ENHANCING POWER QUALITY IN SOLAR POWERED ELECTRIC VEHICLES CHARGING STATIONS WITH CLOSED LOOP CONTROL

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ABSTRACT

This is the first all-inclusive model of fast charging EV stations linked to a hybrid grid-RES system, including wind, solar, and mini-hydro. Factors such as EV demand characteristics, arrival and departure times, battery capacity, and state of charge are all factored into this model. In addition to maximizing revenues, this helps minimize power use from the grid. The first simulations are done using the hybrid genetic with pattern search (hGPS) method, which is a major step forward in the evolution of metaheuristic methodologies. They are utilized for fine-tuning the charging station's system parameters, also known as the NPV. As a result, the net present value is maximized. A sequential Monte Carlo simulation and a demand distribution for electric vehicles (EDVs) based on their habits and the time intervals between them are used to conduct the study. Compared to Genetic Algorithm (GA) and Pattern Search (PS) algorithms, the economic considerations gained using the hybrid genetic with pattern search (hGPS) algorithm show that hGPS optimizes profit. The hGPS method was used to make these comparisons. Furthermore, it is clear that the proposed approach lessens the grid's impact on the system network. To do this, the amount of electricity that can be exchanged between the system network and the grid is limited.
Keywords: EV, Genetic Algorithm (GA), hybrid grid-RES, hybrid genetic with pattern search (hGPS) algorithm, NPV, pattern search (PS), and RES.

1. INTRODUCTION:

The amount of energy needed by the world is continuously increasing. Opposite the ever-increasing need for energy, the conventional energy sources—coal, gas, and oil—are under tremendous strain. On the other hand, there is a limited amount of energy that comes from fossil fuels, and these fuels also add to environmental damage. Using solar power is one alternative to conventional energy sources that does not cause environmental damage. In addition to being an endless supply of pure, renewable energy, it also doesn't harm the environment in any way. There are a lot of major hurdles that must be overcome before renewable energy may be used extensively. The large investment required, energy price fluctuations, locational reliance, and energy variability are all factors to consider. The efficiency and power output of the PV modules are very sensitive to changes in the insulating conditions [1]. Improving the PV modules' overall efficiency has been he focus of a great deal of research. As a remedy to the efficiency problem, devices that use the various methods proposed for tracking PV modules' maximum power points have been developed and are already on the market [4]-[8].

Managing maximum power point tracking (MPPT) for the solar array is crucial in a PV system, as PV modules currently have a very poor conversion efficiency. An array's operational voltage is proportional to the amount of power that a photovoltaic (PV) system is capable of producing. Solar insulation and temperature both have an impact on a PV system's maximum power point, or MPP [4].

When it comes to machine learning and other challenging technological problems, GAs are promising techniques to consider. In this research, the optimal control settings of a PID controller are determined using a genetic algorithm. Two distinct kinds of computer programs that mimic evolution are known as "genetic algorithm" and "genetic algorithm." pages 3–4. It does this by iteratively improving a set of possible solutions across many generations. Optimal solution candidates are selected from the population at the start of each generation according to their fitness values. Through mutation, in which the solutions are changed, and crossover, in which prior solutions are merged, these solutions form a new population. It avoids getting stuck at local minima by simultaneously looking for many peaks. From [10] to [12].

2.PROPOSED ALGORITHUM

Genetic algorithmic amplification (GA) is a method for moving from one set of "chromosomes" to another set of "chromosomes." It accomplishes this by utilizing a form of "natural selection" in combination with the genetics-inspired operators of crossover, mutation, and inversion. The building blocks of chromosomes are "genes" (also called bits), and each gene stands for a specific "allele" (like 0 or 1). Research has demonstrated that, on average, more children are generated by chromosomes that are more fit than by those that are less fit. The selection operator determines which chromosomes in the population will have the chance to reproduce. Mutation randomly changes the allele values of some spots on the chromosome, inversion flips the order of a contiguous section of the chromosome, and crossover is the process by which two chromosomes exchange subparts [3]-[4]. Inversion also rearranges the order of genes.

In a GA-using population, chromosomes typically take on the form of bit strings. Each location on a chromosome can have one of two possible alleles, or genetic variations: 0 or 1. Imagine each chromosome as a dot in a search area full of possible solutions or answers. Processing chromosomal populations and subsequently replacing one population with another is the GA's responsibility. Using a fitness function—a function that assigns a score (fitness) to each chromosome in the current population—is practically always required by the GA. The fitness of a chromosome is defined by how well it faces a given challenge [10], [12].

The following is one possible implementation of the GAs algorithm:

1. Begin with a population of possible solutions to a problem consisting of n bit chromosomes that have been produced at random.
2. Determine the fitness value, denoted by the symbol x, of each individual chromosome present in the population.
3. Continue to iterate over the following stages until you have made n offspring:

a. Choose a set of parental chromosomes from the existing population, with the likelihood of selection rising as a function of the organism's level of fitness.

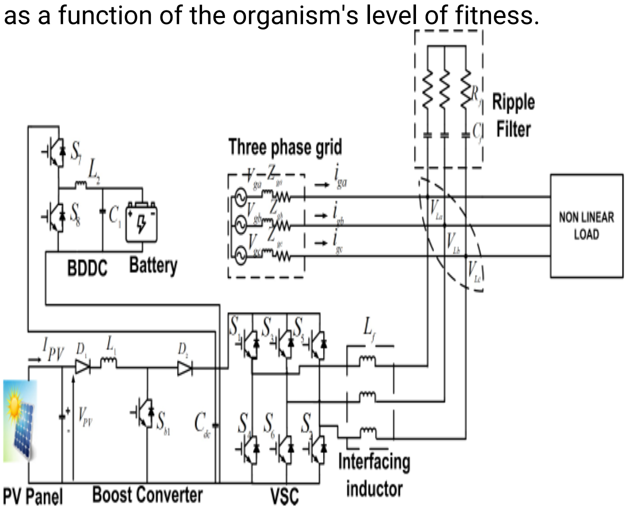

Figure 1: proposed Block Diagram

1. MATLAB/SIMULINK Implementation

MATLAB's graphical system modelling and simulation tool, known as Simulink, is powered by the Simulink plugin. On the screen, Simulink presents system representations in the form of block diagrams. Virtual input and output devices include transfer functions, summing junctions, and other devices like oscilloscopes and function generators. Other examples of virtual input and output devices are function generators and oscilloscopes. are only a handful of the numerous components of the block diagram that may be accessed. Because of their relationship, MATLAB and Simulink are both capable of swiftly exchanging data with one another. A Simulink model of a photovoltaic (PV) charging station for electric vehicles is used.

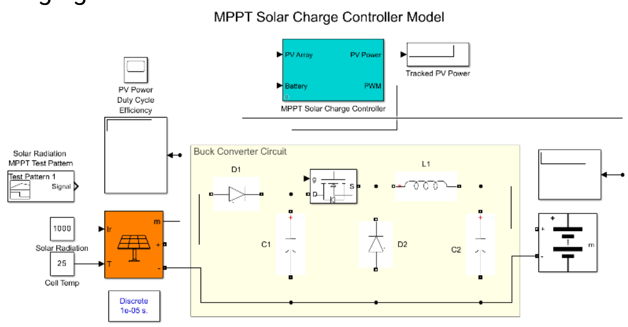

Figure 2: Matlab implementation of an electric vehicle (EV) charging station

2. SIMULATION RESULTS

System performance was examined under various operating conditions at a line voltage of 415 V, 50 Hz, using MATLAB/Simulink. Battery charging and discharging control, an MPPT controller block developed using FLC, a converter topology, and solar PV panels are all components of the system. Charging the battery and draining it both made use of CV and CC techniques, respectively. To compensate for non-linear loads, LMS control algorithms were put into place.

Figure 3 shows the boost converter's output waveform for four different irradiance levels and a constant temperature: 1000W/m2, 800W/m2, 500W/m2, and 250 C. The PV power that allows for accurate tracking under varying environmental conditions when FLC is used is shown in Figure 9. The simulation is conducted with the following values: 45μH for the inductor and 27.7μF for the capacitors of the converter. Additionally, 215.6μH for the inductor and 11.13μF for the capacitor are selected for BDDC.

The PV array is connected to the electric vehicle battery in figure 4. Similarly, figure 5 shows the properties of an electric vehicle battery while discharging. The DC bus allows the EV battery with enough state of charge to power the DC load in the event that the PV fails.

The PV response when coupled to a nonlinear load is shown in Figures 6(a)-(d). Viewed in Figures 6(a)–(d) are the voltage (Vg), current (Ig), compensating current (Ic), and load current (IL) of the grid.

The features observed in the event of an abrupt EV disconnection are illustrated in Figures 7(a)–(e). When EVs are disconnected, the electricity required to charge them decreases. As a result, the power generation from the PV is not overwhelmed by these transients, and the source power increases. Additionally, as seen in Figure 7(c), phase 'a' current is enhanced to sustain power. The compensating current is same to the source current of phase 'a' after the EV is disconnected.

The THD of the load current is displayed in Figure 8. There is a total harmonic distortion (THD) of 29.49% in the load current because the grid appears to be carrying a nonlinear load. The grid voltage (Fig. 10) and current (Fig. 9) exhibit total harmonic distortion (THD) values of 0.09% and 3.07%, respectively, when measured using LMS. Despite a load current THD of 29.49%, both the grid voltage and current fall within the harmonic range allowed by the IEEE standard.

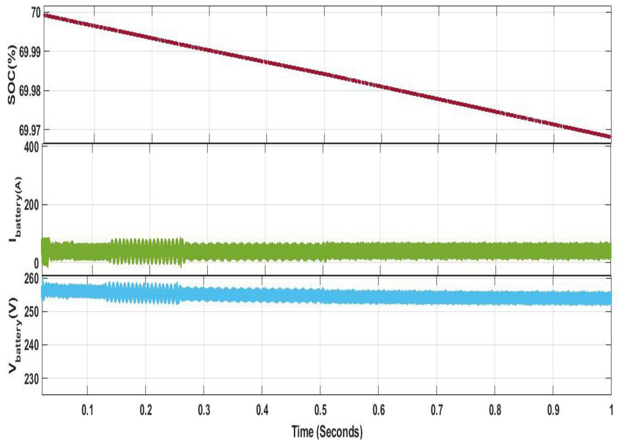

Fig. 3. Boost output for varying irradiances using FLC (a) *Vo* (b) *Io* (c) *Po*

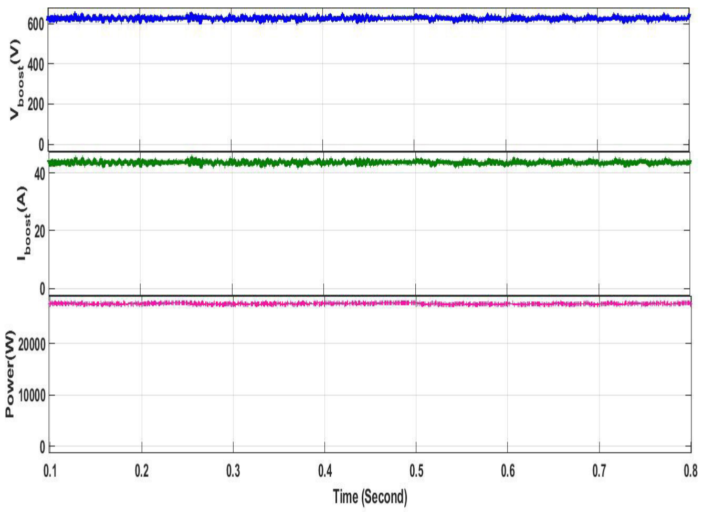

Fig 4 Charging of Ev battery

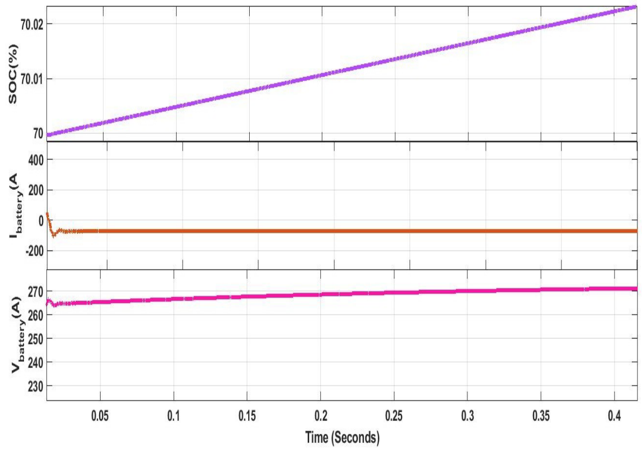

Fig. 5. Discharging of EV Battery

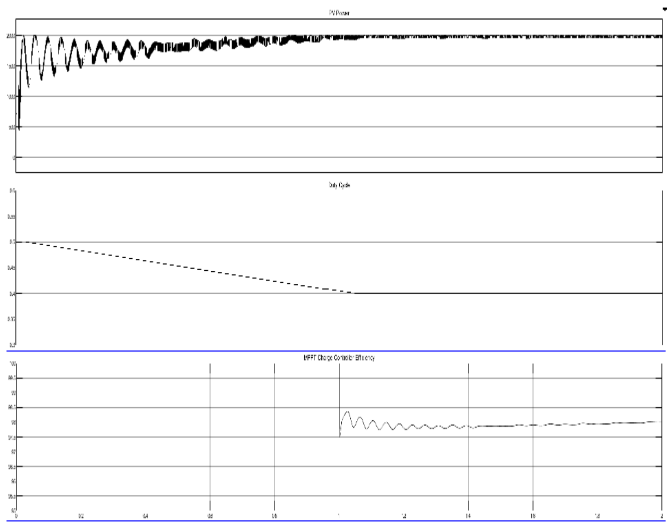

Fig. 6. Load compensation when PV supply power to the grid

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