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DESIGN AND DEVELOPMENT OF ANN BASED ON MPPT CONTROLLER FOR THE CHARGING OF ELECTRIC VEHICLES

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ABSTRACT

Electric vehicles have a substantially lower range than conventional vehicles, range has long been regarded a fundamental hurdle to acceptance of electric mobility. The range of electric vehicles has an impact on not just the vehicle's design but also on driving style and operational variables. The capacity of the battery is the most important design consideration. On the other side, the size of the battery has an impact on the vehicle's curb weight and price. The right battery pack size can also help to extend range. If an electric car is used to commute to work and the daily route does not exceed 50 km, it is inefficient to use an electric vehicle with a 24kWh battery pack when a 50km distance can be covered with an electric vehicle with half the battery capacity. Charging based on the renewable sources is the need of today's electric vehicle.

In this thesis, the modelling of ANN based charging mechanism for the electric vehicle has been discussed and simulated in a MATLAB SIMULINK environment. The results obtained are found to be satisfactorily.

Keywords: Electric Vehicle, Vehicle To Grid, Smart Charging.

I. INTRODUCTION

Charging electric vehicles (EVs) through solar panels is essential for several compelling reasons. First and foremost, it promotes sustainability and reduces carbon emissions. Solar panels harness energy from the sun, a renewable resource, making EVs significantly cleaner than those powered by fossil fuels. This shift toward clean energy sources is crucial in combating climate change and reducing our dependence on non-renewable energy.

Moreover, solar charging provides energy independence to EV owners. They can generate their electricity, reducing reliance on centralized power grids and minimizing the impact of power outages. This independence also insulates users from fluctuating electricity prices, providing long-term cost savings.

Additionally, solar charging can enhance the overall affordability of EVs. By reducing the operating costs associated with traditional fossil fuel-powered vehicles, EVs become more accessible to a broader range of consumers. It also aligns with the broader shift towards a sustainable, clean energy future. In summary, charging through solar panels represents a pivotal step towards cleaner, more accessible, and self-sufficient transportation solutions. Millions of EVs will be used, transported, and integrated into the electrical system as electrical power and battery technologies advance. However, a significant barrier to the successful delivery of EVs on this scale is the lack of suitable charging infrastructure.

In this research work, the main emphasis is given on the utilization of solar pael with improved algorithm to charge the electric vehicles efficiently.

II. MPPT CONTROLLER

A Maximum Power Point Tracking (MPPT) controller is a critical component in a solar panel system, designed to optimize the efficiency and energy output of photovoltaic (PV) panels. It achieves this by constantly tracking and adjusting the electrical load to ensure the panels operate at their Maximum Power Point (MPP), where they generate the most electricity.

MPPT controllers are essential because they enhance the overall efficiency of solar power systems. They adapt to changing environmental conditions like cloud cover or shading, ensuring the PV panels consistently produce the maximum possible power output. This efficiency boost translates into more electricity generation and shorter payback periods for solar installations.

Furthermore, MPPT controllers extend the lifespan of batteries in off-grid or hybrid solar systems. By delivering the right voltage and current levels, they prevent overcharging and deep discharging, which can damage batteries and reduce their longevity.

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In summary, MPPT controllers are indispensable for optimizing the performance, efficiency, and longevity of solar panel systems, making them a crucial component in harnessing the full potential of solar energy. We have used perturbation and observation algorithm to design MPPT controller.

III. PERTURBATION AND OBSERVATION ALGORITHM

The Perturbation and Observation (P&O) algorithm is a widely used method in the context of Maximum Power Point Tracking (MPPT) for solar photovoltaic systems. Its primary purpose is to ensure that a solar panel operates at its Maximum Power Point (MPP), where it generates the highest possible electrical output.

The P&O algorithm works by perturbing (slightly changing) the operating point of the PV panel, typically by incrementing or decrementing the duty cycle of a DC-DC converter or adjusting the load, and then observing the resulting change in power output. It compares the new power output with the previous value and determines whether the power has increased or decreased. Based on this observation, the algorithm makes further adjustments to approach the MPP. This iterative process continues until the MPP is closely approximated.

While the P&O algorithm is straightforward and cost-effective, it may exhibit some limitations. It can oscillate around the MPP in dynamic or rapidly changing conditions, leading to reduced efficiency. Additionally, it may not precisely converge to the true MPP under partial shading or non-uniform irradiance.

In conclusion, the Perturbation and Observation algorithm serves as an accessible and effective method for MPPT in many solar PV applications. However, it may require enhancements or supplementary algorithms to address its limitations and ensure optimal performance in various operating conditions.

IV. SIMULINK MODEL WITH THE MPPT CONTROLLER AND DC-DC CONVERTER

Here we have a simulink model that integrates a solar panel, Maximum Power Point Tracking (MPPT) controller, and a DC-DC converter is a powerful tool for simulating and optimizing photovoltaic (PV) energy systems.

The solar panel component simulates the electrical behavior of the PV module, converting incident sunlight into electrical energy. It considers factors like irradiance, temperature, and the panel's characteristics to generate an output voltage and current.

The MPPT controller is crucial in the Simulink model as it continuously adjusts the operating point of the solar panel to extract the maximum available power. It uses algorithms like Perturbation and Observation (P&O) or Incremental Conductance to find the Maximum Power Point (MPP).

The DC-DC converter module serves to regulate the voltage and current levels to match the requirements of the load or battery. It ensures efficient energy transfer between the solar panel and the target storage or consumption system.

Overall, this Simulink model provides a comprehensive platform for analyzing and optimizing the performance of solar PV systems under various conditions, allowing engineers and researchers to fine-tune the system for maximum energy harvesting and efficiency.

The above discussed Simulink model is shown in the figure below

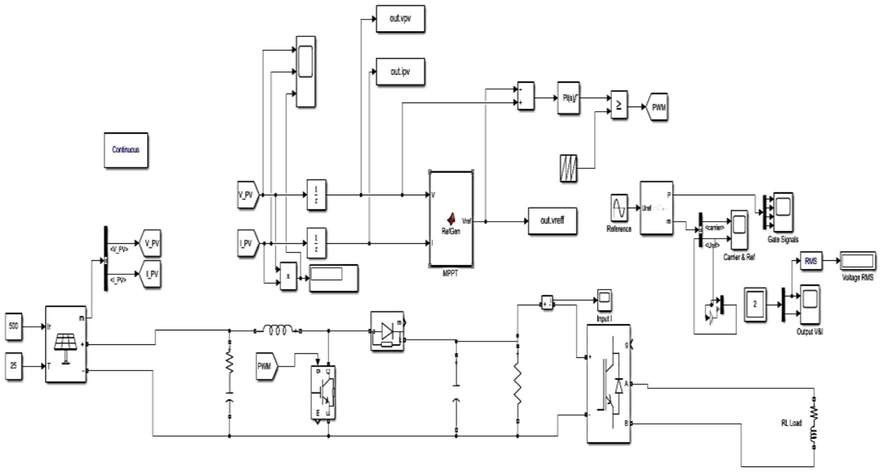

Figure 1: Simulink model without ANN controller

Creation of dataset to design ANN controller

In this section, we have discussed a creation of ANN controller. This ANN controller has been designed with the dataset taking from the previously discussed Simulink model. Here voltage 'V' is taken as the input data and the 'Vref' is taken as the output data. This data has been used to create the ANN controller.

Simulink model with the developed ANN controller

Given below is the developed Simulink model with the developed ANN controller

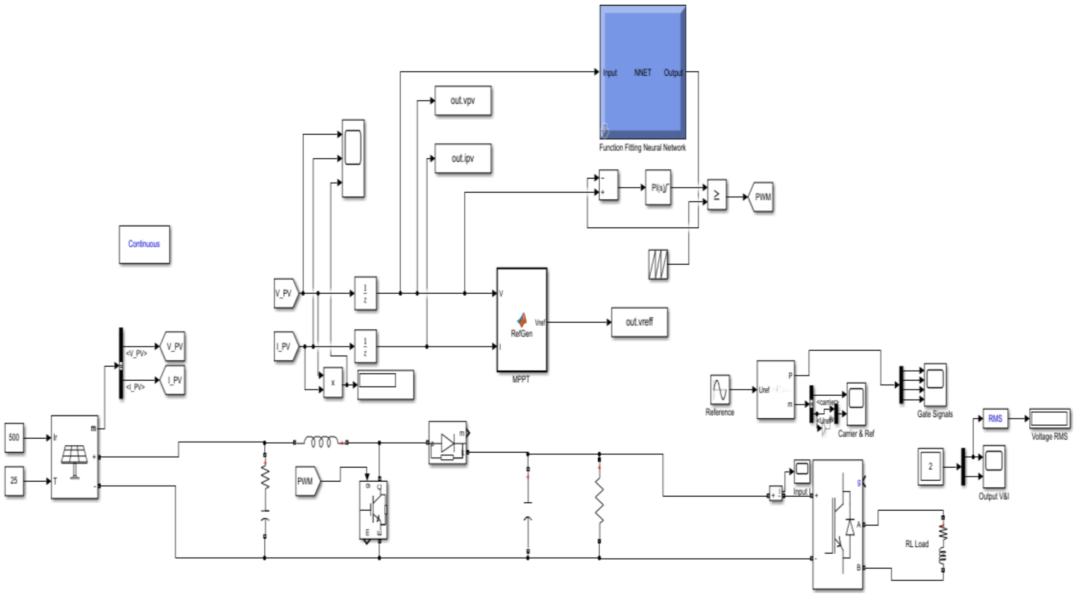

Figure 2: Simulink model with ANN Controller

It can be seen the the blue box is our developed neural network controller which is used to modifiy the pwm signal for the MPPT tracking. It results are discussed in next section.

V. RESULTS AND DISCUSSION

MPPT tracking from the non-ann Simulink model.

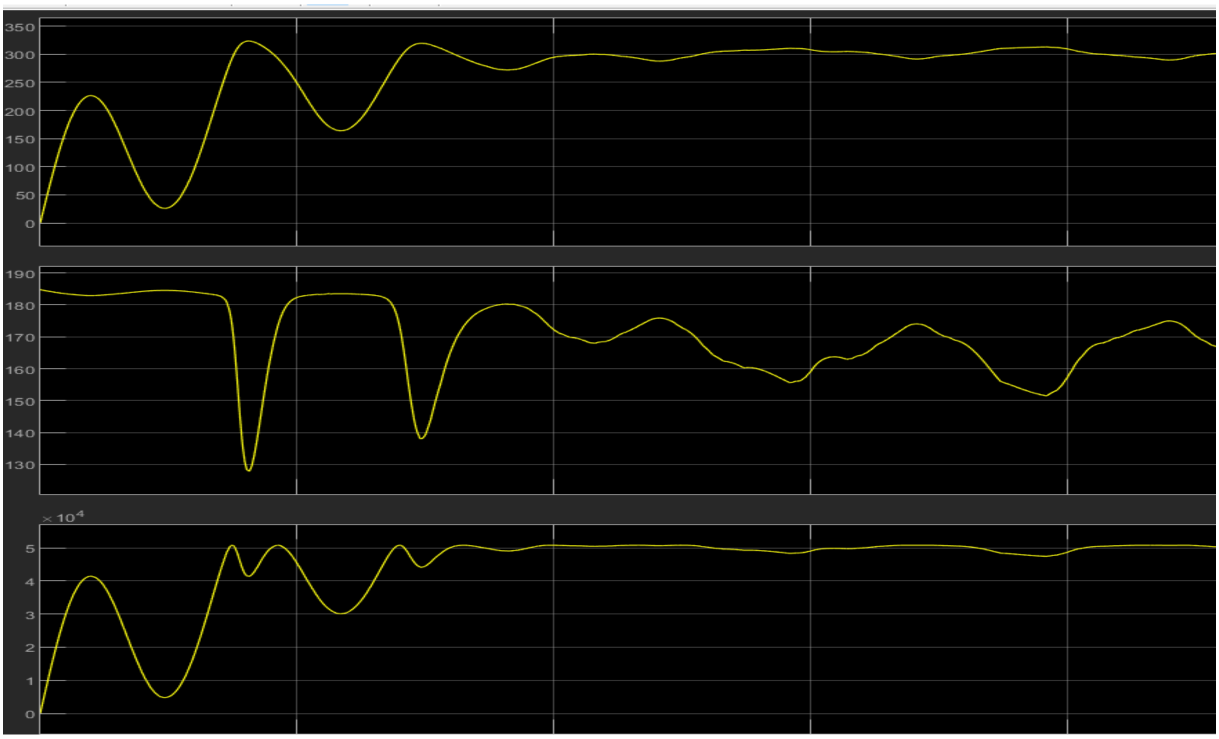

Figure 3: MPPT tracking from the non-ann Simulink model.

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As shown in the figure above, the top waveform is the voltage waveform, the second waveform is the current waveform and the third waveform is the power waveform. It can be seen the power is reaching at maximum power point correctly.

MPPT tracking with the developed ANN controller

As shown in the figure below, the obtained waveform is perfecting doing the MPPT tracking

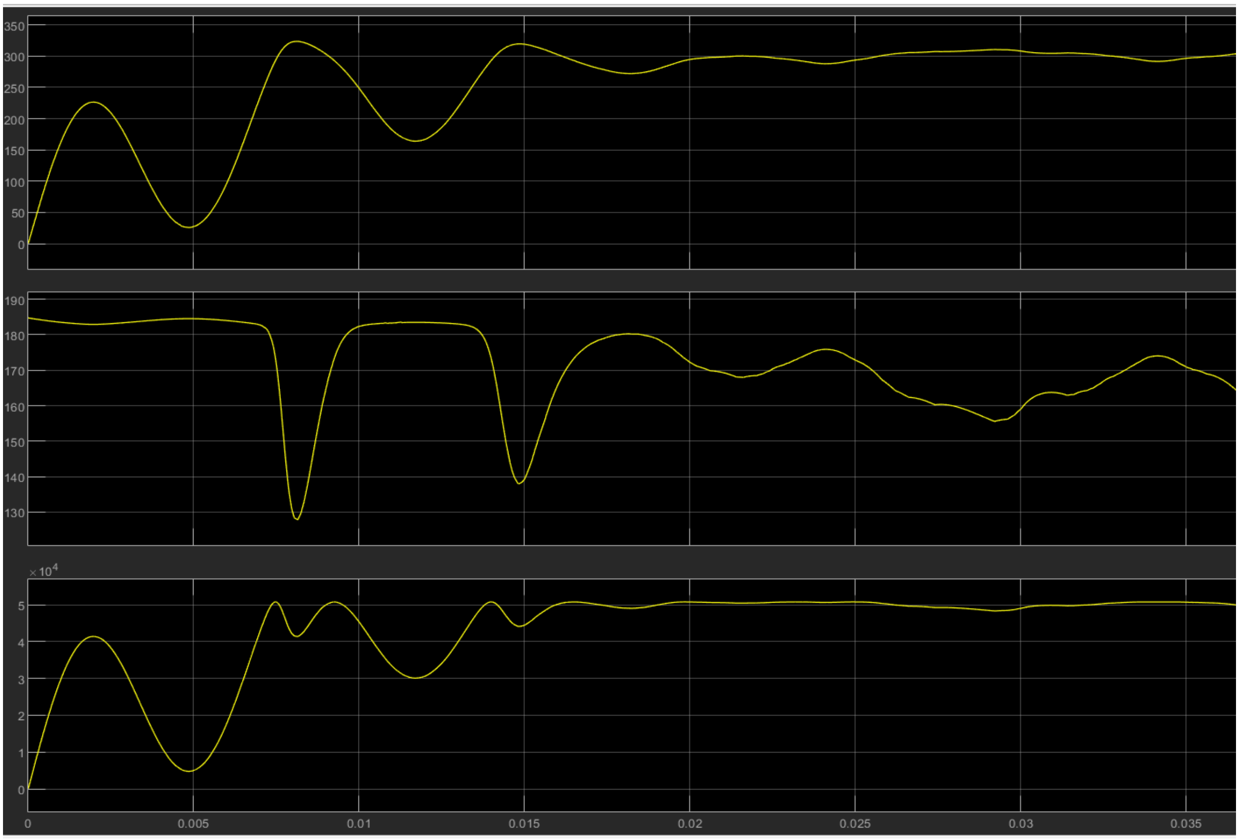

Figure 4: MPPT tracking with the developed ANN controller

Carrier wave and the reference wave is shown below

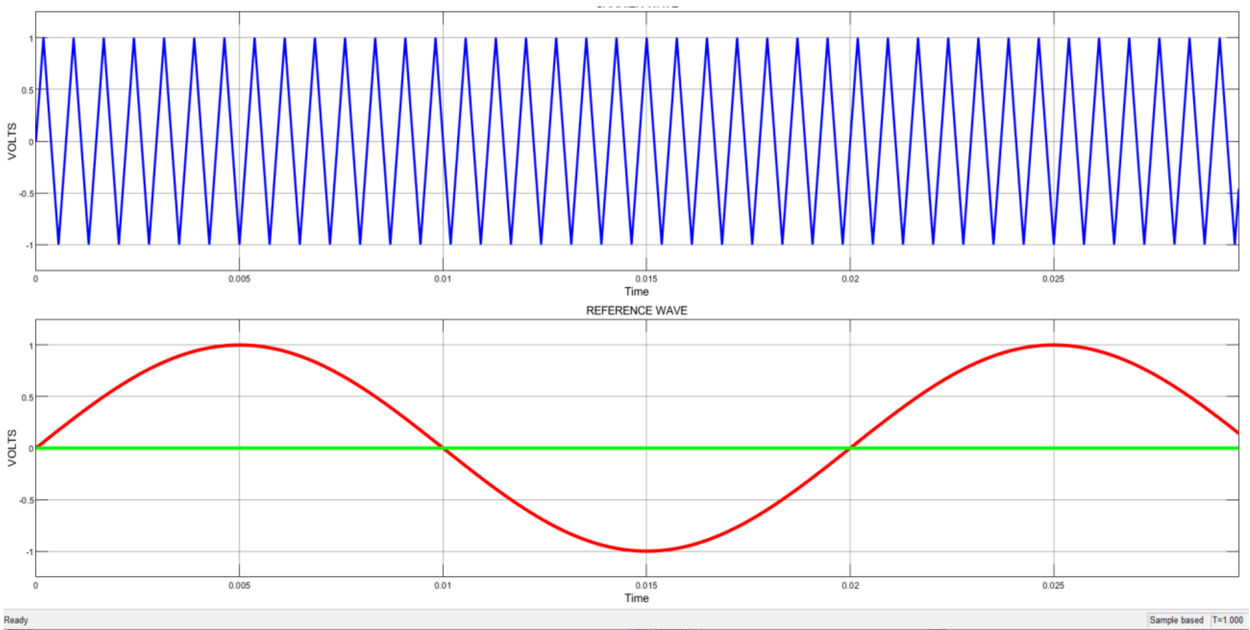

Figure 5: Carrier wave and the reference wave is shown below

PWM signal generated from the ANN controller

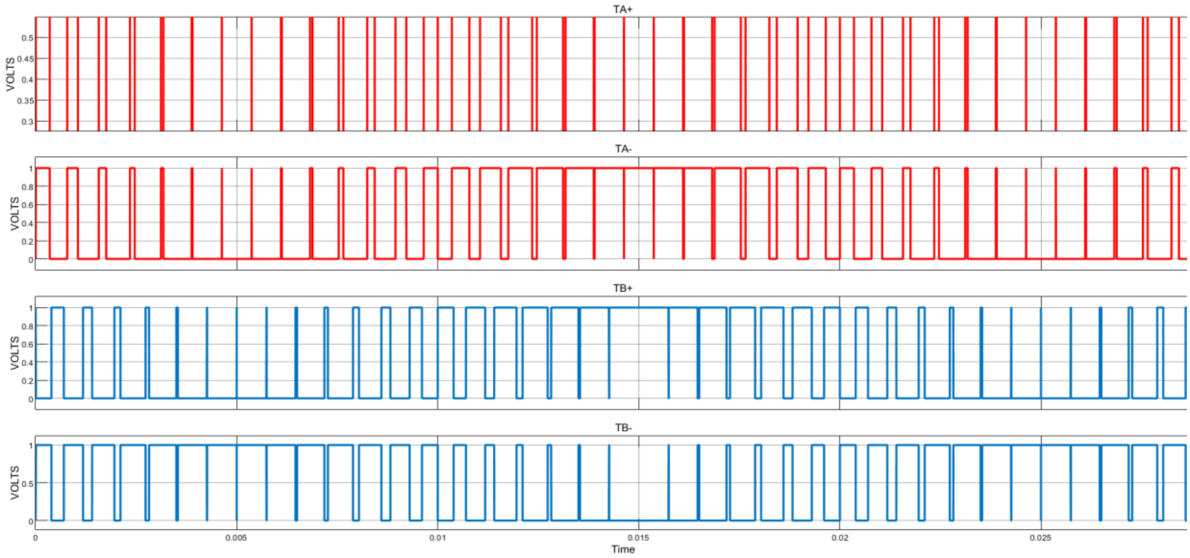

Figure 6: PWM signal generated from the ANN controller

VI. CONCLUSION

This research work focuses on the integration of Artificial Neural Network (ANN) into the Maximum Power Point Tracking (MPPT) algorithm to anticipate the pulse-width modulation (PWM) gating signals for the Insulated Gate Bipolar Transistors (IGBTs) employed within the Simulink model. To facilitate the training of the ANN controller, the Perturbation and Observation (P&O) algorithm was employed to generate the requisite dataset. Preliminary assessments indicate that the developed ANN controller is performing satisfactorily, with the achieved power output falling within acceptable operational parameters.

Currently, our model incorporates a Resistive-Inductive (RL) load as a representation of the load profile. However, as part of future research directions, we plan to diversify the load profiles by introducing different types of motors. This expansion aims to simulate the behavior of electric vehicles more accurately, considering the varying power demands and characteristics they exhibit. By incorporating diverse motor types, our model can better reflect real-world scenarios and contribute to the advancement of MPPT algorithms for electric vehicle applications.

In summary, this research demonstrates the successful integration of ANN into the MPPT algorithm, providing a promising avenue for optimizing power extraction from renewable energy sources. The future inclusion of various motor models will enhance the versatility and applicability of our Simulink-based system, aligning it with the evolving landscape of electric vehicle technology.

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