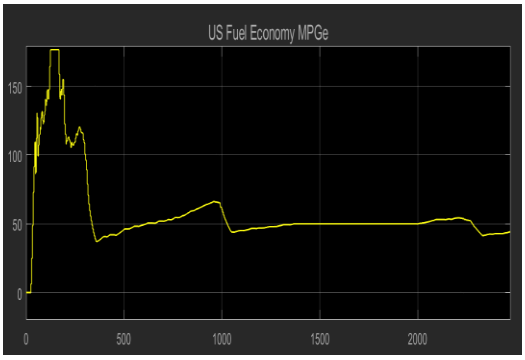

Fig (f): Fuel economy

1. The system's settling time and steady state inaccuracy can be minimized .
2. The hybrid electric vehicle's steady-state performance can be improved.

IV. CONCLUSION

Internal-combustion automobiles are unquestionably more environmentally friendly than hybrid electric vehicles. Batteries are being designed to last for a long time. Battery recycling will become economically feasible as hybrid cars become more common. Other energy sources, like as fuel cells and renewable fuels, are being researched, making the future of hybrid automobiles look brighter.

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