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Sensorless Iterative Solar Tracking In Multiple On-Grid Photovoltaic Generators With Improved Tracking Strategy

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Abstract. The efficiency of the energy conversion in photovoltaic panels varies according to the angle of light incidence. A new method of iterative repositioning of the panels at maximum-efficiency direction has been proposed. This method frees up the use of sun position sensors and uses the instantaneous power delivered to the power line by each panel, among a series of photovoltaic panels, as a feedback in determination of the best position in a closed-loop operation. The proposed repositioning method, as well as the repositioning dynamic of a series of photovoltaic panels, has been modeled. The system has been simulated in a single parallel-rays light source scenario. In simulations, the convergence of panels to the best energy conversion position was observed.

Key words

Solar Tracker, Solar Energy, Photovoltaic Panels, Sensorless Control, Iterative Control.

1. Introduction

The increasing demand for electric power and the emerging need of reduction of the human activities impact on the environment has motivated much progress on the development of alternative energy sources [1], with special attention to renewable energy sources, said sustainable [2]. In this context, stands the study of the luminous energy to electrical energy conversion [3]. This one is shown to be gainful considering the reduced environmental impact, in addition to its high reliability and low cost of maintenance and operation [4], [5].

Nevertheless, the use of photovoltaic (PV) panels still exhibits a slow and progressive growth, mainly because its elevated cost per watt(U$/W) [6]. Thus, it is noted the necessity of improving the efficiency of PV panels, with the purpose of minimizing its implementation cost.

The critical point observed on optimizing the use of PV panels consists mainly on the control of the orientation direct through the light source direction [7] and the control of his load operation [8], [9], in different situations of irradiation and power demand.

The active methods for panel reorientation through the light source direction latterly used can be sorted in two main groups: the position control using sensors of the light source position; and the geoastronomical based. The first, also known as Solar Tracker, basically consists in luminosity sensors connected to a controller that acts on the correction of the position of the panel in relation to the sun's position [4]. On the other hand, the geoastronomical control is based on a reference table of the sun's position through the year and on the open loop orientation of the photovoltaic panels by the previously calculated best position. [2], [3], [10]. In both cases, the main function of the position control is to ensure that the sun light incidence is the most perpendicular to the PV panels as possible, operating in one or two rotating axes (Fig. 1).

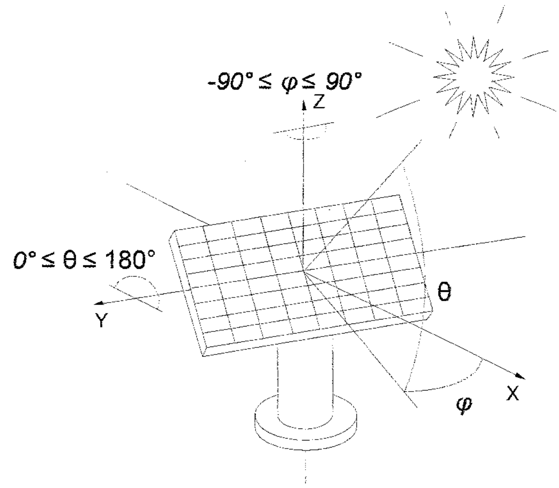

Figure 1. Orientation axis of a photovoltaic panel.
φ – east-related orientation. θ – horizon-related elevation.

In this context, a closed loop control strategy of PV panels was looked for, without using sensors of the position of light source. Therefore, it was assumed that the instantaneous power generated by each PV panel, of a set of panels, can be used as an indicator of its relative orientation to the light source [11]. Thus, it enables the sensorless reorientation of the PV panels, even in a challenging scenario in which all the PV panels are connected to the power line through individual DC/AC inverters.