PERFORMANCE ENHANCEMENT OF A GRID-CONNECTED INVERTER WITH PV ARRAYS UNDER DIFFERENT ENVIRONMENT CONDITIONS USING ADAPTIVE NEURO FIS BASED CONTROL

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Abstract- Inverters that draw power from solar photovoltaic cells and are linked to the power grid are becoming increasingly widespread. Photovoltaic (PV) panels can be affected by external factors such fluctuating irradiance and temperature. Because of this, the PV's performance may suffer. The currently available advances in gird-connected PV inverters do not provide very trustworthy yields or dependability in this scenario. This research proposes a more robust control framework strategy for a pair of PV that are fundamentally incompatible. The final result is a solar inverter that connects to the grid and has a very low total harmonic distortion (THD) of less than 1% for both voltage and current. The regulator implements a control approach comprised of an ANFIS-based control system in tandem with the MPPT's incremental conductance method. The results are validated and simulated with the help of MATLAB Simulink.
Keywords- MPPT, Inverter, Solar, PV

Introduction

Energy is critical to our way of Lives and the economy.The industrial revolution has significantly increased energy demand. Fossil - fuels have begun to deplete gradually. Our civilization's long-term viability is jeopardised. The opposite is true for greenhouse gas emissions from conventional energy generation continue to rise. Reduced carbon dioxide emissions, Global challenges include the need for more sustainable energy systems, safe, clean, and affordable energy. [1].

Using renewable energy sources is thought to be a great way to generate clean, sustainable energy. Solar, wind, and other renewable energy sources are available. One of the most promising renewable energy sources, photovoltaic (PV) systems have attracted the attention of researchers. Solar energy is quiet, clean, pollution-free, and requires no upkeep because there are no moving parts [1, 2]. The adoption of photovoltaic systems is, however, constrained by two important factors. These have high installation expenses and ineffective energy conversion.

One of the efficient techniques is the maximum power point tracking system of photovoltaic modules for lowering photovoltaic power system costs and increasing solar energy utilisation efficiency and efficiency is improved . To maximise the output power of photovoltaic modules, various techniques have been developed. One of these methods is the open-circuit voltage method. This method is based on, which states that the PV module's open circuit voltage is linearly proportional to the PV module's voltage at the maximum power point [4].

The alternate approach is constant voltage tracking (CVT). In order to operate the PV module at a predetermined point close to the MPP, this method continuously adjusts the duty cycle of the DC-DC converter by comparing the measured voltage of the PV module to a reference voltage [4]. The constant voltage approach cannot track the maximum power point as temperature changes, despite the fact that the CVT approach is very straightforward. An alternative technique for figuring out the PV module's peak power is the perturbation and observation (P&O) method. Voltage, current, and power are all monitored for the PV module. After that, the voltage is altered to reflect the direction change. High oscillations around MPP and slow tracking speed are problems with this approach. [5].

Implementation

Hybrids of artificial neural networks and fuzzy logic are termed to be like neuro-fuzzy. It shows hybrid system that synergizes.Both of these techniques are created joining fuzzy systems' learning & adaptive framework. In the literature, neuro-fuzzy hybridization referred to as Fuzzy Neural Network (FNN) or Neuro-Fuzzy System (NFS). The application of fuzzy sets and a linguistic model made up of IF-THEN rules. Power of Neural Networks is responsible for the adaptive or learning capability. ANFIS is one well-known example.

A method for representing and working with uncertain information is fuzzy logic. Each fact or proposition, such as "It will rain tomorrow," must be either true or false according to the more conventional propositional logic. However, there is some uncertainty in a lot of the information that people use to understand the world. In order to represent uncertainty, fuzzy logic assigns numeric values between 0 and 1 to each proposition, much like probability theory does. The degree to which the proposition is correct, as opposed to the likelihood that it is, is measured by fuzzy logic, not probability theory. Fuzzy set theory has been combined with neural networks to control the production of semiconductors. It has also been used in expert systems and control devices for trains and elevators in commercial applications. Significant advancements in many AI systems have been made by including fuzzy sets and fuzzy logic in production systems. This strategy has worked especially well when dealing with ambiguous data sets or when the rules are not completely understood.

A data processing system that draws inspiration from nature and has a greater number of straightforward, intricately interconnected processing components is known as an artificial neural network (neurons). These processing elements are typically organised into layers. Each neuronal connection has a weight that can be adjusted.

Learning and recall are the two main functions of neural networks. Learning is the process by which an artificial neural network adjusts its connection weights to generate the desired output. accepting a stimulus as an input and responding with result in line considering network frame is known as recall. There are several artificial neural network training algorithms. The process is much more complicated at an earlier layer.

ANFIS is a hybrid neuro-fuzzy control system. To put it another way, ANFIS is a kind of adaptive network that performs operations akin to those of fuzzy inference systems.

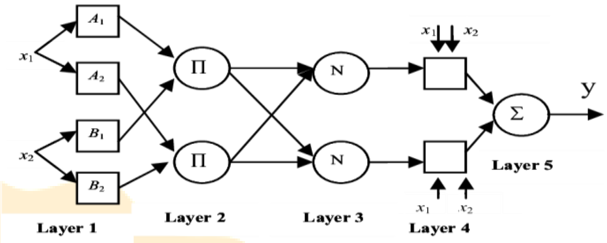

Fig. 1 ANFIS controller structure

In this study's main controller synthesis, The Takagi-Sugeno linear architecture of the ANFIS was applied. To braking & steering manage, respectively, there are two ANFIS systems in use, lies on a FIS work and adaptive network capability, ANFIS controller is a highly efficient system.

Major benefit of ANFIS used is to improve fuzzy controllers' ability to learn on its own, allowing for the achievement of control goals that are close to optimal.

ANFIS is multi-layer network, controller architecture shared by the steering and braking controllers is shown in Figure 1. Four entered variables & one result variable make up the ANFIS. In this system, every point responds to incoming signals by carrying out a particular task. Group of unique info. to every point define this functional feature. The fixed point, in contrast to square nodes, are known as adaptive nodes and have parameters. A group of adaptive parameters make up the adaptive network's parameter set. To gain desired result, these parameters are updated using input-output mapping provided info.

The ANFIS is trained using a blended education formula that joins Gradient Decent Method & Least Squares Method for back propagation. The LSM & gradient descent method can formulated in a variety of ways.

A group of eq. resulting through replacement of paired value for the regression function, written like A0 equals Y, (1) as A equals to matrix made up of the familiar functions of the value entered, y equals to mxl vector result. Eqn. (1) possibly change to include the problem vector . Formula for the sqr. problem sum is m.

Search terms can be chosen using techniques for gradient-based optimization. Directions are given based on the derivative information of an objective function. A real-life example objectively valued function.

• It is important to find least value that minimises £''(0) foremost priority. Following point 0A+I is used in iterative decent methods is influenced by a step down in the direction vector d from the current point 0

Results

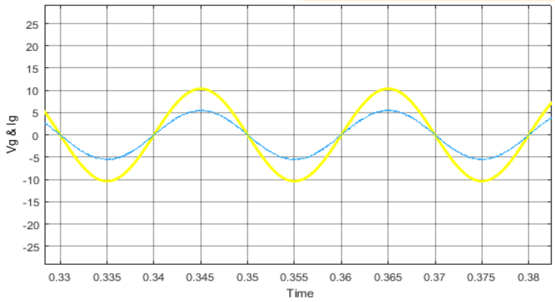

Fig. 2: Output Current and Voltage of Inverter

Using Incremental Conductance scheme without proposed controller, the observed wave shape of output current and voltage is shown Fig. 2.
To measure Total Harmonic Distortion (as defined in chapter 1), FFT analysis of output voltage and current is performed in MATLAB Simulink as shown in Fig. 3 and 4

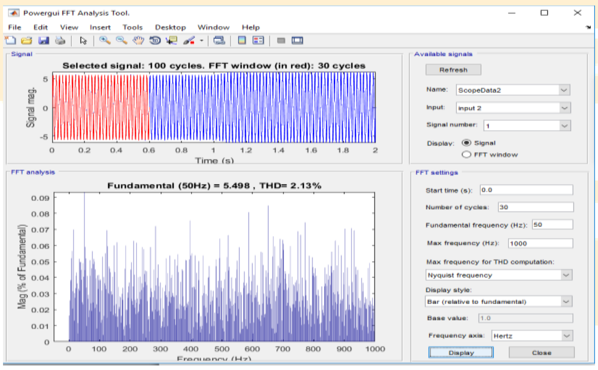

Fig. 3 THD output for Current

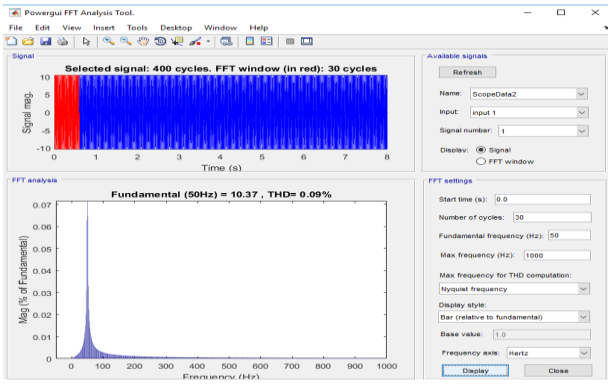

Fig. 4: THD output for Voltage

This section shows the improved results by using Anfis based control regulator

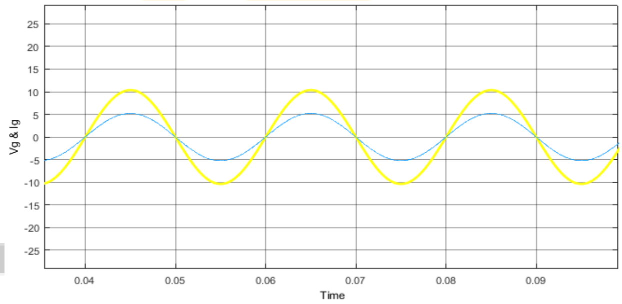

Fig. 5: Output Current and Voltage of Inverter

The zoomed output of current and voltage in Fig. 5 shows a sine wave, which is improved from the existing and less distortion, perfectly fine.

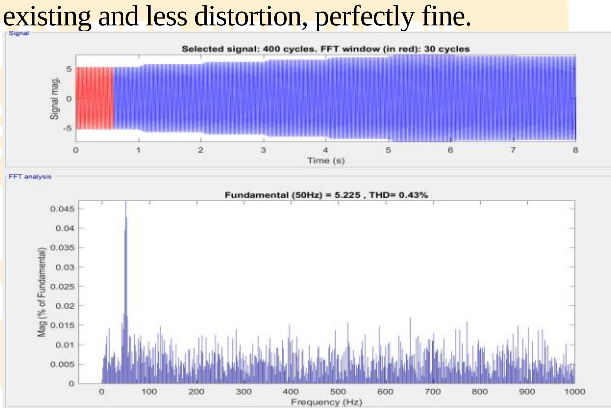

Fig. 6: THD output for Current

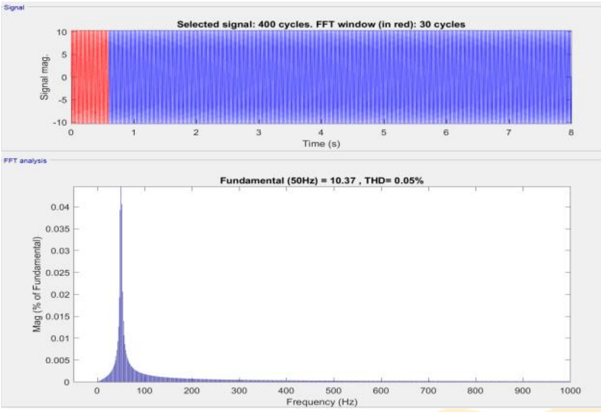

Fig. 7: THD output for Voltage

The final comparison of performance of the system by using Incremental Conductance method & ANFIS is shown in Table 1, based on the findings given in the previous section.

Table 1: Comparison results for Two Inverters

	Existing	Proposed
THD Voltage	0.09%	0.05%
THD Current	2.13%	0.43%

Conclusion

In this study, we realise a more noise- and distortion-free inverter for two PV-based arrays operating in different environments.

Results are displayed in MATLAB Simulink after an efficient experiment has been conducted. Current and voltage waveforms on the grid are enhanced, and distortion is reduced to below 0.5 percent with the suggested controller. The ANFIS regulator accounts for MPPT's inherent unpredictability, environmental fluctuations, and power imbalance.

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