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Review of Auto-Charging E-Vehicle with its Battery Management

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Abstract: "Energy Cannot Be Created nor Annihilated" as per the thermodynamics law. Attempting to harness the maximum energy from auxiliary power sources (solar) is a formidable task. In traditional electric vehicles, there is only a single accumulator which charges through electricity from the wall, and the car operates from the same accumulator. This leads to a limited range and necessitates searching for charging stations, even in some electric vehicles where they add solar panels to charge batteries while the vehicle is in motion, resulting in inefficient charging and battery heating. Consequently, a switching circuit model is being developed. As we all recognize, there are common issues with electric vehicles, one of which is charging time. For instance, the minimum charging time for an electric vehicle is 6-8 hours, during which they should cover a specific distance. Our project is centered on this; we aim to create a type of vehicle that can self-charge with unlimited distance capabilities. As a result, the charging time should be minimized or eliminated. In this endeavor, we aim to devise a controller that can manage the charging and discharging of batteries simultaneously. The controller may utilize either hard switching or soft switching techniques. Additionally, the provision of batteries for charging should be facilitated by the gear coupling of the generator on the vehicle shaft. Through the development of this type of vehicle, we can regulate global pollution as well as the energy demands on charging stations.

Keywords*:* EV's Project, New E-Vehicle, New Innovation, New Concept E-vehicle, Electrical Engineering Project.

I. INTRODUCTION

In the project we are addressing the issue with the charging time of electric vehicles, which is significantly lengthy, requiring them to cover a specific distance within that time frame. Our solution involves making the electric vehicle auto- charging, thereby enabling it to travel an unlimited distance.During the project, we must consider the various ratings of motors suitable for the vehicle and batteries capable of sustaining the motor load.

The fundamental concept of our project entails using a generator, which can be either AC or DC. We connect the generator to the vehicle wheel shaft through a gear mechanism, ensuring that this coupling doesn't impact the speed and efficiency of the vehicle. Regarding the batteries, they are divided into two sections, labeled A and B. One of these batteries serves as the main battery, while the other acts as an auxiliary battery.

The main battery bears the motor load, while the auxiliary battery is responsible for charging. When the main battery is fully discharged, the motor load shifts to the auxiliary battery, and the main battery enters the charging phase using the controller. Another switch occurs when the motor load increases, transitioning all batteries from parallel to series operation to handle overload conditions. The entire switching process is managed by a controller.

Switching can be accomplished through two methods: hard switching and soft switching. Soft switching is implemented using advanced-level programming controllers, while for hard switching, we employ the rack-pinion method, controlling their movement through micro-controllers.

II. METHODOLOGY

The following block diagram shows the working path and simple working methodology of out project.

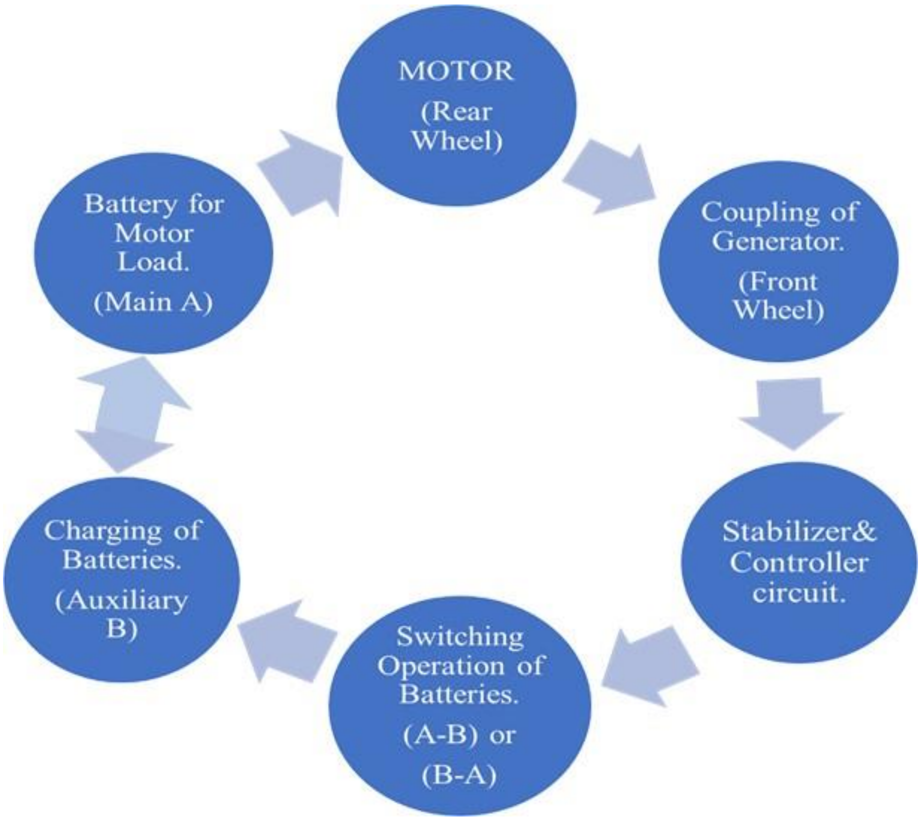

Fig. 1 Methodology of projectThe paper Survey regarding to the project as follows :-

First , gather the information about the opinion regarding to the current E-vehicle and problems in EV's, searched the literature regarding to project used as a base if it is need full.

The literature used in the project as :-

AIP Publishing-Switching of battery and charging the subsequent one in vehicle.
V. Ra. Nitharshan,V. Ra. Nitharshan.
-School of Mechanical Engineering, Vellore Institute of Technology,Chennai, India.

INFORMS- Optimization of Battery Charging and Purchasing at Electric VehicleBattery Swap Stations.
Frank Schneider , Ulrich W. Thonemann, Diego Klabjan

MDPI -Dual Battery Control System of Lead Acid and Lithium Ferro PhosphateWith Switching Technique.
Muhammad Nizam, Hari Maghfiroh, Fuad Nur Kuncoro and Feri Adriyanto

III. WORKING

The project is centered around the development of an Electric Vehicle (EV) by modifying the workings of conventional Battery Electric Vehicles (BEVs). Our aim is to create a new type of EV that does not require charging at charging stations, thereby reducing or eliminating charging time, and potentially increasing the distance covered by the vehicle to an unlimited extent. We have implemented this concept into a small working prototype.

The working principle involves two batteries: the Main Battery and the Auxiliary Battery. The Main Battery supplies power to the

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vehicle, while the Auxiliary Battery remains in a charging or fully charged state.
A controller supervises the condition of both batteries. When the Main Battery reaches its threshold state (e.g., 20% charged), the controller initiates a switching action, causing the Auxiliary Battery to become the Main Battery and vice versa. This swapping ensures continuous power supply to the vehicle.

To charge the components within the vehicle and the Auxiliary Battery, power is generated by an alternator coupled to the shaft of the vehicle. This setup eliminates the need for charging at external stations, thereby reducing or eliminating charging time and enabling the vehicle to cover more or unlimited distances.

We are developing a prototype considering all necessary factors and specifications pertinent to our project. Specifications, calculations, and observations may vary based on project requirements. For controller purposes, we have utilized an Arduino UNO board; however, for industrial applications, a different controller may be necessary. During the design phase of the EV, minimizing losses and maximizing efficiency are paramount. We have implemented hard switching in the project to facilitate the necessary transitions.

Efforts have been made to minimize losses and ensure accurate results from the project. The constructional diagram depicted in

Fig - 1 illustrates the conceptual implementation of the project within an actual vehicle.

Fig - 2 displays the basicimplementation idea and the connection diagram utilized in the project accordingly.

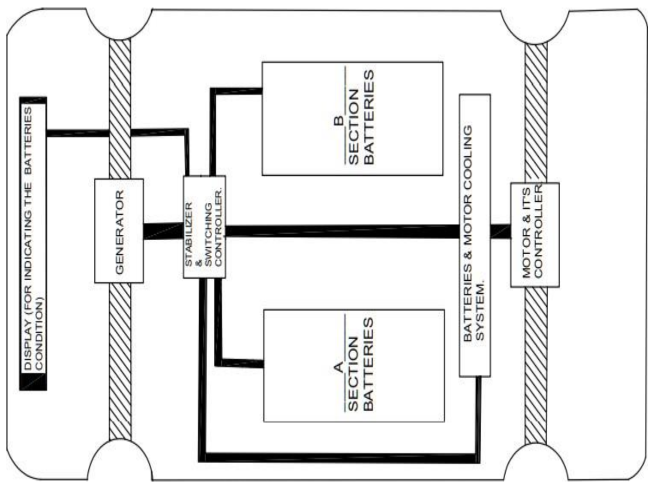

Fig. 2 Virtual Construction of project

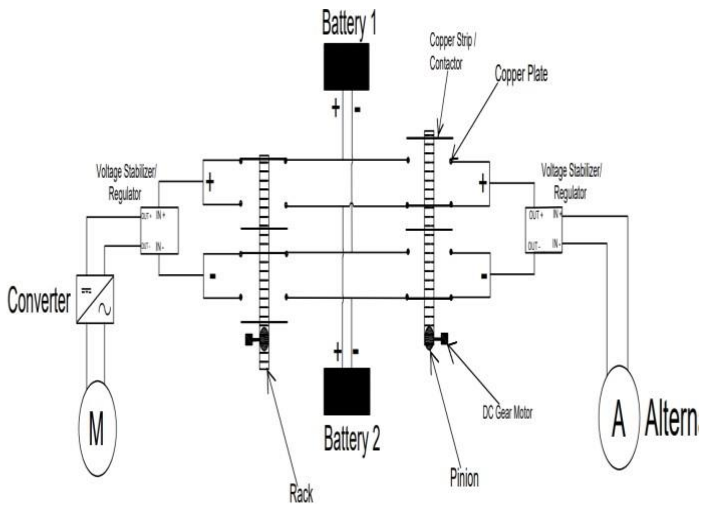

Fig. 3 Connection diagram of project (Actual)

IV. CALCULATION

A. VOLTAGE DIVIDER

We Use the concept of voltage divider for calculation of the Voltages by using Arduino. We use the Arduino analog pin for calculation the source voltage/ battery voltage and display it on the OLED display. The Arduino pin required max 5 volts to their pins. So, we using voltage drop method & drop the higher voltage at Vout and given to the Arduino Pin to Measure the higher voltage and by some calculation / formulas we get the actual supplied Voltage (Vin) on the display. The Voltage divider diagram andFormula is given below. The formula also seen which is provided in code.

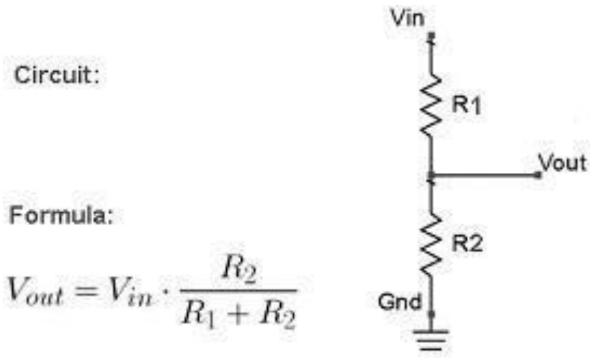

Fig. 4 Voltage Divider

B. BATTERY CALCULATION- CAHRGING AND DISCHARGING RATE

For example, if you have a 100 Ah battery and want to charge it in 5 hours, the charging rate would be 100 Ah / 5 hours =20 amps. From this we can find out the charging time and charging current required for charged the batteries. Calculate the maximum discharge rate the battery can handle without damaging it. This is typically expressed as a multiple of the battery's capacity, such as C/10 (where C is the battery's capacity in Ah). For example, if you have a 100 Ah battery, the maximum discharge rate at C/10 would be 100 Ah / 10 = 10 amps.

C. RPM TO KM/HR CALCULATION

Formula for calculating speed (km/hr) from RPM:

Speed (km/hr)= RPM× Wheel circumference (in km) / Minutes per

D. ROLLING RESISTANCE

Rolling resistance is a force that opposes the motion of a rolling object. It occurs due to the interaction between the object's tires (or contact surface) and the surface it is rolling on. The primary factors influencing rolling resistance include the surface roughness, tire material and design, and the weight of the object.

The coefficient of rolling resistance (Cr)represents the proportionality between the normal force (weight) acting on the object and theresulting rolling resistance force. It is a dimensionless value that depends on various factors such as tire type, tire pressure, and surface condition. Higher values of (Cr) indicate greater resistance to rolling.

Rolling Resistance Coefficient μ_R is defined by $\mu_R = F/G$, where F is the force necessary to pull the axle of a tire horizontally in the direction of travel, and G is the vertical load on the tire which is assumed to roll on a flat horizontal surface.

E. AIR RESISTANCE CALCULATION

Air resistance, also known as drag, is a force that opposes the motion of an object as it moves through the air. It occurs due to the interaction between the object and the air molecules surrounding it. The magnitude of air resistance depends on factors such as the object's shape, size, speed, and the density of the air.

Air resistance can be calculated using the formula: $F D = 1 / 2 * P * V^2 * Cd * A$. This formula incorporates air density, object velocity, an object's aerodynamics, and an object's cross-sectional area. The formula can be used to estimate air resistance for any object, from a flying frisbee to a speeding bullet.

F. ENERGY CALCUALATION

Calculate the energy consumption by multiplying the battery capacity, charging rate, and charging efficiency. For example, if the battery capacity is 40 kWh, the charging rate is 7 kW, and the efficiency is 90%, the energy consumption would be 40 x 7 x 0.9 = 252 kWh.

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G. RANGE ESTIMATION

Range estimation is crucial for planning EV trips. It involves calculating how far an electric vehicle can travel on a single charge.The range (R) can be estimated using the equation:
$R=Eper / Etotal$;Where;

Eper = is the total energy capacity of the EV battery (in Wh)
Etotal = is the energy consumption per unit distance (in Wh/km or Wh/mile)
The energy consumption per unit distance can be determined from tests or provided by the manufacturer.

H. EFFICIENCY ASSESSMENT

Efficiency is an essential aspect of EV performance. It's calculated as the ratio of useful output energy (e.g., kinetic energy fordriving) to input energy (e.g., energy from the battery). The efficiency (η) can be expressed as;
η=Input EnergyUseful / Output Energy×100%
Efficiency can vary depending on driving conditions, vehicle speed, temperature, and other factors.

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I. EFFICIENCY OF CHARGING

This calculation helps to understand how efficiently the electrical energy from the grid is converted into usable energy stored in thevehicle's battery.
Thr Formula As Follows:
ηcharging=Edelivered / Estored×100%

Efficiency calculations help in evaluating the overall energy efficiency of the charging process and identifying areas for improvement to minimize energy losses and optimize charging infrastructure. This is crucial for enhancing the sustainability and cost-effectiveness of electric vehicle charging systems.

J. MECHANICAL RESISTANCE

Mechanical resistance includes various internal frictional forces within the vehicle's drivetrain, such as friction in bearings, gears, and other moving parts. These mechanical losses contribute to overall energy consumption and affect vehicle efficiency.

V. OBSERVATION

TABLE 1 OBSERVATION OF PROJECT

Sr. no.	**Battery Voltagebefore Switching.**		**Switching/ RackRotation**		**State of battery After Switching.**	
0.	**Battery 1**	**Battery 2**	**Switch 1**	**Switch 2**	**Battery 1**	**Battery 2**
1.	12 v	12v	Initial Condition (Down)	Initial condition (Up)	Discharging	Charging orFull Charged.
2.	6 v	12v	Up-ward	Down-ward	Charging	Discharging

3.	> 6v	< 12v	Up-ward(Stop)	Down- Ward(Stop)	Charging orcharged full	Discharging
4.	12v	6v	Down-ward	Up-ward	Discharging	Charging
5.	<12v	>6v	Down- ward (Stop)	Up-ward(Stop)	Discharging	Charging orcharged full

In the above observation table, it shows the data while performing and rough testing of the project. The table shows the data in a form of truth table i.e., by the battery condition the switching action is took place. As shown in above Table 1

VI. CONCLUSION

In conclusion, it is evident that global warming is a real phenomenon, and it is happening right now. There are several factors that contribute to this issue, and the impacts can be seen both socially and environmentally. If we do not take the necessaryprecautions and act now, the situation is only going to worsen in the future. One should be well-aware of the consequences and ensure that they are not doing anything to contribute to it.

For the solution of global warming the EVs are widely manufacturing but not sale as the government is expected. Due to some the limitations of EVs the seal of the E-Vehicle is less as compared to conventional petrol and diesel vehicles. By overcoming this limitation, the sale of the EVs should be increased or should be better in the future. Some off the problem are overcoming by help of our projects. We made a prototype which should give the basic idea to manufacture a E-vehicles which should overcome the problems of charging of EVs, finding the charging station and a limited distance of travelling

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