**Performance Analysis of ML Based Techniques for MPPT under Various Shading Pattern**

**Problem: According to the PDF file, some of the challenges in designing solar units, panels, and modules with exceptional translating shapes include the non-uniform incidence of solar irradiation due to fractional shade caused by surrounding structures, plants, houses, dust, etc. This can result in the PV array's power-voltage curve showing a large number of local maximum power points (MPPs) under these conditions, and out of these LMPP, there will be only one prime peak power point at which the highest power will be extracted from solar modules. Additionally, the PPP's location in the IV plot is not known earlier and must be identified either through model computations or a search approach. The problem is made more challenging by the nonlinear dependency of the PPP on temperature and illumination. ,[object Object],**

**Aim: The aim, as outlined in the PDF file, is to implement machine learning (ML) techniques in existing Maximum Power Point Tracking (MPPT) methods to accomplish the Ultimate Peak Power Point (UPPP) and compare the efficiency of photo systems with conventional MPPT methods and ML-based hybrid methods. Additionally, the aim includes conducting a comparative study of different ML-based MPPT tactics for photo systems under different solar irradiance conditions and designing and developing ML-based MPPT techniques to achieve the Maximum Power Point (MPP) in minimum time and with fewer search iterations. ,[object Object],**

**Parameters:** **The parameters considered in the study include solar irradiance, temperature, and humidity, which were used to train the machine learning models. These parameters are crucial in determining the performance of solar panels and are essential for accurate Maximum Power Point Tracking (MPPT) in varying environmental conditions. Additionally, the study also considered the VI and PV characteristics of the solar panel under uniform conditions, as well as the effect of variable meteorological conditions on the received power from the photovoltaic panel. ,[object Object],, ,[object Object],**

**ML ALGO: The PDF file mentions the use of various machine learning algorithms in the context of Maximum Power Point Tracking (MPPT) for solar energy systems. Some of the machine learning algorithms used in the study include multivariate linear regression, artificial intelligence (AI), fuzzy logic controller (FLC), artificial neural network (ANN), neuro-fuzzy (NF), genetic algorithm (GA), particle swarm optimization (PSO), cuckoo search (CS), and firefly algorithm (FA). These algorithms were employed to enhance the performance of MPPT techniques and achieve the Ultimate Peak Power Point (UPPP) under varying solar irradiance conditions. ,[object Object],, ,[object Object],**

**Efficiency:** **The efficiency of Maximum Power Point Tracking (MPPT) techniques is increased through the incorporation of machine learning (ML) algorithms, which enable the identification of the Ultimate Peak Power Point (UPPP) and enhance the overall effectiveness of conventional MPPT techniques. By utilizing ML-based hybrid models, the efficiency of MPPT techniques can be increased up to 99.8%, and the convergence time to achieve the Maximum Power Point (MPP) can be reduced compared to conventional methods. Additionally, the use of ML algorithms allows for more accurate tracking of the MPP under varying environmental conditions, leading to improved efficiency and performance of solar energy systems. ,[object Object],, ,[object Object],**

**How do ML-based techniques improve MPPT performance under different shading patterns?**

**Sol: ML-based techniques improve MPPT performance under different shading patterns by enabling the identification of the Global Maximum Power Point (GMPP) in a shorter amount of time compared to conventional MPPT techniques. ML algorithms can search for the locality of the universal peak power point at the voltage-current (VI) graph of the photovoltaic (PV) generator with fewer search steps, reducing the time required to achieve the GMPP. Additionally, ML-based techniques can accurately track the MPP under irregularities in temperature and irradiance, allowing for improved efficiency and performance of solar energy systems under varying shading patterns. The use of ML algorithms also allows for the harnessing of maximum power of solar panels at MPP under variable solar irradiance conditions, further improving the efficiency of MPPT techniques. ,[object Object],, ,[T7],**