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INVERTER CONTROL FOR GRID-INTEGRATED SOLAR PV SYSTEM

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ABSTRACT:

Renewable energy sources (RES) are gaining extra significance today because of the depletion of fossil fuels and growing electricity demand. Integration of PV device with current grid has so many troubles like distorted voltage, current and reactive power and so on. For improving PQ in a three phase grid-integrated solar photovoltaic system (GISPV) a proper inverter control approach must have to be followed to gain the more efficient overall performance of the GISPV under unfavourable conditions. This paper presents a technical overview on diverse inverter control technique to be had in literature to mitigate numerous PQ issues.

KEYWORDS: *Grid-integrated Solar Photovoltaic (GISPV), Photo Voltaic (PV), Repetitive Control, and Reference frame, Impedance Control, Neural Network (NN)*

1. INTRODUCTION

The issues on the environmental troubles are increasing daily. These issues may be minimized through the use of renewable Energy sources (RES). To conquer the mission of power for the sector desires, from the previous couple of many years a variety of research is going on the renewable energy. Solar power is pioneer amongst them. The sun is a constant source of strength for the world. Solar power generation has also many advantages which includes no wear and tear, much less upkeep and no waste is produced in the course of generation and it's far absolutely surroundings pleasant.

The photovoltaic energy offers many benefits over the alternative RES. They could be installed as standalone or grid connected system.In phrases of preservation and reliability it is above the other RES. It attracted a great investments in last few decades. International agreements and the commitments to reduce the carbon emission had been the riding pressure in the back of growing hobby inside the renewable power sources.

On the other hand, due to depletion of fossil fuels like coal, oil and natural gasoline with the speedy boom of population has forced industrialists, scientists and widespread people for a long term answer of strength disaster. That's why maximum of the research work now-a-days is focusing on a way to capture greater strength from the solar . PV gadget is the most fundamental approach to utilize the solar energy. This system is shaped by way of photovoltaic cellular that is a photo active semiconductor material. It converts daylight at once into electrical electricity. Also it does not need that a great deal protection and operation price.

In grid-integrated solar photovoltaic (GISPV) system, inverters are essential interfaces to connect RES with the utility grid. To reduce the cost, operation, maintenance price, man-hour, as-properly-as

the majority, and beautify the cost-effective characteristics of the GISPV grid-connected inverters performs vital role. The inverter connects the RES with grid and improve the power quality at the point of common coupling. Hence they are able to save capital investment and device area. Several difficult technical issues need to be addressed so that we can completely maximize the benefit of GISPV. Which are defined in short underneath ;

- POWER QUALITY (PQ) CONTROL- It is the most compulsory property and if no longer maintained, it could have an effect on the normal function of electrical structures. Without proper PQ, the system or load may malfunction, fail in advance or no longer operate at all.
- SYNCHRONIZATION- There are unique states; firstly connecting an inverter to the grid and the other is at some stage in the operation. Improper synchronization which results in big disturbances, temporary currents may seem at the time of connection, which might be harmful. During normal operation, the inverter desires to be synchronised with the connected input for proper functioning. In both situations, to synchronise the inverter with the grid voltage, the grid records in a timely manner is needed.
- NEUTRAL LINE PROVISION- For GISPV we need a neutral line to work with inverters so that a path is supplied for unbalanced loads. The provision of a impartial line additionally helps the installation of any compensating devices if had to enhance PQ.
- POWER FLOW CONTROL- Since the simple application of integrating renewable energy, into a grid is to inject power to the grid, for this reason it have to be done in a managed manner.
- FAULT RIDE-THROUGH- When the penetration degree of GISPV to the grid reaches its excessive, it is must so one can efficiently negotiate the short faults that have happened inside the grid, e.g. Voltage-sags, voltage-dips, phase-jumps, frequency-versions, etc.

A nicely designed manipulate algorithm of inverter may additionally triumph over all the above stated demanding situations. This paper provides a technical overview on numerous inverter control to be had in literature to mitigate various PQ issues.

2. GRID-INTEGRATED SOLAR PHOTOVOLTAIC (GISPV)

Integrating solar energy to the grid in most cases have unfavourable impact on the power quality within the grid. The inverter is a key phase that's liable for the control of power quality in GISPV in a few PV based framework. The essential block diagram for designing an inverter is offered in fig-1. The primary blocks are Power levels, , output filtering, , signal conditioning and protection, voltage and current sensing, a digital controller and the necessary auxiliary circuits for isolation and many others. The proper control structure of inverter may additionally completely or partially gives a remedial approach to all the PQ problems. Some of the available manage techniques for inverters are provided in next phase.

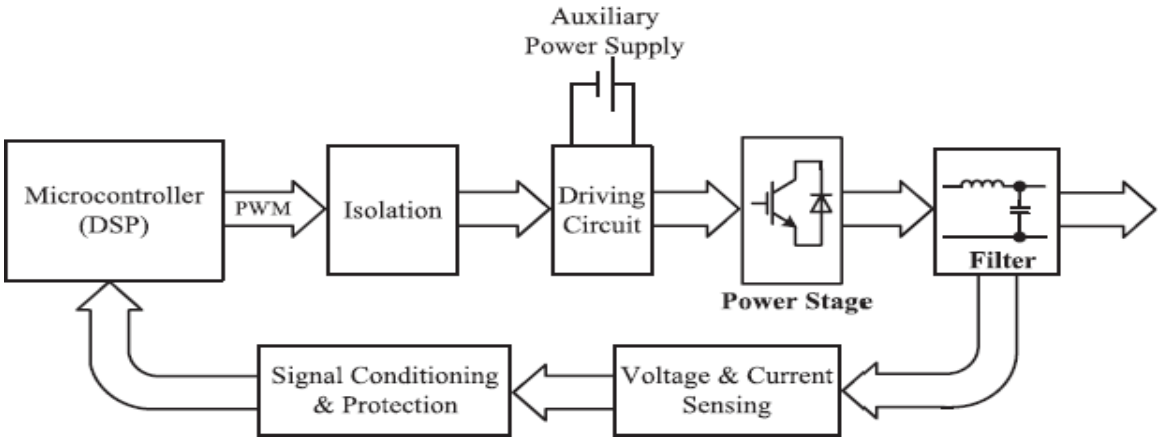

Fig. 1 Functional block diagram of the inverter.

3. INVERTER CONTROL TECHNIQUES

Various inverter control technique have been shown below

3.1 PROPORTIONAL–INTEGRAL CONTROL

These are the broadly used controllers in enterprise. A proportional-integral (PI) controller is applied to grid-connected inverters to track a reference current in order that a desired amount of current can be injected into the grid. This is finished inside the synchronously rotating reference (dq) body. Its equivalent within the natural (abc) frame is presented in Figure -2 which exhibit the performance of the PI manage scheme.

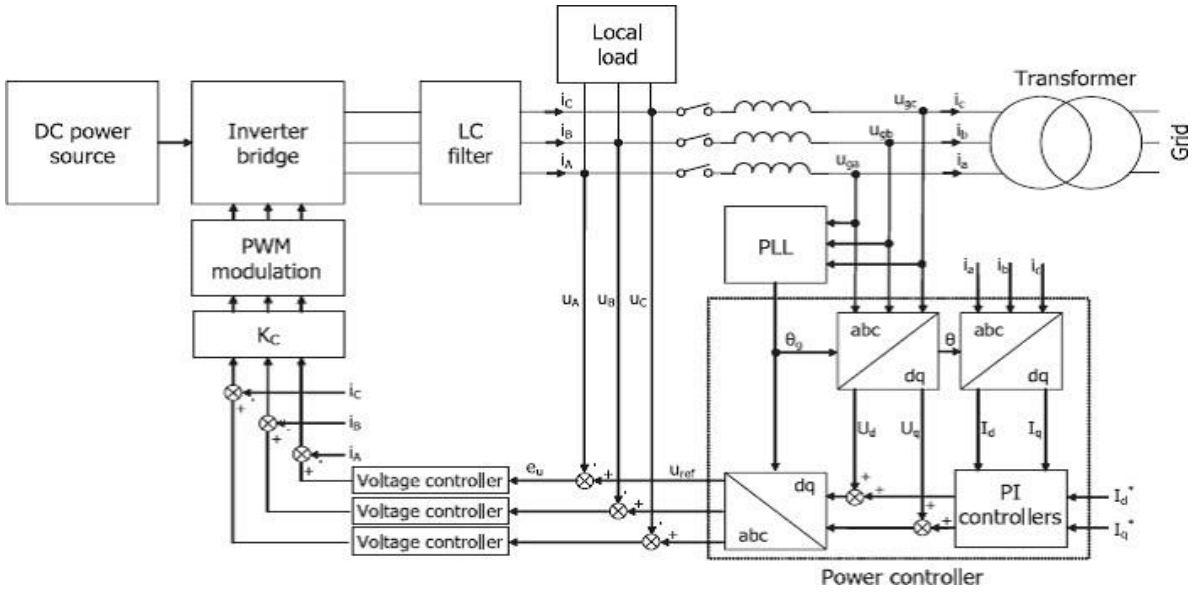

Fig.2 Circuit model of GISPV with PI voltage controller.

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3.2 REPETITIVE CONTROL

Repetitive Control adopts an limitless dimensional inner model that could offer a chain of conjugate poles at all harmonic frequencies. The internal model consists of a nearby positive feedback through a delay line cascaded with a low-pass filter, that's introduced to enhance the steadiness of a repetitive control system because the system without it is a neutral-type delay system. A voltage and current repetitive control inverters is designed using this approach as shown in fig-3.For. voltage controller voltage signal is being selected, while for current based controller current signal are selected as feed-back reference

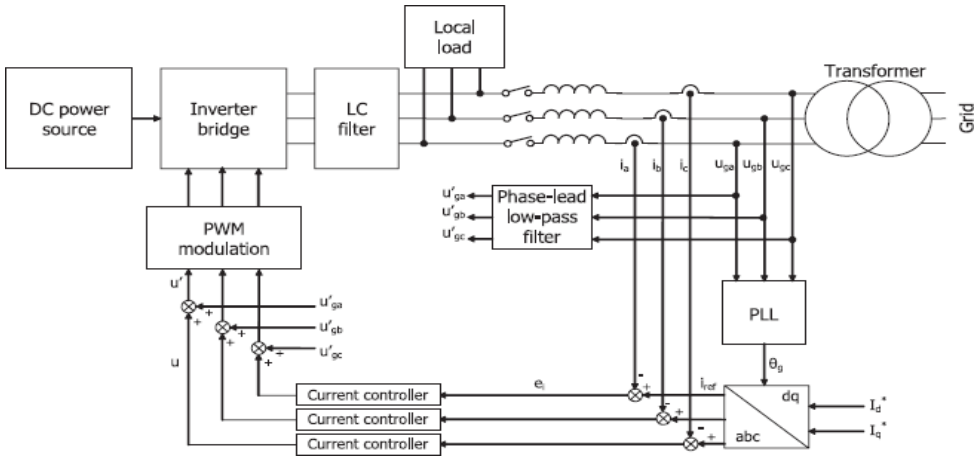

Fig. 3 Cuircuit model of GISPV with repetitive current controller.

3.3 PROPORTIONAL–RESONANT CONTROL

It is also a extensively used controllers for GISPV to regulate the injected current in the grid.For 3-phase inverters, the PR current control controller is designed and implemented, in the natural-reference frame and in the stationary-reference frame. for resonant frequency the gain of PR is high, subsequently it is able to eliminate the steady-state error while monitoring or rejecting a sinusoidal signal. The GISPV with PR controller is shown in fig-4.

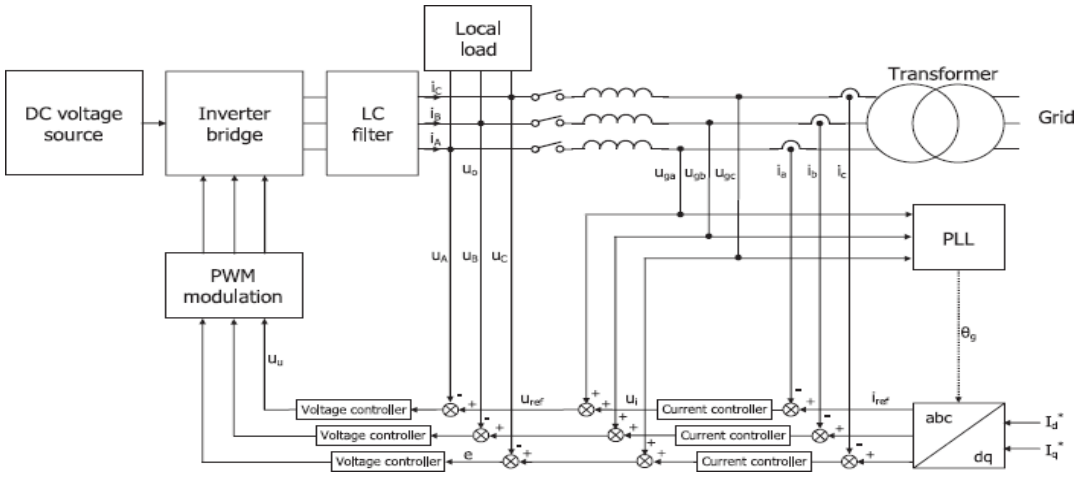

Fig. 4 Circuit model of GISPV with PR controller.

3.4 TRAINING OF NEURAL NETWORK

A neural community is made from neurons linked to every different neurons. Each connection of our neural network is related to a weight that dictates the importance of this relationship in the neuron while expanded via the input cost .Each neuron has an activation function that defines the output of the neuron. The activation feature is used to introduce non-linearity inside the modelling competencies of the network. We have numerous alternatives for activation functions that we can found in this put up. NN consist of three layers i.e. input, hidden and output layers as shown in fig.5. All input are given to the model through input layer. There may be a number of hidden layers for processing of input received from input layer after that the processed data is made available at output layer.

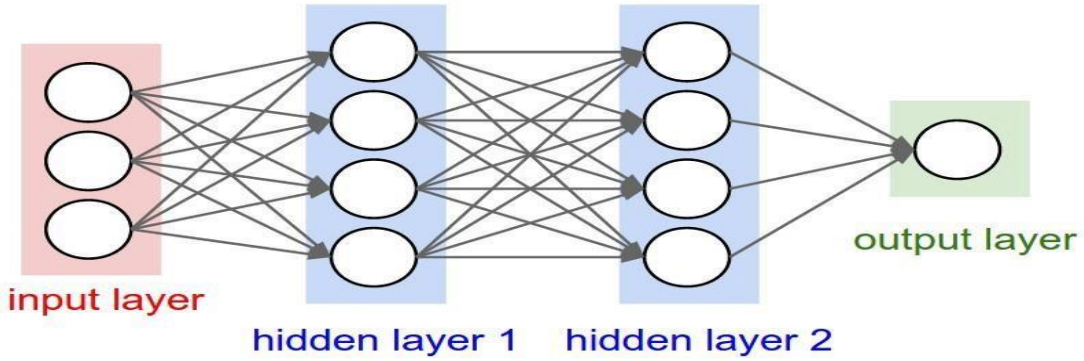

Fig. 5 Structure of Neural Network

The most genuine part of Deep Learning is the training of our neural network i.e. learning the values of our parameters (weights and biases).This learning process in a neural network is an iterative process of " going and return" by the different layers of neuron. The forward propagation of the information is called "going" and the back propagation of the information is called as "return".

The first phase is forward propagation which takes place while the network is exposed to the training facts and those pass the entire neural network for their predictions to be calculated. i.e. passing the input data records through all the neurons in a way that all the neurons follow their transformation to the information they get from the neurons of the previous layer and sending it to the neurons of the following layer. When the records has crossed all the layers of neurons, and all its neurons have made their calculations, the final layer could be reached with a end result of label prediction for the ones input examples. Pass the result through a sigmoid system to calculate the neuron's output. The Sigmoid characteristic is used to normalise the result between 0 and 1.The output can be computed as mentioned below for input I ,weight W and b is the bias.

$$Y = W_i I_i = W_1 I_1 + W_2 I_2 + W_3 I_3 + b$$

Next, we will use a error characteristic to estimate the error & to examine and measure how desirable or awful our prediction end result became in terms of the right result. Ideally, we need our cost without divergence among estimated and predicted values. Therefore, the model is being skilled, the weights of the interconnections of the neurons will step by step be adjusted till accurate predictions are obtained.

Once the error has been calculated, this information is propagated backwards. Hence it is called as back propagation. Starting from the output layer, that error data propagates to all the neurons within the hidden layer that make contributions to the output as shown in fig 6. However, the neurons of the hidden layer get a small fraction of error signal, primarily based at the relative contribution that each neuron has contributed to the authentic output. This process is repeated, layer by layer, till all the neurons in the community have obtained a error sign that describes their relative contribution to the total error and hence the output will be enhanced.

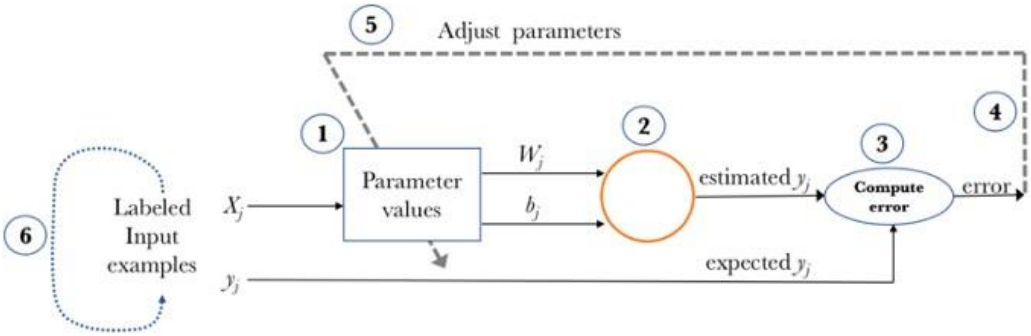

Fig. 6 Predictive control of Neural Network

We additionally focus on the manipulate of the inverter in order to properly inject the identified reimbursement currents. We advocate to use manipulate strategies based on ANNs wherein multilayer and recurrent networks interconnected in novel configurations have been added in a unified way. We therefore introduce different learning schemes: a neural PI scheme as shown in fig.7 and a direct inverse neuro-manage schemeas shown in fig.8.

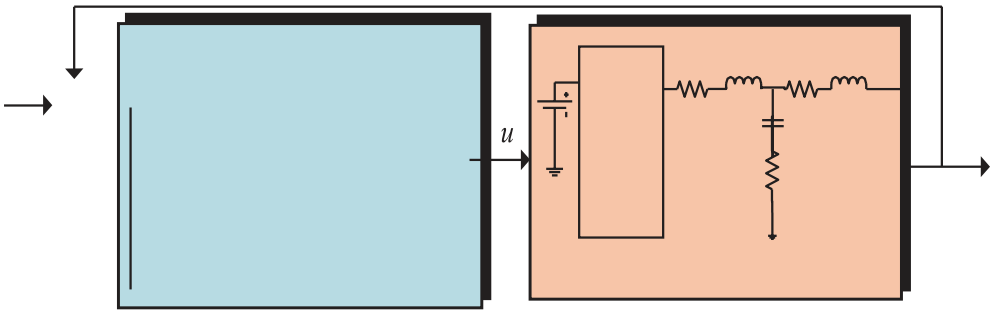

Fig. 7 The neural PI regulator scheme applied to the control of an inverter

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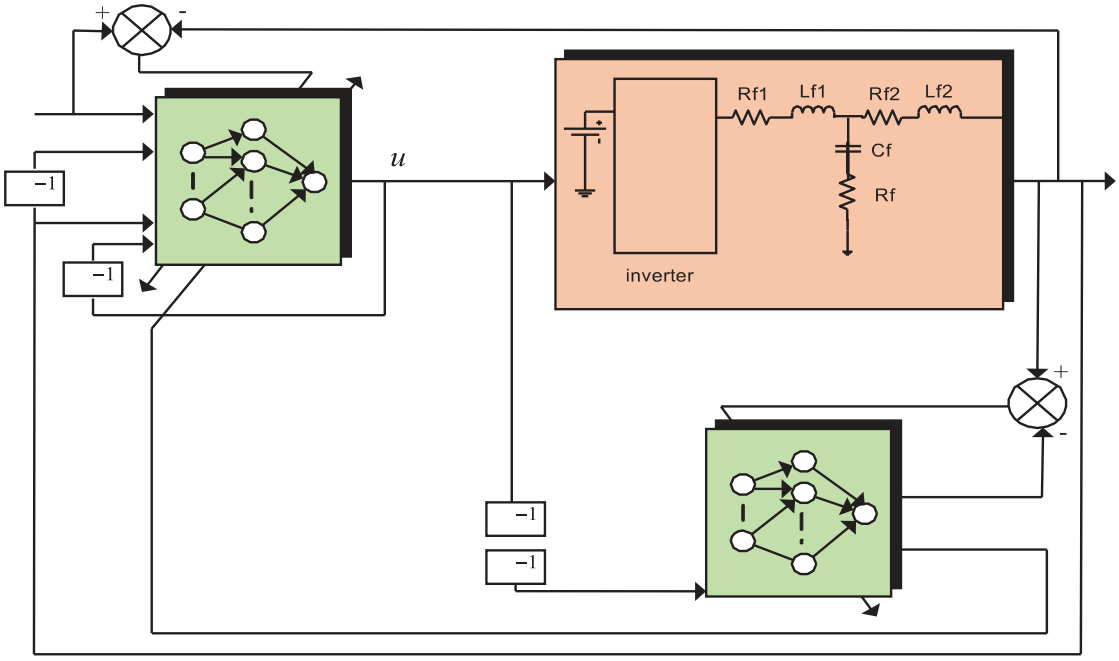

Fig. 8 The direct inverse neuro-control scheme applied to the control of an inverter

5. CONCLUSION

This paper gives an outline of requirement of power quality at the time of designing an inverter for GISPV. A short assessment review on basic control requirements for grid integration of PV system is presented. The most widely used manage techniques like PI, repetitive control, PR control,neural network control is likewise described in short and the factors in their circuit model is likewise presented.

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