Modeling Simulation and Performance Electrification of Cuckoo Search Based Charge Controller for Electric Vehicle Applications

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Abstract- In 2008, the launch of the Tesla proved to the public electric vehicles' ability to fuel and greenhouse gases reduction in the transport sector. It brought the worldwide spotlight on electric vehicles when, because of increased demand and fossil fuel prices, they reached unexpectedly high and developing countries needed strong economic growth. The capacity for energy storage by electric cars as well as the likely random discharge and loading of the grid are important challenges in operation and maintenance. The Optimal preparation techniques are important for large number of vehicles to be incorporated with the smart grid and electric vehicles. Greenhouse gas emissions are one of the major environmental problems and their emission rates are rising more quickly with rapid industrialization. This can be overcome by solar energy for transport. The purpose of the work proposed is to include a technology that supports green energy. The presented research underlines the functional properties of electric vehicle and illustrated literature review on recent developments of electric vehicles. The research paper also explains the fundamental components of electric vehicle incorporated with solar photovoltaic system. Research is useful in understanding properties and challenges in the field of electric vehicles. This research also involves the characteristic analysis of electric vehicles using mathematical modeling and design simulation. The secondary goal of this research is to implement the photovoltaic solar energy plant's equivalent design model. The solar photovoltaic system mathematical model has implemented using the MATLAB for maximum power point monitoring using the Cuckoo search algorithm.

Keywords– DC-DC power converters, Solar PV, Grid Connected Energy System.

1. INTRODUCTION

The rise in Green House Gas (GHG) anthropogenic emissions has significant impacts on global warming have been on practices. Natural disasters in severity and frequency partly because of the severe weather imperative shown by global warming has forced countries to reduce emissions of GHG and decrease the pollution indices. In addition, fossil is limited significant fuel reserves such as coal, petroleum and gas additionally put restrictions on global economic growth and concern for the atmosphere because of the carbon combustion fuels. All these challenges require new development renewable and non-emitting energy technologies resource and the need for improved energy and socialization.

Transport is a key contributor to GHG emissions and a major consumer of fossil fuel emissions around the world. However, successful electric vehicle (EV) marketing can change this scenario. EV inventions, which began in the early nineteenth century, have a long history of evolution. Tesla has made significant technological advances in recent years, with the Roadster and Model achieving technical integration. EVs were popular because of their environmentally friendly attributes.

From a grid standpoint, EVs can be classified as Battery Electric Vehicles (BEV) and Plug-In Hybrid Electric Vehicles (PHEVs) [1]. A BEVa battery to recharge, while a PHEV uses a battery as the primary power source and an internal combustion engine to increase the range of the vehicle. The range of motor vehicles and PHEVs is normally battery-based, while internal combustion in PHEVs is dependent on both Motor. Battery capacity can range from over 80kWh to less than 10kWh. For this reason, both are referred to as Plug-In Electric Vehicles (PEV) [2]. Tesla and other electric vehicles, such as the Nissan Leaf and Toyota Prius, are new to the market. According to the automotive industry, the BMW-i3 is a revolutionary vehicle. Investing heavily and thinking that the demand for the future of electrical transmission exists in electric vehicles (EVs).

There's a couple technical problems mainly related to the range of EVdue to the limited power of the battery. Some of the reasons for cars that use other sources the energy regulations have become a requirement. Advances in electric motor technology are focusing on high-efficiency batteries [3].

A number of companies all over the world has started to take more seriously and started working on Electric Cars (EV). Automobiles are about to close combustion motors in terms of efficiency. Electrical traction engines produce quick EV power while the internal combustion engine is in good operating order in hybrid autos. Most EVs are currently powered by an external generator plant that feeds a bank of batteries. New energy storage technologies are a major step forward breakthrough comprising solar cells, batteries with high-performance. Using the battery bank energy usage monitor shortens the time it takes for the battery to deplete and increases the battery's capacity.

Electric vehicles have been developed by several Mexican universities. The car "Kalani," a three-wheeled steel frame and fiberglass vehicle that fulfills various international quality criteria, was recently designed by Engineering Faculty. It weighs 50 kilograms and stands 220 centimeters tall, 80 centimeters tall, and 220 centimeters long. The Mexican Institute adapted a sedan car for Volkswagen to develop an electric vehicle that operates between 36 and 92 volts. Each of the six deep-cycle 8 V lead-acid batteries is in the battery bank [4].

2. OVERVIEW OF ELECTRIC VEHICLE

The PHEV studied in this paper is simultaneously configured. In Figure 1, the configuration of the drive mechanism is shown. A motor is driven by the Integrated Starter Generator (ISG) and power sources the engine. To achieve dynamic relation, the engine and ISG are coaxial and position the master clutch, the engine and the ISG. In addition, to satisfy the criteria for transmission, different speed and torque driving times, a Dual Clutch Transmission (DCT) is used. In one of five modes, including mode drive and charge, motor drive mode, electric mode, hybrid mode, and regenerative braking modes, the PHEV's motor power train system can work. Furthermore, by altering the state of the master seizure and double seizures, function modes are altered. In Table 1, the basic parameters of the PHEV are presented.

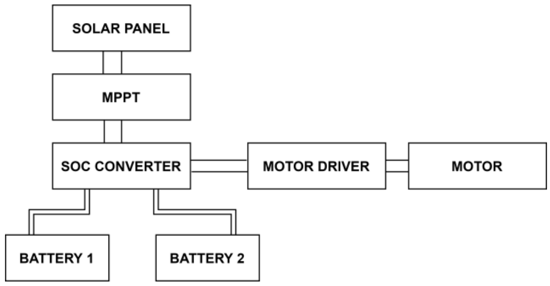

Figure 1: Block diagram of interconnection of Solar Powered Electric Vehicle

The solar-powered electric vehicle block diagram is explained in Figure 1. From the diagram, it is obvious that solar energy is driven by a photovoltaic system that is connected to a Maximum Power Point Tracking (MPPT) controller that is integrated with a State of Charge (SOC) converter that functions as a central processing unit and is connected to the motor drive and the battery system [1]. The battery charging module is accessible from the solar panel and is the responsibility of the vehicle to run it. Simpler and cost-effective polycrystalline solar panels are used because of their processing. If the mono crystalline solar panels are equivalent, polycrystalline solar panels have poorer heat resistance. The view of the solar panel projection is shown in figure 2. The vehicle has 80 W on the side, the front view is 20 W, and the vehicle's top view is 400W. With 500 W of solar panels, thus, fully Solar Powered Electric Vehicle (SPEV) was installed. Horizontal panels and other 30-degree slanting position panels are located. It produces 500 W of energy from built-in solar power during clear sunshine. The description of the 500 W panel SPEV design arrangements is guaranteed by projection view [5].

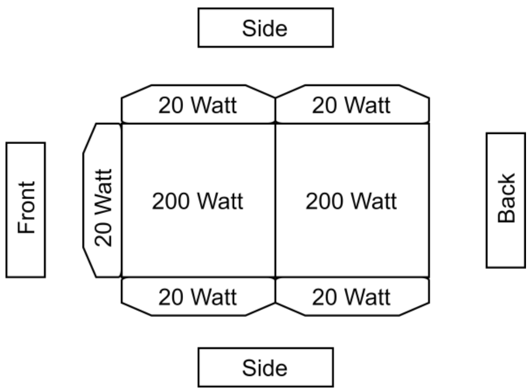

Figure 2: Arrangement of solar panels in electric vehicle

Therefore, the polycrystalline solar panel is responsible for direct sunlight harvesting capacity of 500 watts. The best way is to calculate the energy that can be charged by the solar panel by an electronic converter. The load controller thus analyses the output of the panels and compares it with the battery voltage. Therefore, the voltage DC output to the lower voltage required to charge the respective battery. It is transformed by the best power it takes. At voltage, mppt systems are installed to get full amperage in the battery [6].

Modern MPPTs, most notably, are around 93-97% successful conversion. Normally gets a power gain of 20% to 45% in winter and 10-15% in summer. Real benefit can vary greatly depending on the weather, temperature, charge state of the battery, and SOC factors. The parameter is an important for taking hybrid vehicles into consideration. It depends on the state of the SOC after loading and discharging the battery [7]. Data acquisition SOC flow map to measure the SOC, we used the battery's open circuit voltage system, which in lead acid batteries is much simpler and more precise [8]. The integrated SOC microcontroller comparator compares both batteries SOC standard and the respective SOC level relay operates. Battery with larger SOC linked to the charge connexion between battery and load connexion Relay, the solar panel battery with a less SOC By relay of PV. The processing of SOC data takes place periodically Comparison of the time intervals and the corresponding SOC battery [9].

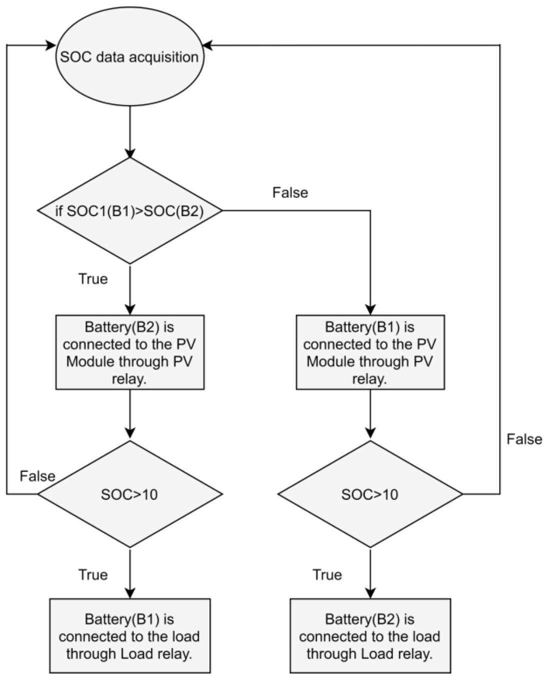

Figure 3: SOC Data Acquisition system Overview

Figure 3 explains the flow chart and working system of SOC data acquisition system. The electric vehicle control system should be robust, dynamic and efficient controlled system. The integration of PID controller and other control system components enhance the overall productivity and efficiency of the system [6]. It is evident that the solar powered electric vehicle battery management and charging control is major area of research.

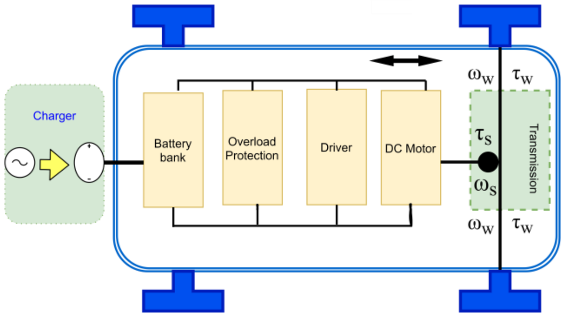

Figure 4: Interconnection of charging circuit and motor drive

Figure 4 indicates the interconnection of charging circuits and motor drive of electric vehicle it is evident from the diagram that the battery bank is connected to charger and accompanied by overload protection. DC motor primarily brushless dc motor drive is connected to the driver circuit which is connected to the axle through shaft. The operation of electric vehicle is a complex control system with multiple input multiple output control system parameters.

The integration of PEVs in electricity systems is obvious is a challenging subject, which has a lot to do with power system, generation, transmission and distribution system to optimization of economic dispatch and electricity operation and control.

3. DESIGN OF EFFCIENT CHARGE CONTROLLER

The maximum power point is tracked by various methods. Few methods are amongst the most popular:

1. Conventional Methods
2. Soft Computing Based Methods
3. Heuristic and Meta Heuristic Based MPPT Method.

The algorithm's choice depends on the time complexity, implementation and ease of implementation of the algorithm to track the MPP.

The system presented includes four blocks, namely the PV (Photo Voltaic) array, the MPPT system, the controller and the measuring systems which are coupled to execute the simulation required [10]. Our effort is focused mostly on tracking the power under partial conditions of shade and therefore, through our initial block, we have produced partial conditions for shading where we linked four PV modules in series with various inputs of radiation and temperature. The array block output is supplied directly to the optimization block to maximize our output. MPPT algorithm duty cycle output is supplied to enhance converter through pwm converter. Here the boost converter output is connected via resistive load to know the power we get from the system [11].

Through MPPT algorithm we are controlling the duty cycle which is being given to the converter. Hence we can say that MPPT algorithm is basically needed to control the operation of Controller. In the measurement block, we have taken a reference power just to obtain better understanding of our output. In output, basically trying to know at what time it is starting the tracking and if the tracking is being done in stable manner. This study is trying to know the time domain specifications of the system. Different studies therefore suggest that MPPT methods cannot analyze the exact follow-up of the global Maximum Power point (MPP). The complexity of the algorithm, costs and failure while working in shade situations is thus the difficulty in the implementation of MPPT technology. In particular, in the last five years, the analysis of worldwide power peak identification under shading conditions has been carried out [12]. Each study explains a monitoring approach that varies in complexity, cost, operational speed and efficiency. Fitting factors for the hunt must be selected to use CS (Cuckoo Search) to design MPPT. First, the examples; the estimates of the PVvoltages, such as V_i (i = 1, 2... – n are characterised for this case). The total number of tests is defined as n. Secondly, the size of the progress, a. The wellness work (J) is the PV power estimate at MPP. As J depends on the PV voltage, hence J = f (V). At first, the results are tested and the voltage is the fundamental equation for the PV modules.

$$V_i^{(t+1)} = v_i^t + \alpha \oplus \ Levy\ (\lambda) \tag{1}$$

$$s = \alpha_0(v_{best} - v_i \oplus \ Levy\ (\lambda) \approx k \times (\frac{u}{(|v|)^{\frac{1}{\beta}}})(v_{best} - v_i) \tag{2}$$

$$u \approx N(0, \sigma_u^2\ )\ \ v \approx N(0, \sigma_v^2\ ) \tag{3}$$

$$\sigma_u = \ (\frac{\Gamma(1+\beta)\times \sin\left(\pi\times {}^{\beta}/_{2}\right)}{\Gamma\left(\left(\frac{1+\beta}{2}\right)\right)\times\beta\times(2)^{\left(\frac{\beta-1}{2}\right)}})^{1/\beta}\ and\ \sigma_v = 1 \tag{4}$$

The highest voltage power is considered to be the best example today. The Lévy flight is carried out from there, so fresh voltage tests are carried out depending on the conditions of the flight. The new tension tests are estimated by each individual force using the PV modules. In the light of the value of force, the highest voltage power is picked as the best new example. Others are arbitrarily devastated with the probability of a Pa (Probabiliy of discovering an alien egg)-such method copying the behaviour of the host winged creature that finds and then wracks the eggs of the cuckoo. At that time, the damaged ones are supplanted by new irregular cases. The strengths for all cases are therefore re-evaluated and the best current results are evaluated. The cycle will continue until all examples reach the MPPT. The sample below should be distributed over the entire voltage distance to look at the entire P-V bend. The test quantity (n) is fundamental. A huge n enhances the efficiency of pursuit (e.g. improvements in the chances of combining to the proper value) but takes longer time to converge. Due to the MPPT problem, widespread simulations reveal that n=3 is a good deal and is used throughout the entire project. The system under CS is shown in Figure 6 with a uniform (typical) irradiation. Three instances of X (green1), Y (red) and Z (yellow) factors are used here. Here are three. The above appendix shows the number of the cycle. Y0 is closest to the MPP in the major cycle; it is deemed the best value according to this line. X0 and Z0 are therefore limited to the Y0. The evolution of the examples depends on how the best example contrasts with alternative examples.

$$\frac{|P(S_{i+1}) - P_{si}\,|}{P(S_i)} > \Delta P \tag{5}$$

$$V_{oc} = V_{oc\_STC} + K_v \Delta T \tag{6}$$

$$V_i^t = V_L + Rand\ (0{,}1) \times (V_H\ - V_L)) \tag{7}$$

Furthermore, the progression sizes for CS, due to the flight of Lévy, are correspondingly bigger than the progression size for the PSO (Particle Swarm Optimization) or GA (Genetic Algorithm) [13]. This result in faster convergence ensures that the ideal position can be achieved on both sides. Once again, the progression size in PSO is based on the vector summation of the greatest instances in the world and nearby, sooner or later. In any event, the arbitrary idea of CS causes the extent of the advance in each focus to shift. Whatever the case, the progression size is littler as the molecule moves closer to MPP. Finally, the progression size reduces to zero following unification with MPP. This clarifies why convergence in the MPP is achieved once; every example continues to remain in the mixture. The instances are initially distributed in various locations of the P–V curve, due to the midway shading. In the first cycle, Y0 is in the best position; consequently, X0 and Z0 are forced away and move to Y0. However, Z2 reaches a superior position in the subsequent cycle than the others;

hence diverse examples progress towards it. It can be noticed that the real MPP is located somewhere on the Z2. Since the Lévy flight allows the best example to pass neighbourhood tests, the X and Y cross Z2 and also the MPP. In MATLAB, the computation is updated. All constants and factors are initially introduced, especially voltage, current, power, number of tests and estimate.

The force is also determined using the current-voltage estimate, current. Also, the new voltage estimate, power, is inserted independently in the Vti voltage, wellness Jti arrays. Before each focus begins, a check is done to determine if the instances have only converged or in any case again. If the instances have been joined to the MPP, then the separate force converges as an equivalent value. If the examples do not meet, all the comparative test force estimates will be calculated and placed on the array. The example with the most remarkable force is selected as the best example by measuring the array. Therefore, there is another test arrangement. The weather conditions must be reacted to improve the efficiency of PV. Two key criteria are used to alter the power, radiation and temperature created by photovoltaics; if photovoltaic panels are installed, power shifts from one area to the next.

Obviously, this similarity does not consider Lévy flight progression size. Be that as it may, CS is much stronger than climbing by a few highlights:

A. CS, however, shows elitism in determination techniques, is a populace based calculation (like GA or PSO) (like concordance search)
B. Randomisation is substantially more productive in CS; because of flight from Lévy, means become greater some of the time, which leads to faster convergence,
C. the CS tuning limits are just two; when three or more limits are required, GA and PSO are three or more limits and
D. the CS execution is not dependent on the introduction of instances at all as is the case with PSO

The following is explained in the pseudo code of the cuckoo research algorithm

1. Objective Function f(x)
2. Generate initial population of n host nest xi, (i=1, 2….. n)
3. While (t<Maximum Generation) or (stop creation)
4. Get a cuckoo randomly or by Levy fight;
5. Evaluates its quality/Fitness Fi;
6. Choose a nest among n (say, j) randomly;
7. Evaluates its quality/Fitness Fj;
8. If (Fi >Fj)
9. Replace j by new solution;
10. End
11. A fraction (Pa) of a worst nest are abounded and new nest are built via Levy fight;
12. Keep the best solution;
13. Rank the solution and find the current bests;
14. End while
15. Post Process of results.

The differences between the expected and the actual output power of a PV module are explained as causing problems in the generation of PV technology. The misalignment can be internal or external depending to its source. When the decrease in PV power takes place because of panel quality, for example ageing and Silicon crystal impurities, the mismatch is internal because it is due to its qualities and is remedied by product replacement problems. In the case of decreasing because of environmental conditions, especially the shadowing of the PV line and the environment, however, the discrepancy is regarded external. The precise difference between two circumstances can be explained here by the fact that shading creates several local peaks whereas the regular situation only reveals one peak. The name of each peak as the highest local power peak among all sites as the global power peak increases the problem for the MPPT system of determining the exact global power peak.

4. SIMULATION & RESULTS

Models the exploration of standalone solar photovoltaic system has been carried to generate an improved maximum power point tracking system for solar photovoltaic system. The maximum power point tracking system has been developed for a battery connected solar photovoltaic system. The system is integrated to an interconnected system which is also connected through inverters and converter system via DC link. Results of the proposed work can be classified into following broad categories-

1. Design Simulation of solar photovoltaic System
2. Design Simulation of Efficient Maximum Power point tracking system based on metaheuristic method using cukoo search algorithm.

The problem of mathematical modelling and design of solar photovoltaic system has been addressed with the help of MATLAB [13]. The process of design has been completed with the help of design of solar photovoltaic panel. Design of maximum power point tracking system integrated with power converters and inverters. The system is also with integrated battery for analysis of charging of battery. The system constitutes of battery used for being feeder by solar photovoltaic system.

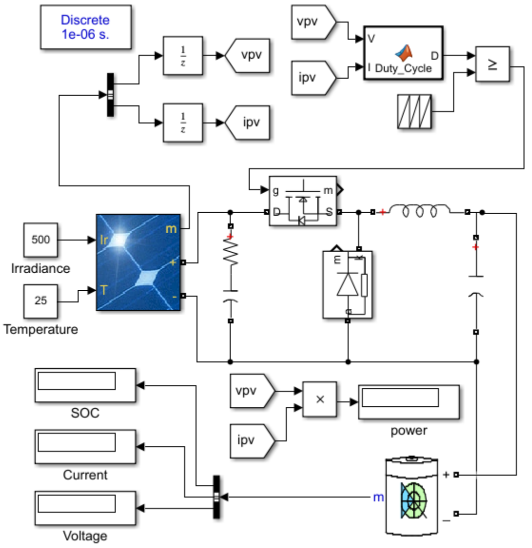

Figure 5: Simulation of PV System integrated with Battery and Maximum Power Point Tracking System using Perturbation and Observation algorithm

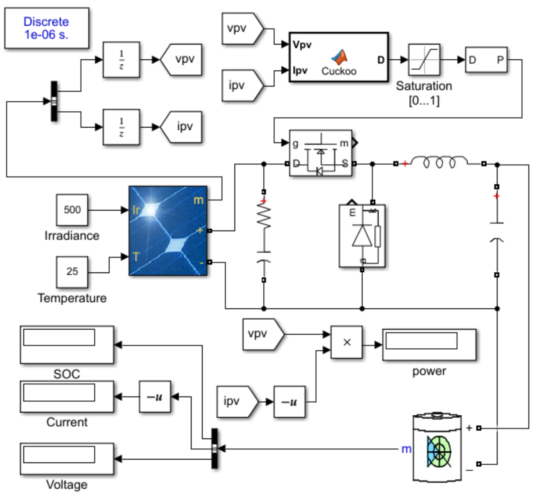

Figure 6: Simulation of PV System integrated with Battery and Maximum Power Point Tracking System using Cukoo search algorithm

Figure 5 and Figure 6 demonstrated the design of system used for simulation. The system is rated at 200 Watt is being provided by a variable isolation to test the robustness of the system for analysis and design of the system efficiency. The simulation carried out is provided to track the maximum power of the solar photovoltaic system which is integrated with a battery bank and interconnected power system. The simulation carried out is divided into two parts. The first part of the research includes the design of maximum power point system which is connected to charge controller, the second part of the simulation is related to the efficient sizing of standalone system.

The stand alone system sizing is an essential part of the design of stand alone solar photovoltaic system as the sizing error can lead to the scenario of power mismanagement. The concept of sizing involves crucial parameters like the load analysis, weather analysis, back up analysis and all related informations which are further analysed.

Table 1: Parameters of Solar Cell Used in System

Parameters	Value
Short Circuit Current	7.84 A
Open Circuit Voltage	36.3 V
Irradiation	500 W/m^2
Quality Factor	1.6
Series Resistance	5.1 mili Ohm
Operating Temperature	25ºC
Energy Gap	1.1 eV

Table 2: Parameters of Battery System Used in Simulation

Parameters	Value
Nominal Voltage	12 V
Rated Capacity	104.16 Ah
Initial Stage of Charge	45 %
Nominal Discharge Current	20 A
Internal Resistance	0.012 Ohms
Capacity at Nominal Voltage	31.02 Ah
Nominal Voltage	12 V

The bus system is connected through the inverters and power converters in order to inject power to the system through the photovoltaic system. The system is designed to have both AC and DC load in form of load and Battery bank. The specification of battery system indicates that the battery used in simulation is rated at 100 Ah (Ampere Hour) with maximum capacity of 104.12 Ah. The battery is of Nickel Metal hydride type with nominal discharge current of 20 A as shown in table 2.

Table 3: Comparative Analysis of Charging Current

MPPT Charging Methodology	Charging Current	Tracked Power	Operating Voltage
Perturb and observe	6.5 A	50-92 Watt	11.5 V
Cuckoo Search Algorithm (Proposed)	8.4 A	100 Watt	12 V

Comparative analysis of charging current is prepared between Perturb & Observe and Cuckoo Search Algorithm, which is presented in Table 3.

5. CONCLUSION

An SPEV offers less transport and use of waste of non-standard energy. The SPEV will benefit from end users such as Industries, Campus University, fun parks. People with physical disabilities will profit with the concept for the automatic driving mode. It is obvious that PEV integration in power systems SPEV contributes its supports to Green Transport is a challenging subject, which has a lot to do with power System, generation, transmission and distribution system. Poor energy efficiency in the Charge Sustaining (CS) mode is the key drawback of the conventional Charge Depleting Charge Sustaining (CD-CS) control strategy. The CS mode is considerably less energy efficient than in CD. In contrast to conventional HEVs which maintain a high-efficiency engine area, PHEVs are much more necessary for the full utilization of electricity to power. The engine-on/ off control rule has been proven to be a vital part of the PHEV energy management strategy as important as engine torque control. It is important to incorporate an effective mathematical model, design and installation process, as well as forecasting techniques for planning and reliability, in order to optimize the use of solar energy.

For maximum power point monitoring, the device was simulated with a maximum power point system based on incremental conductance process. For analysis and design considerations, the device is also fitted with a battery and a DC connection.

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