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Modeling and Control of Electric Vehicle Operated by Hybrid Energy Sources Through Wireless Charging Station

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Abstract **------ The rapid utilization of fossil fuel and increased environmental damage caused by it has given a storage impetus to the growth and development of fuel-efficient vehicles. The demand of vehicle is increasing with high speed; the exigency of vehicle even raises the need of non-renewable fuel resources. According to the recent study, 44% of CO2 emission is due to the warming emission of gasses through conventional Vehicle. EV technology has become trendier in transportation sector, because they assume less amount of crude oil and environmentally friendly. This proposed study is of prototype model Of HEV that operated on Plug in and Solar Battery charger. This electrical vehicle is charged through solar cells and through the plugging system of HEV. Further in this, the charging station of Electrical vehicle has an addition of wireless power charger and the parameters of electrical vehicle are controlled and monitored through mobile application. Through this visualization of parameters can easily be observed.**

Index Terms**—: Battery management system, Electric vehicle, Electric drives. electric propulsion, Inverter and Plugging system,**

I. INTRODUCTION

In the recent years, new paradigms are emerging in rapid manner and the world is shifting to an alternative fuel which will not cause any ecological hazards to nature. The quick consumption of fossil fuel and emerging environmental issues caused by it have given a strong impetus to the growth and development of fuel-efficient vehicles.

The Electric Vehicle (EV) is considered to be a best solution to reduce the global warming emission gases in transportation sector. EV technology has become more modish in transportation sector because they consume very less amount of crude oils and are more environmentally friendly[1].

The most punctual electric vehicle fueled by non-battery-powered batteries was underlying 1834, much before the improvement of IC motors. Electric vehicles were extremely famous during the 1890 to 1920 period apart their exceptionally significant expense. In 1912, EVs have arrived at their leading, making up almost 28% of the vehicles on the market.

A hybrid electric vehicle (HEV) is a kind of vehicle that utilizes both an electric motor and a customary inward burning (Sunlight based cells) motor. This sort of vehicle is considered to have better execution and mileage compared with a regular one. Hybrid electric vehicles (HEVs) can possibly spare fuel utilization and lessen contamination discharge.

In proposed analysis and model, the main goal is to utilize hybrid sources for electric vehicle. Electrical vehicle technology has the potential to contribute to an increasingly sustainable Pakistan's transport sector. Electric vehicles may, depending on how electricity is generated, cut greenhouse gas emissions while reducing Pakistan's exposure to rising whole prices. The goal of study achieves greater fuel economy and lower emission through Hybrid electric vehicle. In proposed model the improving the Charging experience for HEV's by implementing wireless charging station.

In this proposition, the fundamental point is to diminish the fast utilization of petroleum derivative and ecological harm brought about by traditional vehicles through Hybrid Electric Vehicle (HEV) which has demonstrated to be a promising answer for the genuine existential issue presented to earth. In addition to the fact that HEVs provide better efficiency and lower discharges fulfilling ecological guidelines, yet additionally, they decrease the impact of rising fuel costs on purchasers. Also, the utilization of remote charging station innovation upgrades the unwavering quality and productivity of intensity transmission to electric vehicles without interfacing electrical wiring. It is foreseen that remote charging will massively improve the charging experience for HEV proprietors, to make such vehicles more alluring to buyers.

In the first chapter, introduction and background history of electric vehicles are defined. Literature review has been done in the second chapter, in which a vast number of research papers are analyzed. Third chapter describes the methodology of this thesis project, in which working and simulation of EV & HEV is elaborated. Fourth chapter consist of the Results of HEV model. fifth chapter is based on conclusion & future recommendations are explained..

II. LITERATURE REVIEW

A. *Hybrid Electric Vehicle Development*

Internal Combustion Engine (ICE) was one of the best designing accomplishments towards the finish of the nineteenth century[2]. The acknowledgment of this vehicle was because of the ease of fuel, convenience, increment in unwavering quality and long scope of driving. It has an exceptionally low productivity of up to 20-25% and it discharge enormous measure of harmful gases, so the specialists concern is currently to move toward a dependable and eco-accommodating source [3].

The greatest bit of flexibility of IC motor vehicles is the long driving reach because of the high energy-thickness of oil

energizes[4]. Despite the fact that battery EVs have numerous important points over customary motor vehicles, for example, zero contamination, high productivity and so forth, their movement range per battery charge is significantly less than motor vehicles because of the lower energy substance of batteries. HEVs have the advantages of both ICE vehicles and electric vehicles and beat their individual disadvantages [5].

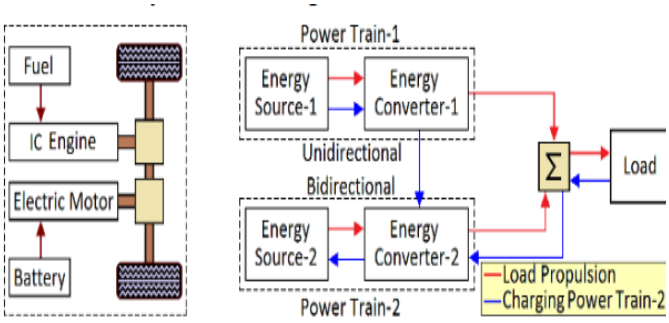

Fig 2.1: Arrangement of HEV model with power flow paths

B. ***Smart EV Charging System***

The research proposition is to bring software engineering deal with programming improvement, Web 2.0, geographic data frameworks, portable calculation and remote correspondence, to another developing zone of Smart Grid and EV (Electric Vehicle) [6]. Because of the expanding intricacy and variety of alternatives, clients in Electrical Machine (EM), when playing out an EV charging measure, will require the assistance from programming application, for the most part to cell phones. along these lines, the proposition, introduced in this paper, are the origination and the making of a versatile application and encompassing framework, to help clients on EV charging or releasing cycle, and furthermore on EM cooperation[7].

C. **Plug in Hybrid Electric Vehicles**

The essential contrast between a standard HEV and a module HEV is appeared in Fig. 1[8]. Module crossover EVs are full-half and halves which utilize a more modest motor, a bigger battery and a bigger engine. Batteries of PHEVs can be energized from any outside force source not at all like in standard HEVs in which batteries are revived simply by methods for the motor driven generator or regen-slowing down[9]. This element of PHEV has the benefit of drawing power from any asset, for example, network power including family gracefully, self-ruling frameworks or even environmentally friendly power. PHEVs have a more limited all-electric driving reach per energize as against battery EVs, however have a bigger all electric reach when contrasted with standard HEVs in light of the fact that the motor generator drive can help the framework when the batteries are drained. Likewise, attributable to the huge electric engine, PHEVs have higher regen-slowing down capacity contrasted with conventional HEVs[10].

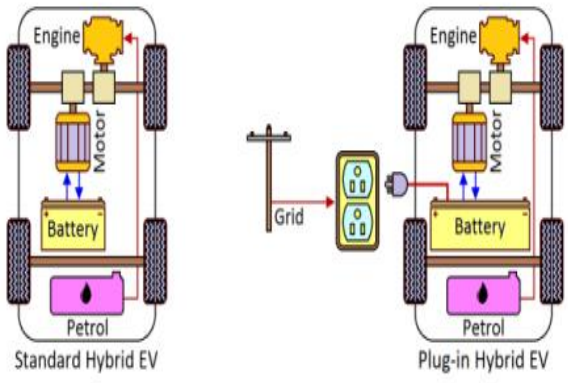

Fig. 2.2: Comparison of a standard HEV and a PHEV.

Advantages of PHEV include: preferred eco-friendliness over customary HEV, long driving reach than EVs, potential for disseminated energy stockpiling, low running expense contrasted with petroleum, and naturally well disposed. Significant drawbacks are: significant expense and non-accessibility of quick charging stations Models: Chevy Volt, Toyota Prius, Passage CMax Energi.[8]

D. **Solar Powered Electric Vehicle**

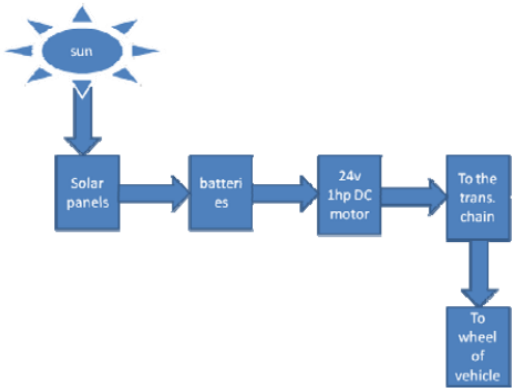

Fig 2.3: Basic block Diagram Representation of Solar Vehicle

Energy is one of the most essential requirements for human endurance on earth. We are subject to one type of energy or the other for satisfying our needs. we have to take a gander at the NONCONVENTIONAL Wellsprings of energy. As to this thought we have planned an Electrical vehicle that sudden spikes in demand for sun oriented energy.

Energy from Sun is caught by the sun powered boards and is changed over to electrical energy. The electrical energy hence framed is being taken care of to the batteries that get charged and is utilized to run 24 V DC high forces DC arrangement engine. The pole of the engine is associated with the back tire of the vehicle through chain sprocket. The batteries are at first completely energized and from that point they are charged by boards. This aides in finishing the charging-releasing pattern of the batteries, which is significant for legitimate working of batteries [11].

E. Block Diagram of Wireless charging station

The square graph of remote versatile charger comprise of two segments specifically the transmitter circuit and the recipient circuit, the transmitter circuit comprise of a 230V Air conditioning flexibly, air conditioning to DC rectifier, DC to air conditioning inverter, a high recurrence transformer and a transmitter curl whiles the collector circuit comprise of a beneficiary loop, air conditioning to DC rectifier, voltage controller lastly a cell phone which is utilized as a heap[12].

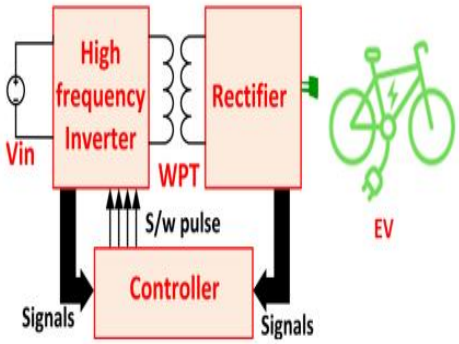

Fig 2.4 Closed loop control in conventional WPT charger.

III. METHODLOGY

Electric Vehicle technology has become trendier with the passage of time due to their less consumption of crude oils and environmental friendliness. The main challenge in the electric vehicle is the cost of energy source which we've tried to overcome by developing a plug-in hybrid vehicle model having the additional application of charging by utilizing the solar energy through a solar panel installed on top the hybrid electric car model and wireless charging station as shown in the Fig 3.1: Basic Working Block Diagram.

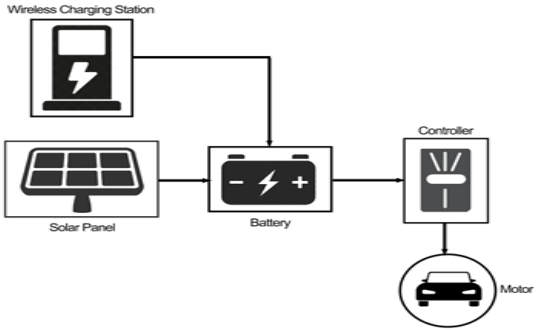

Fig 3.1: Basic Working Block Diagram

A. List of Components:

Following table represent the components used in the development of this project.

Table 3.1: List of components and their values

Component's Name	Component's Value or Code
Solar Panel	10 Watt
PWM Solar Charge Controller	10 Amp
Phoenix Gel Acid Battery	12 Volts | 7AH
Hennkwell PZ22GR9120R-084BBH DC Gear Motor (6)	24 Volts
Arduino Volt Sensing Module	0-25 Volts
ACS 712 Current Sensor	
Capacitors - C1 & C2	22Pf
Crystal Oscillator	16 MHz
HC-06 Bluetooth Module	
Relay (4)	6 Volts
817C Opt-coupler IC (4)	
Capacitors – C3:C9 (7)	470uF
BC547 NPN Transistor (4)	
1N4007 Diode (4)	
1N5817 Diode (2)	
1N5408 Diode	
Resistors (9)	1K Ohm
Xl6009 Boost Converter	
Boost Converter	150 Watts
Wireless Charge Receiver (2)	5V

B. Electric Vehicle Simulation

In this simulation of electrical vehicle:

- The Arduino UNO is used as a microprocessor and is connected with the L293D Motor Control circuit.
- Arduino is programmed to control the motors M1, M2, M3 and M4 which are connected with the L293D Motor Control circuit OUT pins.
- Arduino is also connected with a Bluetooth Module, if the Arduino is not connected with the Mobile Application through Bluetooth, the vehicle will not operate.
- The motors M1, M2, M3 and M4 are connected in H-bridge circuit to provide the flexibility of Forward and Backward motor drive capability.

- Diode-Led is used to indicate the current working state of the Arduino.

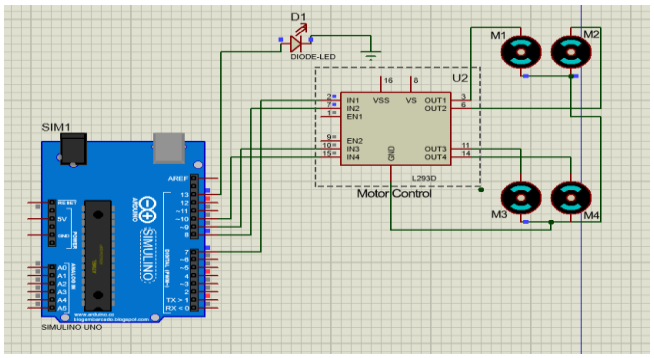

Fig 3.2: Simulation of Electric Vehicle

C. Simulation of Solar Charge Controller

In the following Solar Charge Controller simulation:

- A Solar Panel Is attached to the circuit, to provide a constant supply of 12V DC to the battery in order to charge it.
- Necessary pre-cautions are taken by attaching a Diode, in case where the battery is fully charged and current starts flowing from the battery to the solar panel.
- Following the case, the diode is reverse biased and stop any current from battery to circulate to the solar panel.
- The whole circuitry is present in a charge controller circuit, which monitors and controls the charging aspect of the battery.

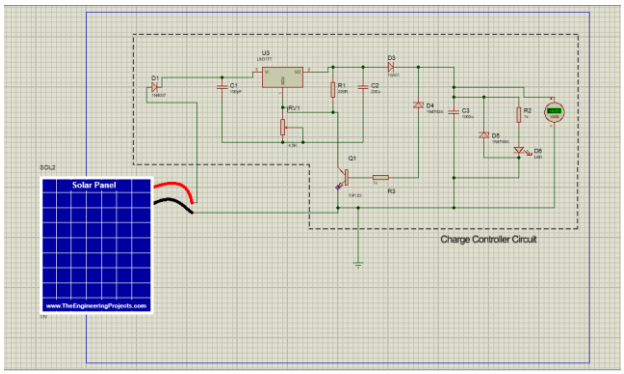

Fig 3.3: Simulation of Solar Charge Controller

D. Workflow of Hybrid Electric Vehicle

The elaborated workflow of Hybrid electric vehicle is shown in the following figure:

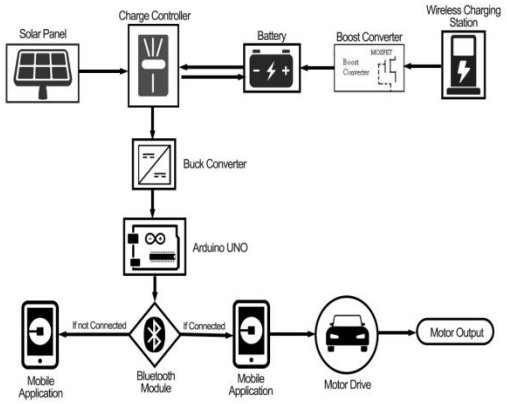

Fig 3.4: HEV Workflow Block Diagram

- Solar Panel and Wireless charging station are the main supplies appointed to the Battery. The source from the Solar Panel is given to the charge controller, which advances the supply to the battery.
- On the other hand, the other supply surface from the wireless charging station. The wireless charging station provides a supply of 5V, which is amplified to 12V through a Boost converter.
- A boost converter is a DC to DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it "steps up" the source voltage.
- The 12V supply from the Boost convertor is given to the battery as the other source to charge it.
- Once the battery is completely charged, the charge controller yields a signal to the Buck convertor.
- A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while stepping up current) from its input (supply) to its output (load)
- The buck converter will step-down the 12V supply from the battery to 5V with regard to Arduino UNO, that operates on a 5V supply.
- Arduino is programmed to run the hybrid electric vehicle through a mobile .application which is connected via Bluetooth Module.
- If the mobile application is successfully connected with the Bluetooth Module, the mobile application will provide a signal to the Bluetooth module that it is connected.
- If you're not connected, you're required to go to the Mobile application in order to connected with the Bluetooth Module.
- Once you're connected, you can monitor different parameters such as current sensor and voltage sensor readings and operate the motor (speed and movement) via providing a signal to motor drive circuit through the mobile application.

IV. RESULT AND DISCUSSIONS

A. Plug in EV Charging

Battery Voltages shows battery charge time through Plug in System, it takes approximately 3 hours for battery to completely charge.

The Battery charger used in Battery is of 3A and gives and Dc supply of 12-14 V.

Charge Indicator Shows Full bars when it is completely charged. When battery voltages are below 7 v, it is mandatory to charge battery with Plug in system it builds up sufficient voltage, Electric Vehicle can operate Solar Cells that it can further Charge Battery.

Fig 4.1: Plug-in Supply to EV

Battery Discharge of Electric Vehicles.

- Load of almost 4 A is connected in Electric vehicle has 6 DC motors.
- Electric vehicle can operate for 2 hours on Single charge.
- Charge controller goes off when battery voltages fall below 7v, below 7 v charge controller will shut down the supply and restricts the electric vehicle to charge from PV cell, then its only charge through Plug in system.

Data and Curve

Table 4.1: Plug-in charge of battery

Plug in Charge of Battery		
Battery Discharge(V)	Battery Voltage(V)	Time
13.5	5	0:00
12.5	9	0:20
11.3	10.2	0:40
10.4	10.9	1:00
9	11.5	1:20
7	12	1:40
0	12.7	2:00
0	13.1	2:20
0	13.5	2:40

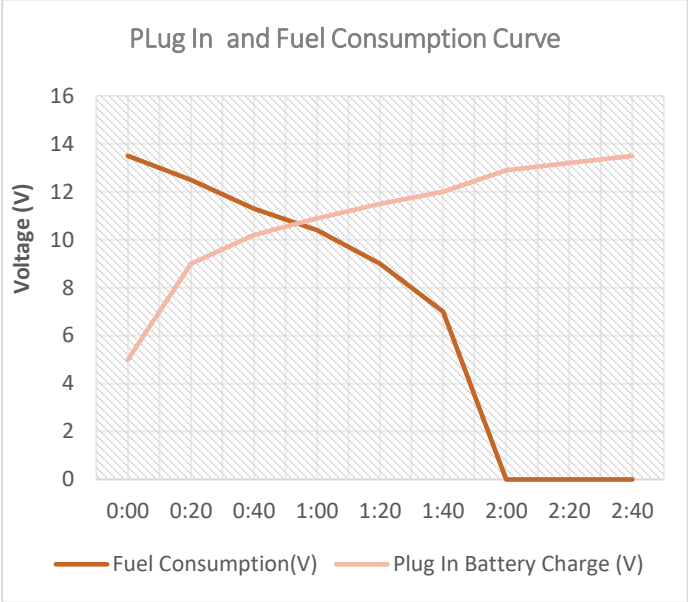

Fig 4.2: Plug in and Fuel Consumption Curve

A.***Electric Vehicle Charge from Solar cell.***

- Solar cell only charges battery when charge controller is on, approximate voltage given by Solar cell is 12-13V.
- When Battery voltages are below 7v charge controller shuts off for protection of equipment.

Fig 4.3: Electric Vehicle Charge from PV cell

Data and Curve

Table 4.2: Solar Cell Electric Vehicle Charge

Solar Cell Electric Vehicle Charge		
Battery Discharge(V)	PV Cell Battery Charging (V)	Time
13.5	10.04	0:00
12.5	10.80	0:20
11.3	11.33	0:40
10.4	11.66	1:00
9.7	12.01	1:20
7.1	12.33	1:40
0	12.58	2:00
0	12.78	2:20
0	12.96	2:40

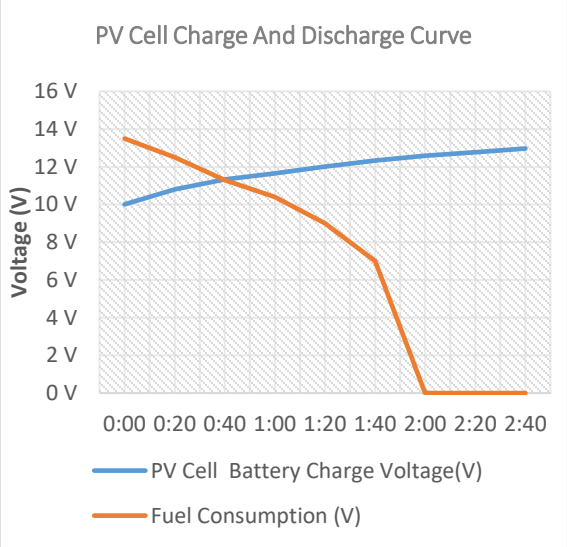

Fig 4.4: PV Cell Charge and Discharge Curve

B. ***Wireless Charger Simulation Model***

- The Wireless power transmission simulation is implemented in the Multisim platform.
- The frequency is set up to 1 MHz, the transmitting and receiving voltage is 12-20-volt A.C.
- AC at receiving end is rectified through Bridge rectifier 1B4B42 and converted in 12v constant supply through Voltage regulator IC LM7812KC, the output of IC is connected to 10micro Farad something capacitor which is connected in parallel with Load gives constant supply of 12 V dc.

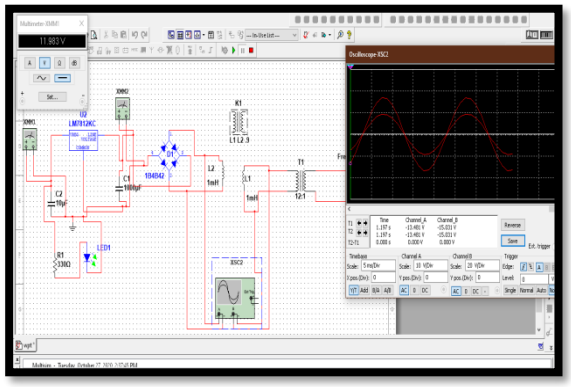

Fig 4.5: Wireless Charger Simulation Model

C. ***Prototype Design of Wireless Charging Station***

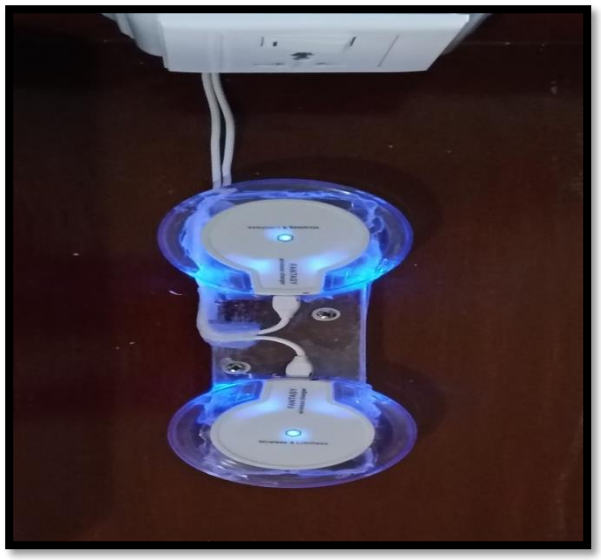

Fig 4.6: Wireless Power Transmitter

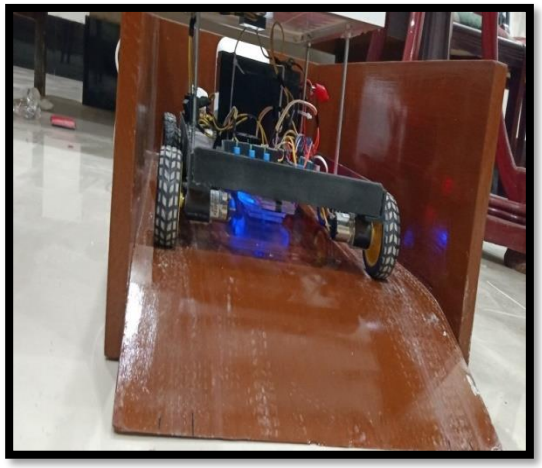

Fig 4.7: Wireless Charging of Electrical Vehicle

D.***Design Mobile Application***

- "HEV Controller" Application is needed to connect with the Bluetooth Module.
- Once it's connected, Real-time readings of various parameters and can control the motor through the application.
- From this application, Battery voltages its motor consumption, wireless charging output and Solar charging current are monitored.

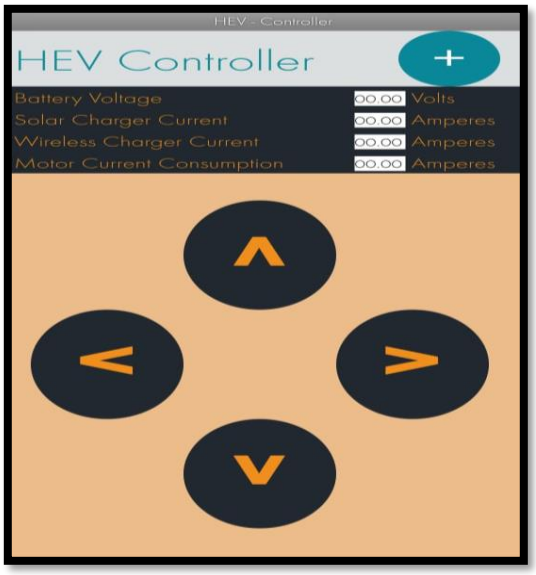

Fig: HEV Controller Application Interface

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V. CONCLUSION

In the last few years, the demand for Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs) has been increasing drastically due to the rapid consumption of fossil fuels and increased environmental issues. Compared to internal combustion engine vehicles; Hybrid Electric Vehicles (HEVs) provide better fuel economy and lower emissions, satisfying environmental legislations.

In this thesis project, we have developed a model of Hybrid Electric Vehicle (HEV) and have done the simulation of the circuits to analyze the results through software. The two sources which are utilized to provide power to the Hybrid Electric Vehicle (HEV) are: a 10 Watt solar plate (which takes the energy from solar rays and provide power to battery) and a 12 volts battery. A plug-in system for the charging of the battery has been developed which charges the battery efficiently. Moreover, we have also established & developed a wireless charging station which wirelessly charges the battery of the vehicle.

VI. FUTURE RECOMMENDATION

In this thesis project, ACS 712H current sensors have been used to evaluate the current consumption values. Updated versions of these current sensors (ACS 722) have been introduced which are more reliable, have better calibration and are easy to use. Hence these current sensors (ACS 722) are recommended for future work.

Another aspect of this thesis project which can be recommended for future is the wireless Transmitter. The current wireless charger in market are not very efficient , As this technology is new so its recommended to for future studies to replace the wireless transmitter to the updated technology of that time.

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