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Modeling of Hybrid Electric Vehicle

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ABSTRACT
With the rise of concerns regarding environmental sustainability and the depletion of fossil fuels, electric vehicles (EVs) have emerged as a promising alternative to traditional internal combustion engine vehicles. This paper provides a comprehensive review of electric vehicles, including their history, current technology, and future potential. The paper covers the key components of an EV, including the battery, motor, and power electronics, and evaluates the performance and efficiency of EVs in terms of range, charging time, and cost. The paper also discusses the challenges and opportunities associated with the adoption of EVs, including infrastructure development, government policies, and consumer acceptance. Finally, the paper provides a future outlook on the development and potential of EVs in the global automotive industry. This review highlights the potential of electric vehicles as a sustainable transportation solution and provides insights into the future of the automotive industry.

Introduction:
A hybrid electric vehicle (HEV) is a type of vehicle that combines an internal combustion engine (ICE) with an electric motor and a battery pack. HEVs are designed to increase fuel efficiency and reduce emissions compared to traditional vehicles that only rely on an ICE for power.
HEVs use the electric motor to supplement the power generated by the ICE, especially during stop-and-go driving, which is where the ICE is least efficient. The electric motor also acts as a generator to recharge the battery pack during regenerative braking. This process converts the energy normally lost as heat during braking into electrical energy that can be stored in the battery for later use.
HEVs come in different configurations, including series, parallel, and series-parallel. In a series configuration, the ICE is used solely to generate electricity to power the electric motor, while in a parallel configuration, both the ICE and the electric motor are used to provide power to the wheels. In a series-parallel configuration, the vehicle can switch between using the ICE, the electric motor, or a combination of the two, depending on the driving conditions.
HEVs offer several advantages over traditional vehicles, including improved fuel efficiency, reduced emissions, and lower operating costs over the vehicle's lifetime. However, HEVs also face challenges such as higher upfront costs and the need for specialized maintenance. Despite these challenges, HEVs remain a popular choice for consumers who are looking for a more sustainable and fuel-efficient vehicle option.
Literature Survey:

i. "Design and control of a hybrid electric vehicle power train for efficiency optimization and drivability enhancement" by Y. Gao et al. (2019):

This paper proposes a novel HEV power train design and control strategy that optimizes both efficiency and drivability. The authors use a combination of simulation and experimental testing to evaluate the performance of the power train.

ii. "A review of power train architectures for hybrid electric vehicles" by M. Omar et al. (2019):

This paper provides a comprehensive review of the different power train architectures used in HEVs, including series, parallel, and series-parallel hybrid systems. The authors discuss the advantages and disadvantages of each architecture and provide insights into the future development of HEV technology.

iii. "Design and analysis of hybrid electric vehicle powertrains using dynamic programming" by D. Kim et al. (2018):

This paper proposes a dynamic programming-based design methodology for HEV powertrains that optimizes both fuel economy and performance. The authors use simulations to evaluate the performance of the proposed methodology and compare it with other optimization techniques.

iv. "Battery management systems for hybrid electric vehicles: A survey" by C. P. Tan et al. (2018):

This paper provides a survey of battery management systems (BMS) used in HEVs. The authors discuss the key functions of BMS, including state-of-charge estimation, thermal management, and cell balancing. They also provide insights into the future development of BMS technology.

v. "Market penetration of hybrid and electric vehicles" by J. Axsen et al. (2019):

This paper investigates the factors that influence the market penetration of HEVs and electric vehicles (EVs). The authors use a combination of survey data and statistical analysis to explore the impact of consumer preferences, government policies, and market dynamics on HEV and EV adoption.

vi. "Optimal sizing of a hybrid electric vehicle using dynamic programming and genetic algorithms" by A. Saberi et al. (2017):

This paper proposes a methodology for optimal sizing of HEVs using dynamic programming and genetic algorithms. The authors evaluate the performance of the methodology on a test case and compare it with other optimization techniques.

vii. "Eco-routing strategies for hybrid electric vehicles: A review" by C. Yang et al. (2019):

This paper provides a review of eco-routing strategies for HEVs, which aim to minimize fuel consumption and emissions by optimizing the vehicle's route. The authors discuss the different types of eco-routing algorithms and provide insights into their performance and limitations.

viii. "A review of electric and hybrid vehicle energy management strategies" by M. A. Aziz et al. (2020):

This paper provides a comprehensive review of energy management strategies for electric and hybrid vehicles. The authors discuss the different types of energy management strategies, including rule-based, optimization-based, and model-based approaches, and evaluate their performance in different driving scenarios.

ix. "Model predictive control for energy management in hybrid electric vehicles: A review" by J. Liu et al. (2018):

This paper provides a review of model predictive control (MPC) strategies for energy management in HEVs. The authors discuss the key features of MPC-based control strategies and evaluate their performance in different driving scenarios.

x. "Optimization of hybrid electric vehicle powertrains using multi-objective evolutionary algorithms" by K. B. Kavitha et al. (2019):

This paper proposes a methodology for optimizing HEV powertrains using multi-objective evolutionary algorithms. The authors evaluate the performance of the methodology on a test case and compare it with other optimization techniques.

Proposed Work:

The methodology of electric vehicles can be broadly divided into three main areas namely Battery technology, Electric Motor, and Power Electronics:-

1. **Battery technology:**

Electric vehicles or EVs rely on rechargeable batteries to store energy for propulsion. The performance of an EV is heavily dependent on the Battery technology used. Lithium ion batteries are the most commonly used batteries in electric vehicles due to their high energy density, long lifespan, and low self-discharge rate. Other type of batteries used in EVs includes lead acid battery, nickel-metal hydride batteries and solid state batteries.

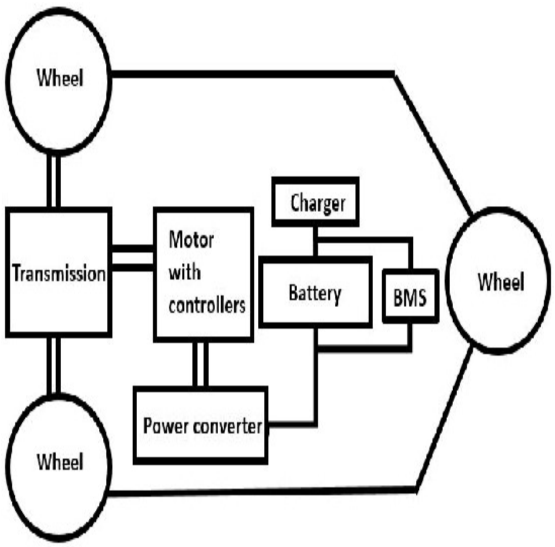
2. **Electric motors:**

The electric motor is the main component responsible for converting the stored electrical energy from the battery into mechanical energy to propel the vehicle. Electric motors are highly efficient, have instant torque, and require less maintenance than internal combustion engines. The most commonly used types of electric motors in EVs are AC induction motors, permanent magnet motors, and switched reluctance motors.

3. **Power Electronics:**

The power electronics system controls the flow of electrical energy between the battery and the electric motor. The system includes components such as DC- DC converters, inverters and controllers. The power electronic system is responsible for regulating the voltage and current supplied to the motor to ensure optimal performance and efficiency.

Overall, the methodology of electric vehicles involves integrating these three components to create an efficient and reliable electric vehicle. As battery technology improves, electric motors become more powerful and efficient and power electronics become more advanced, the performance and affordability of electric vehicles will continue to improve.



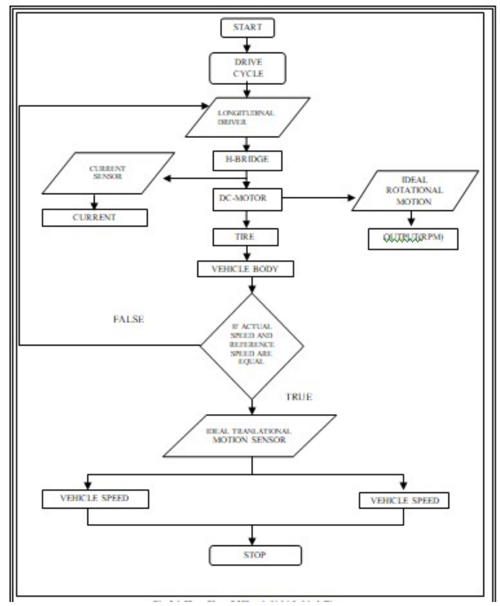


Fig.1 Block diagram **Fig.2 Flow Chart of EV modellingWorking:-**

Electric vehicles (EVs) are powered by one or more electric motors, which are usually powered by rechargeable batteries.

1. **Battery Pack:**

The battery pack is the heart of an electric vehicle. It stores the electric energy required to power the electric motors. Battery packs are made up of many individual battery cells, which are connected together to form a high-voltage battery.

2. **Electric Motor :**

Electric motors are used to convert electrical energy into mechanical energy which propels the vehicle. EVs can have one or more electric motors, depending upon their design.

3. **Power Electronics:**

Power electronics are used to control the flow of electrical energy between the battery and the electric motor. This includes the inverter, which converts the dc power from the battery into AC power that can be used by the electric motor.

4. **Charging System:**

Electric vehicles can be charged using either AC or DC power. The charging system includes a charger, which converts the AC or DC power from the charging station into DC power that can be stored in the battery pack.

5. **Regenerative Braking:**

Regenerative braking is a feature of many electric vehicles that allows them to recover energy while braking. When the driver applies the brakes, the electric motors acts as generators, converting the kinetic energy of the vehicles into electrical energy that is stored in the battery.

6. **Electric Vehicle Control unit(ECU):**

The ECU is the brain of the electric vehicle controlling the various systems and components of the vehicle. It manages the flow of electrical energy between the battery, electric motor and other systems and monitors the performance of the vehicle.

Overall, the electric vehicle operates in a similar way to a conventional vehicle, with the main difference being the source of energy for the motors. Instead of burning fossil fuels, electric vehicles rely on stored electrical energy to power the motors and move the vehicle.

Result :-

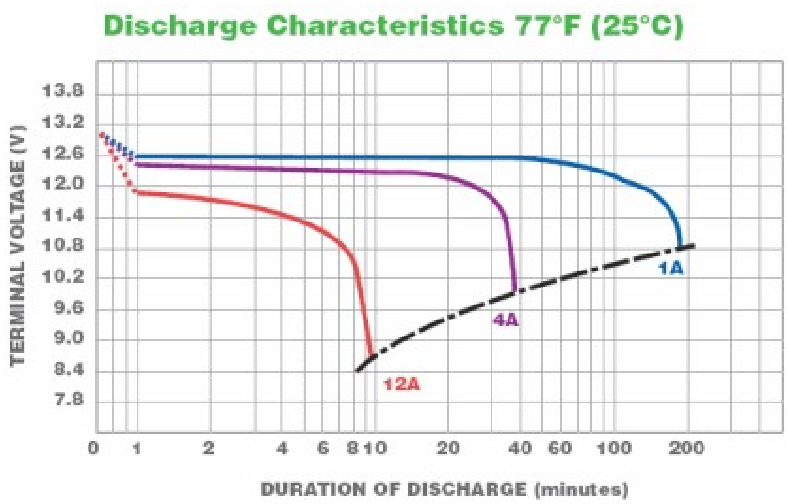
Following results were obtained in the design and construction of an electric vehicle:

1. Data analysis:

For the evaluation of the Electric Vehicle Data we have charged the battery of the vehicle fully and tested for the voltage drop and also drive the vehicle unless the battery drains fully.

2. Performance measurements:

For performance measurement we have driven the vehicle at different speed levels , on slopes , on down hills, at different road conditions. After performing all the mentioned tests we obtained following **characteris**



4. Charging analysis:

i. Charging current:

The charging current was about 6 Amperes.

ii. Charging voltage:

The charging voltage for 4 batteries of 12 Volts 32Amph which is equals to 48 Volts 32 Amph when connected in series is approximately equal to 56.5~ 57 Volts.

iii. Charging time:

The charging time for 4 batteries of 12 Volts ~ 48 volts is approximately 6 Hrs.

iv. Temperature:

The battery temperature was about 50°C~ 55°C.

Future Scope:

Today the world is moving fast towards the more operative and well-organized smarttechnology by switching the current time worn technologies by the smart technology. Thus we can make use of both the expertise in order to make the present more operative and well organized. In addition to that there are many such benefits of using technology. Many current problems that are present in the existing era can be resolved easily. The motive of the paper is to enhance the life of people and sharing of knowledge that the idea of design can be modified by analyzing the basic needs of the people or the world.

Results:

This system is implemented by using digital multidisciplinary technology using 3D experience platform of Dassault Systems. It is based upon the operation of an electric vehicle in different ways other than the traditional way of use. Motor and controller are connected to battery pack and the throttle is used as a medium to accelerate or de accelerate the motor speed. The use of the EV technology has helped in the easy execution of the vehicles for the physically challenged people. This can also be implemented in various other sectors of the society with different design as required and as an alternative for the conventional source of energy use and for the betterment of the society.

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