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Hybrid Electric All-Wheel Drive System

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Abstract:- The development of electric vehicles was spurred by the environmental consequence of Internal Combustion Engine automobiles in the recent decades. One of the many advantages of electric vehicles over conventional internal combustion engine (ICE) vehicles is that, these vehicles do not release carbon dioxide into the air. The world is shifting to electric cars (EVs) as a new, better form of transportation due to its many advantages over conventional internal combustion engine (ICE) vehicles. In comparison to that electric vehicles have less operating and maintenance costs, and their The efficiency of tank to wheel is three times greater than that of internal combustion engine vehicles. The problem statement lists the major drawbacks of electric vehicles, despite the fact that they are the best option. Our plan combines the main advantages and benefits of both technologies in an effort to close the gap between pure electric and conventional internal combustion engine cars. Making any current internal combustion engine vehicle as efficient as possible is the primary objective of the project. Our car can simply run on two different sources of energy, or perhaps both at once. It can operate as a hybrid AWD car (when a great level of power is required), a pure electric vehicle, or a pure Internal Combustion Engine vehicle. Research indicates that the typical urban resident drives their automobile for no more than 25 kilometre a day and leaves it parked most of the time. That person may therefore go that distance entirely on electricity, and our car's solar energy system will replenish the energy used while driving. The individual will therefore be able to produce sustainable energy using our car at no cost to them. Our vehicle's use will definitely have a big impact because the use of ICE vehicles is quickly increasing environmental pollution. The fact that most power is still produced by burning coal makes even fully electric vehicles (EVs) an indirect source of pollution.

Keywords:- *Li-ion Battery System for HEV, Electric Car, Hybrid Vehicles, Transformation Equipment for IC Engines to EVs.*

I. INTRODUCTION

The environmental effects of IC Engine autos in the last two to three decades stimulated the production of electric cars. The fact that electric vehicles do not release carbon dioxide into the atmosphere is just one of their numerous advantages over internal combustion engine automobiles. With three times the tank to wheel efficiency of internal combustion engines (ICE) and extremely low operating and maintenance costs, electric vehicles are rapidly replacing conventional ICE vehicles as the primary means of transportation in the global economy. Electric vehicles have several disadvantages, despite being the best choice, which are listed in the problem statement. Our concept is solely focused on bridging the gap between traditional ICE vehicles and pure electric vehicles by combining the main beneficial aspects of both technologies. The project's main goal is to transform any current internal combustion engine car into the best possible vehicle. In essence, our car can operate on two separate, independent energy sources or even combine the use of both; it can operate as a hybrid all-wheel drive (AWD) car, a pure electric car, or a pure ICE car (when a lot of torque is needed).

It has been noted that the typical city individual seldom drives more than 28-30 kilometers each dayand that most of the time the car is in the parking. Therefore, in pure electric mode, that individual may realistically travel that distance, and our car's solar energy technology will replenish the energy used for driving. Thus, the car will be able to renewable energy because of our designed technology. ICE vehicles are causing pollution in the atmosphere to spread quickly. Even fully electric vehicles (EVs) contribute to pollution indirectly most of the electricity is produced using coal. Using our Vehicles will definitely have a big influence on this.

II. PROCEED TO EXPLAIN BRIEFLY ABOUT MODES IN LIGHT OF A SITUATION

A. Pure ICE mode

Due to EVs' poor range and the scarcity of charging stations, those who need to travel long distancescannot rely only on their car's electric power or mode, and even in those cases, they must wait hours for their car to be charged. Therefore, the user can use the pure ICE mode to travel as far as he wantsto cover on gasoline or diesel in order to get over this specific problem.

B. The only electric mode

A person can choose the pure electric mode, which uses solar energy to power the car's rear electric motors, when they need to travel a shorter distance—roughly more than 100 km. As was previously said, this is the most efficient option.

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C. AWD hybrid mode

When the driver needs high performance, torque, and speed that the electric motors cannot provide,the car's engine will help the drive and the work is done jointly. Because the car has all-wheel drive (AWD), the driver can drive on highways and in off-road areas without worrying about the motors' limited power. The primary function of the hybrid AWD type is the fuel-saving cylinder cut-off technology. When it happens, the cylinder will be cut off since the driver does not want to use too much power, saving gasoline.

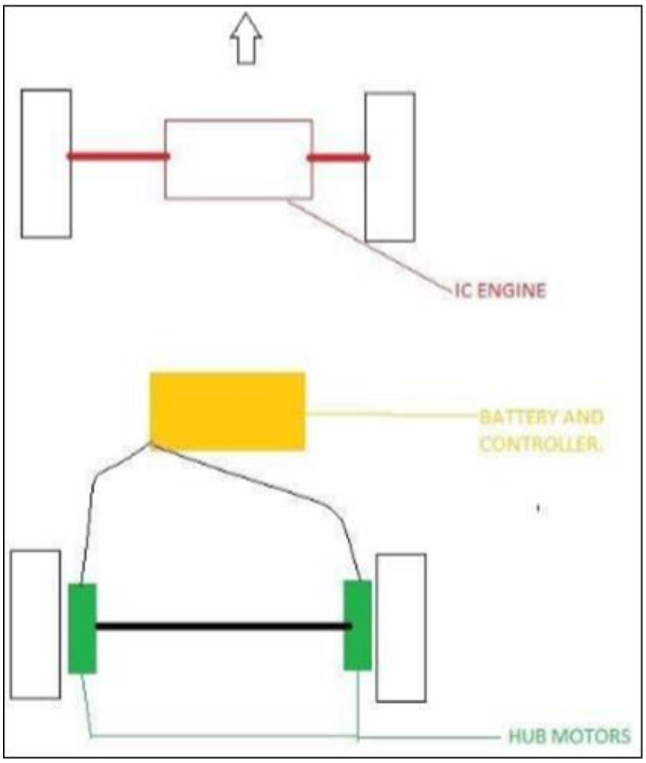

Fig 1 Illustration of Design

III. CALCULATION

A. Tractive force calculation

It has been noted that the rear wheels, which were previously freely free, are the greatest location to apply additional power without jeopardizing the car's structural integrity. The new power source, or the source that will produce power, needs to be robust and ideal for the car. Now, in order to obtain the best power, we must take into account the various forces and resistances that the vehicle would encounter both fixed and moving. The precise power and torque needed can be found using the computation below.

Vehicle Specifications Weight = 800 kg Length = 3335 mm Width = 1440 mm Height = 1475 mm

Area = height X width = 1475 mm X 1440 mm = 212400mm^2 = 2.124 m^2

Radius of wheel = 0.3 m Linear travel of wheel = 1.9 mVelocity = 11.11 m/s

RPM needed = 350 Gravitational force = 9.81 m/s

Coefficient of rolling resistance = 0.02 Air density = 1.23

Coefficient of drag = 0.41We know,

Rolling = mass X gravitational force X velocity X rolling Resistance

P drag = air density X drags X a X v^3 PGradient = m X g X sin10 X v

Power = (m x g x v x rolling R) + (air density x drags x a x v^3) + (m x g x sin10 x v)

= (800x9.8x11.1x0.02) + (1.23x0.41x2.1x11.1x11.1x11.1) + (800x9.8x0.17 x 1)

= **4521.64 W**.

Calculating the Torque required

Torque = power X 60/ (2 X 3.14 X N)
= 4521.64 X 60 /(2 X 3.14 X 350)

Torque = 123.42 Nm.

B. Design of Battery and Calculations

Given: Power = 6KW and 72V. For motor

Find out the current (in Amp.) consumed by a motor to run-

P = V X I

6000 = 72 x I

I = 83.33 A (theoretically)

The watt hour of thebattery to run 6000- watt motor for 1 hour

= 6000 X 1

= 6000-WHR.

Taking efficiency of battery about 85% i.e., 6000/0.85 = 7058.8- WHR

Step 3: Convert watt hr. of battery into amp. Hr. of battery

P = V X I 7058.8 = 72 X AH.

Amp hr. = 98 A Hr.

IV. DESIGN CONCEPTS AND USED METHODS

A. Motor

It has been noted that the rear wheels, which were previously freely free, are the greatest location to apply additional power without jeopardizing the car's structural integrity. In order to obtain the best power possible, we must take into account the various forces and resistances that the vehicle will encounter both when it is stationary and while it is moving. This means that the new power source or the source that will generate power needs to be robust and ideal for the vehicle.

Taking into account the aforementioned variables, the required power, accounting for rolling resistance, air drag, and gradient resistance, is less than 4521.64 watts.

Additionally, we may obtain the necessary torque—123.42 nm—by using power.

The motor to choose now must meet the aforementioned requirements while adhering to the aforementioned constraints.

The required power and torque of the engine will now be calculated based on changes in the vehicle's weight, acceleration, speed, air drag, and other characteristics.

Two 3000 KW BLDC hub motors now fit the necessary power and torque specifications for our prototype vehicle. Below is a detailed specification of the motor.

Table 1 Motor & Battery Specification

Steady Power	3000 W
Max. Power	8000 W
Max Torque	180 NM
Constant Torque	80-90 NM
Supply current	DC
Current used per hour	41.66 A
Voltage Used	72 V
Motor Used	Brushless

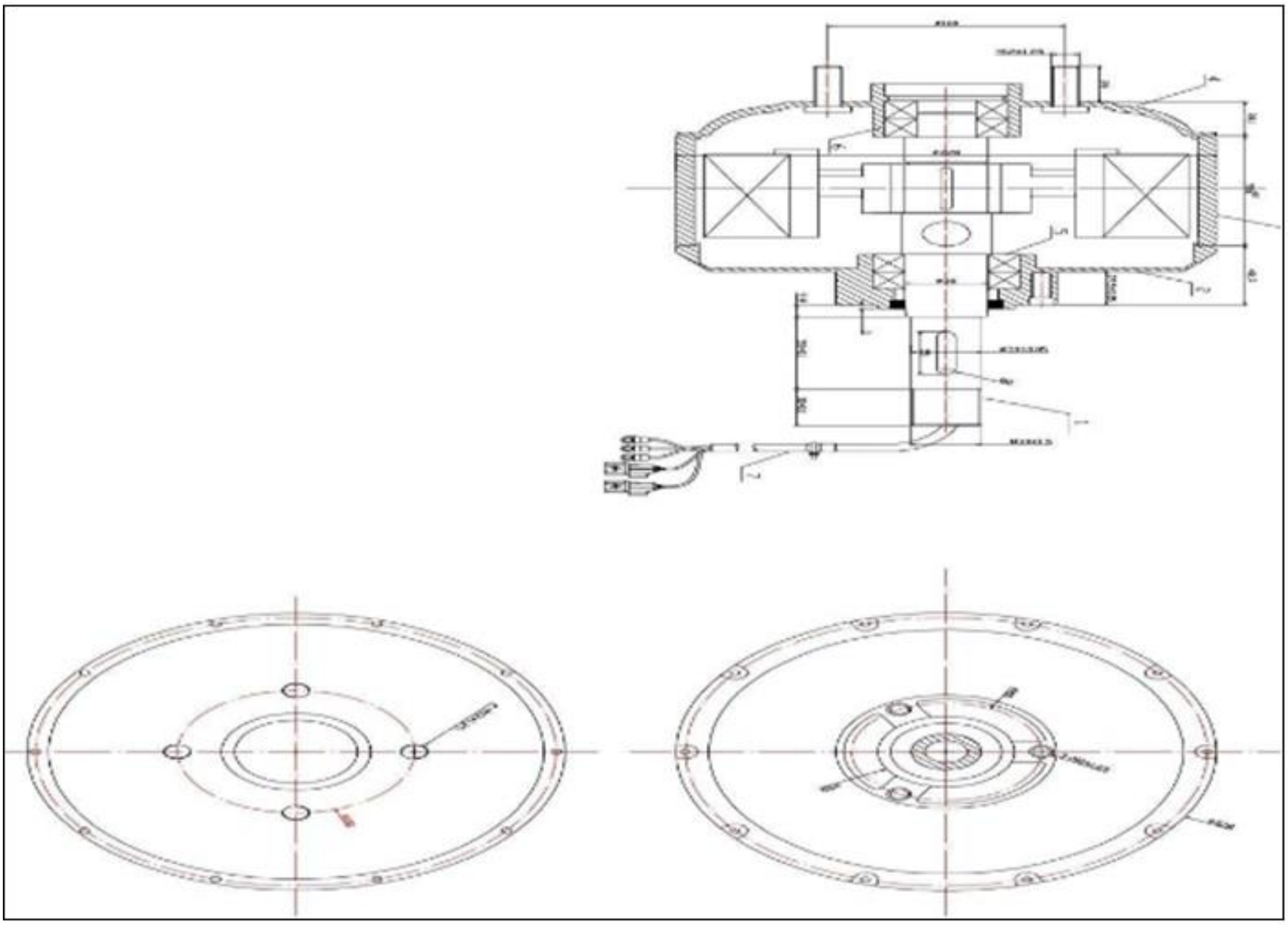

Fig 2 BLDC Hub Motor

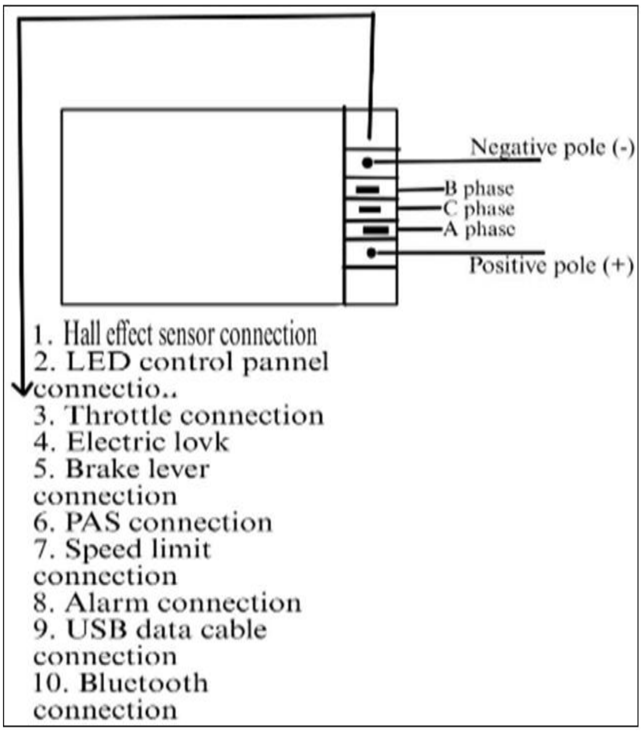

Fig 3 Controller Connections

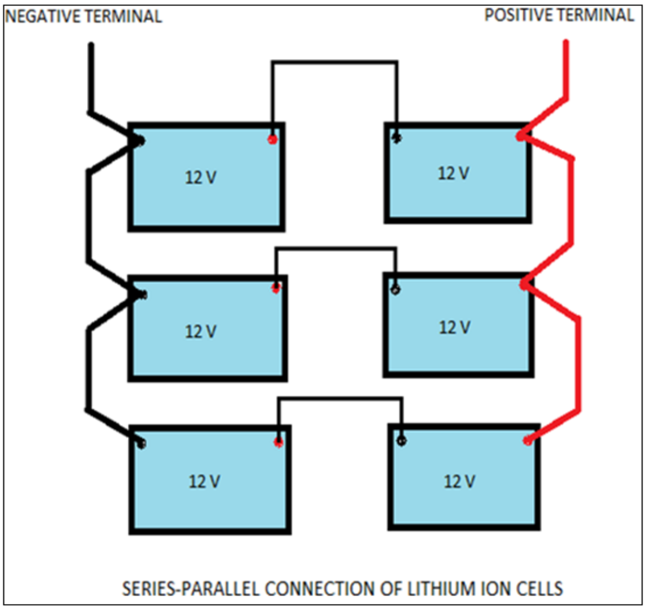

Fig 4 Battery Connections

B. *Virtual Differential*

The purpose of a differential, which is essentially a set of gears, is to distribute and transmit power to both shafts. Additionally, when a vehicle is turning, its inner wheels rotate at a lower speed than its outer wheels. This problem is resolved by the bevel gears, which are crucial in causing both wheels to rotate at different speeds during the turn.

It is challenging to fit a PMS (mid-drive motor) and a differential linked to it because we are not using a rear differential in our situation, unlike passenger automobiles that are front-wheel drive and have a fuel tank positioned close to the back axle.

Because hub motors take extremely little space and can be controlled independently, that is why we have decided to utilize them.

To regulate each motor separately, the idea/approach that follows will be applied.

- Both ICE and electric motors will be controlled by a single accelerator pedal.
- The raspberry pi module will get the input from this accelerator in addition to inputs from thesteering as it is equipped with an angle sensor.
- Depending on the steering angle, this Raspberry Pi module will deliver current to each motorseparately.
- As the car is being turned, the angle sensor will feed information to the Raspberry Pi, which will then adjust the motor of the inner wheel by reducing the current based on the steering angle.

Therefore, we can offset the need for a difference using this strategy.

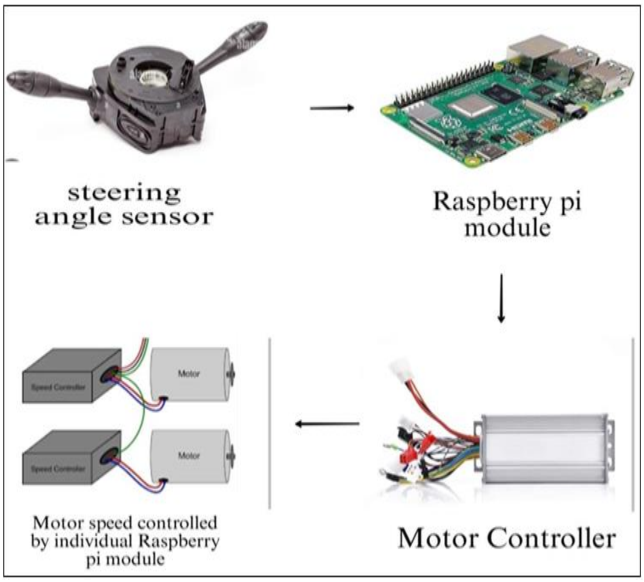

Fig 5 Control System

C. *Cylinder Cutoff*

An automobile with a multi-cylinder internal combustion engine will employ this technology in hybrid mode. Utilizing this technology is mostly done to lessen carbon footprint and fuel usage. When the user or driver selects the vehicle's hybrid mode, this system will activate. When the hybrid mode is activated, the engine control unit (ECU) determines whether to turn off one or more cylinders in IC engines with four, six, or more cylinders based on an analysis of the engine speed, vehicle speed, and selected gear.

By closing a cylinder or cylinders, the engine can work at low RPM and torque outputs since the electric motors will be partially supplying the needed energy. This will conserve fuel because therewon't be any combustion occurring in that cylinder.

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This is how the system will operate:

- The ECU begins analyzing power requirements based on engine speed, vehicle speed, and selected gear as soon as the operator enters hybrid mode.
- The ECU will shut off a cylinder or cylinders by locking the intake and exhaust valves and cutting off the fuel supply to that cylinder or cylinders if the power required is less than
- The electric motors will offset the power required, lowering the amount of fuel used and greenhouse gas emissions.

D. Remote Parking

Car parking is a major issue in densely populated nations like India. Even with a parking place, there are moments when there is so little room between two cars that it is difficult to even open the doors. Therefore, you can operate your car using the remote parking option without ever getting inside. This place allows you to do a number of things, such driving forward and backward, steering left and right, and using the brakes from the outside of the car only using a key that is specifically made for it. The Raspberry Pi will calculate all the data it receives from the user's specialized key and then carry out the necessary operations by providing input to actuators and motors.

The main parts of the car are represented by the diagrams below.

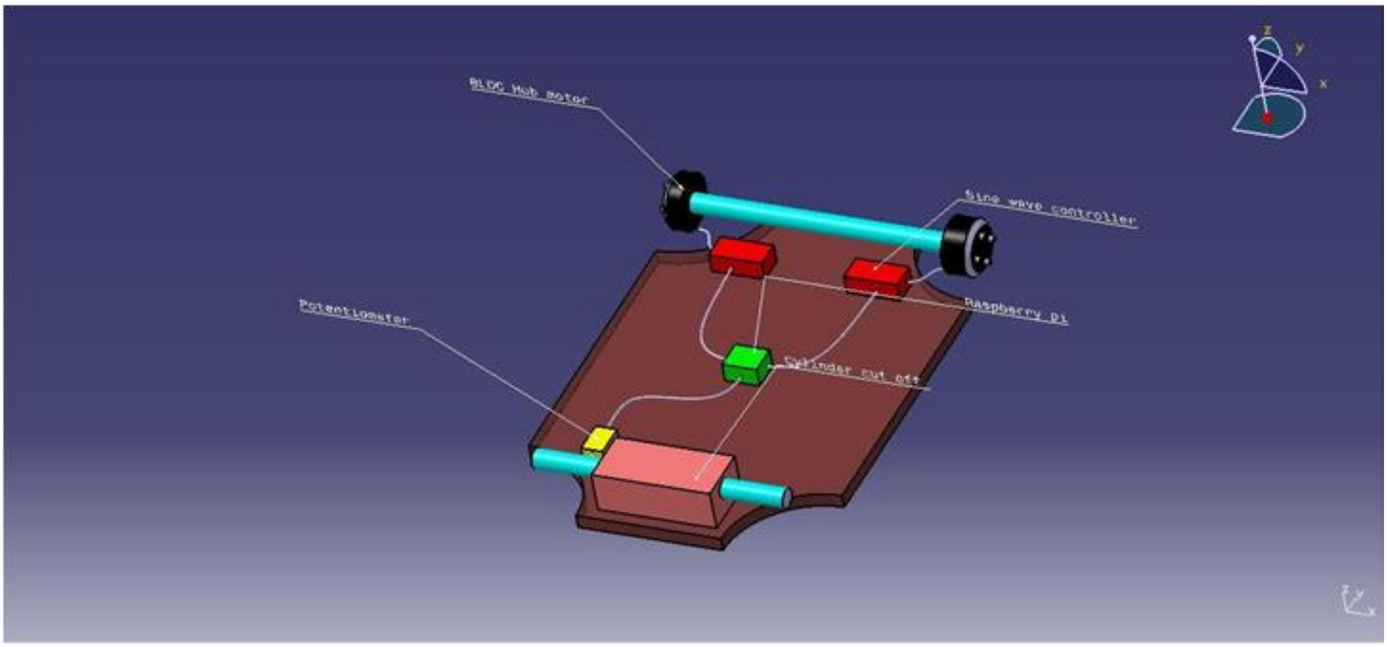

Fig 6 Basic Block Diagram of Components in the Vehicle

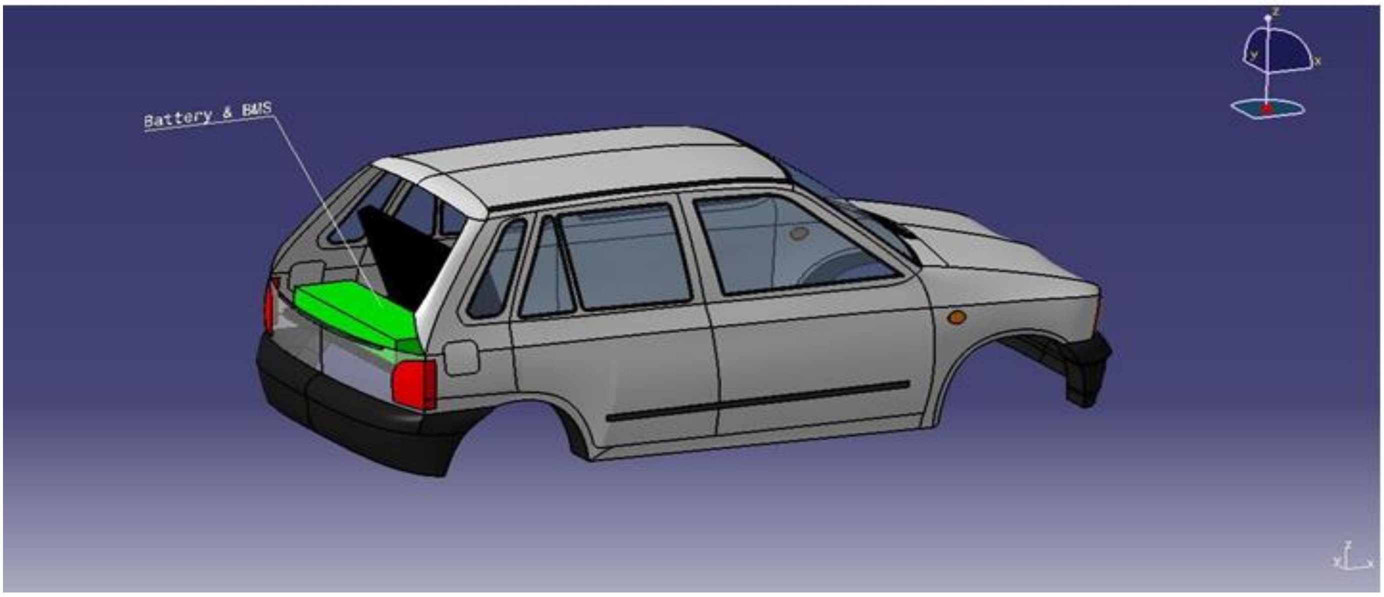

Fig 7 Placement of Battery without Compromising Much Boot Space

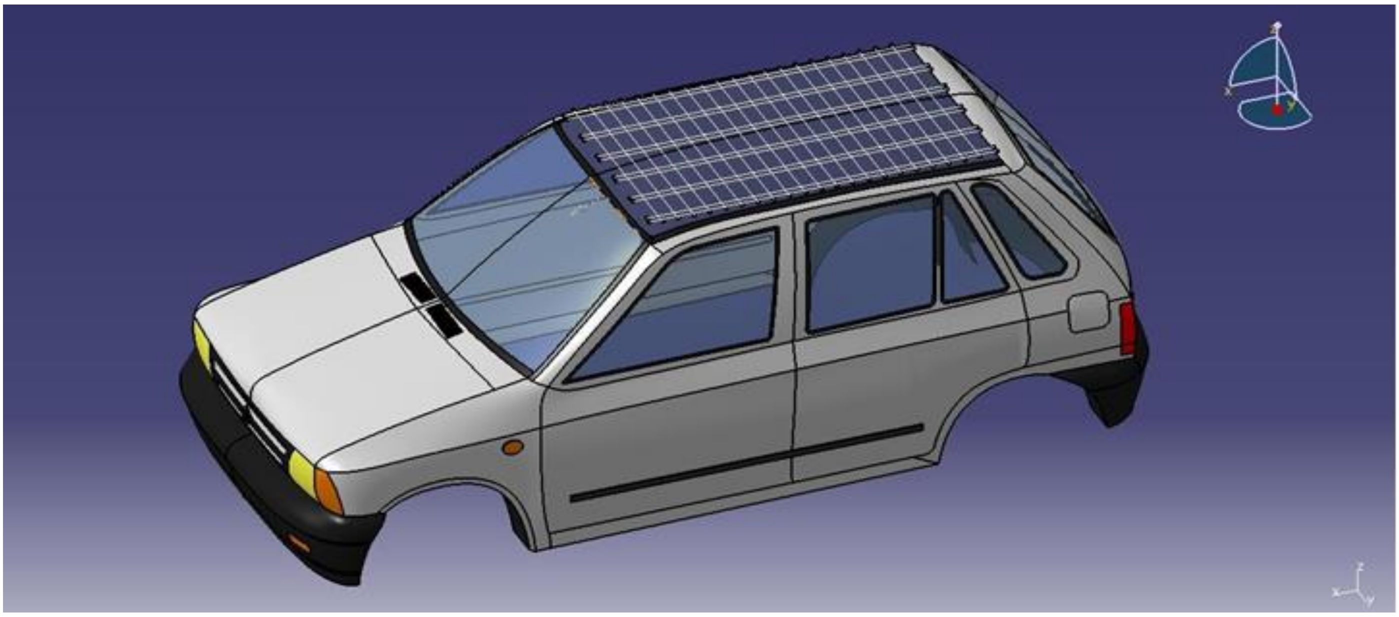

Fig 8 Placement of Thin Solar Panel Sheets

E. Controller

For our necessary operation, a programmable sine wave controller is being chosen. It will support current up to 100 A and intelligently match each motor through self-learning. Additionally, the controller will contain protection against overheating, overcurrent, under voltage, and so forth.

➢ *Special features*

- Smart match / synchronization
- 3 level speed
- Reverse
- Anti-theft
- Regenerative braking
- Electric braking
- Keyless start General speciation

✓ Power supply = 60V
✓ DC current = 100 A
✓ Max phase current = 250 A
✓ Rated power = 3500 W to 5000 W
✓ Peak power = 8000 W
✓ Detecting = Hall sensor

➢ *Advantages*

- The motor can be well matched on its optimal electronic angle the first time in as little as two to three minutes.
- There will be less noise and vibration because the motor torque ripple will be minimized.
- The exact current ring can supply precise torque input to fulfill the need for high torque output during vehicle acceleration and ascent.

F. Raspberry pi

The Raspberry Pi will serve as our car's brain, assisting us in carrying out and computing a variety of tasks. For instance, the car has a remote parking feature that allows the user to operate the vehicle without getting inside with a modified key. The function includes steering the car left and right as well as forward and backward. The Raspberry Pi will handle all of these tasks.

When in all-wheel drive (AWD) mode, all wheels will be turning, but they will be powered by two separate sources: the engine will drive the front wheels, while electric motors will drive the rear wheels. This will cause a discrepancy in wheel synchronization, which can be fixed with raspberry pie. Essentially, we will measure and record the wheel speed at various ratios and acceleration levels,then enter all the data into the Raspberry Pi. Whenever a gear shift occurs, the Raspberry Pi will adjust the electric motor power appropriately.

The specification of raspberry pi will be:

Table 2 Raspberry Pi Controller Specification

Processor	Broadcom BCM2711, quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
Memory	1GB, 2GB, 4GB or 8GB LPDDR4 (depending on model) with on-die ECC

Table 3 Raspberry Pi Controller Specification

GPIO	Standard 40-pin GPIO header (fully backwards-compatible with previous boards)
Input power	5V DC via USB-C connector (minimum 3A1) 5V DC via GPIO header (minimum3A1) Power over Ethernet (PoE)–enabled (requires separate PoE HAT)
Working environment	Operating temperature 0–50ºC

G. Battery

The project's most important component is the battery, which determines how far your car will travel. Batteries are essentially collections of electrochemical cells that store energy—specifically, electrical energy—that may be used as needed.

We required a battery for our research that was not only lightweight but also very energy dense, with respectable life cycles and little charging time. Therefore, the lithium-ion battery was the best option for the task.

A lithium-ion battery is one that transfers chemical energy using lithium as a major component.

Table 4 Battery specifications

Nominal Voltage	3.6 V
Full Charge	4.2 V
Full Discharge	3 V
Minimal Voltage	2.5 V
Specific Energy	150-200 WH/KG
Charge Rate	0.7-1 C
Discharge Rate	1C
Ideal Life Cycle	500-1000

We may now link many cells in parallel and series to provide the necessary power, current, and voltage for the motor and other electronics by taking multiple cells and arranging them according to the required range.

V. BATTERY MANAGEMENT SYSTEM

A battery management system allows users to keep track of particular cells inside a battery pack. Stability across the whole pack is critical since cells work together to deliver energy to the load. In this case, a battery management system (BMS) comes in handy. A Battery Management System (BMS) enables continuous observation, data gathering, and transfer to an external interface, allowing users to examine the state of individual cells as well as the overall health of the battery pack. A battery management system (BMS) monitors and manages a battery pack to avoid damage, increase battery life, and keep the battery within safety boundaries. These attributes are critical for efficacy, dependability, and safety.

VI. ACCELERATOR FOR HYBRID CAR

In an electrical car, a potentiometer is a potential device that generates an electrical signal; an accelerator is a device that provides power to the engine. Now, while our automobile is in hybrid mode, it will operate simultaneously on an internal combustion engine and an electric motor. To address this problem, we have created a brand-new, user-friendly throttle that is effective and efficient and can be used to operate both internal combustion engines and electric motors. This basically means that the customer will have to deal with two distinct sources and two separate throttles, which won't function while the car is in hybrid AWD mode.

VII. SOLAR PANEL

One of the strongest forms of energy that we have access to is solar energy. The heat and radiant light from the sun can be captured by a number of technologies that we can employ to create electrical energy. As we've already discussed, the average city dweller doesn't drive their car more than 25 kilometers a day, and they spend the majority of their time parked. For these reasons, solar energy is a vital component of our project since we use it to charge the cars and attempt to make them clean energy vehicles. Our goal is to use clean solar energy to charge the car as much as possible so that the user can drive it for free for at least 25 kilometers per day. The challenge now was to install the solar cells on the car while maintaining its structural integrity and good looks without sacrificing power output. Therefore, after taking the necessary safety measures, we will employ thin, flexible solar panels that will be mounted on the car's roof and hood. The panels' specifications are listed below.

Table 5 Solar Panel Specification

Power	600 W
Thickness	2 mm
Voltage	12 V
Type	Monocrystalline

VIII. EFFECTS ON ENVIRONMENT

A. Environmental Life Cycle Assessment of ICE & Electric Vehicles

A person primarily has four possibilities while searching for an automobile for his daily commute: purchasing a new car (Car B) a used car (Car A)

Purchase of an electric vehicle (Car C)

Deciding to convert a regular gasoline car to a hybrid vehicle

When selecting from the four options stated above, the environmental impact is displayed in the table below:

Table 6 Environmental Life Cycle Assessment of ICE & Electric Vehicles

Parameters	Car A (USED)	Car B (NEW)	Car C	HybridCar
Energy Source	Gasoline	Gasoline	Electric	Hybrid
Fuel Economy (KMPL)	10	14.9	-	-
Production Emissions (Kg CO2)	0	9000	10400	850
Driving Emissions (Kg CO2/Km)	0.400	0.286	0.125	0.175
Total Driving Emissions(KG CO2) 12000 km/year	4800	3429	1500	2100
Total Emission Production +Driving	4800	12429	11900	**2950**

IX. COMPARISON OF DRIVING EMISSION

When comparing CO2 emissions for vehicle options, used cars and electric cars have lower production emissions, with electric cars emitting the most. For driving emissions, electric cars emit the least, while used cars emit the most. Assuming hybrid cars are primarily used for city commuting, and an average annual distance of 12,000 km, hybrid cars have the lowest overall emissions. Thus, converted used cars to hybrids may offer an environmentally-friendly option, considering both production and driving emissions.

X. CONCLUSION

The latest advancements in the electric car business are greatly needed given the rising levels of greenhouse gases in the world, not to mention how much appreciated they are. The advantages of electric cars much outweigh the disadvantages. The primary financial barrier preventing the mass adoption of electric vehicles is the low cost and widespread availability of gasoline and its-powered vehicles. The transition away from traditional fuel-powered cars is expected to be aided during the next 10 years by technological advancements and policy changes. In addition, a significant factor in the realization and prosperity of this enterprise is the global population. In order to empower and inspire people to use electric vehicles, we plan to implement extensive marketing and environmental education campaigns. Take a stand against global injustice by becoming electric! Each person has the power to change the world!

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