| European Association for the Development of Renewable Energies, Environment and Power Quality (EA4EPQ) | International Conference on Renewable Energies and Power Quality (ICREPQ'11) Las Palmas de Gran Canaria (Spain), 13th to 15th April, 2011 |
|---|---|

# Filtering and Processing IR Images of PV Modules

S. Vergura, O. Falcone

Dipartimento di Elettrotecnica ed Elettronica
Politecnico di Bari
Via E. Orabona 4, 70100 Bari (Italy)
Phone/Fax number:+39 080 5963590, e-mail: vergura@poliba.it

**Abstract.** The aim of the paper is to propose a procedure to process InfraRed (IR) images of PV modules. In fact, when an IR image is acquired by thermo-camera, three possibilities can happen. The first one regards the acquisition of an IR image of a well-working PV module; in this case the IR image reveal no anomaly. The second case regards the acquisition of an IR image of a bad-working PV module; then, the IR image reveal clearly the anomaly. The third one regards the acquisition of an IR image, which gives no clear information about the *health* of the PV module. In this last case, the uncertainty can be totally or partially removed only after filtering and processing the IR image. Proposed procedure and tools have been applied on IR images of real PV modules.

## Keywords

Infrared analysis, median filter, gaussian filter, edge detection

## 1. Introduction

When a PV plant is built up, it is very important to monitor its energy performance, because of the very low efficiency. In fact the efficiency range goes from 6% to 17% for commercial PhotoVoltaic (PV) modules, depending on the used material. Then, an efficiency decrease of some per cent affect strongly its energy performance. The energy decrease of a PV plant can depend on the PV modules (one or more) or on the Balance Of System (BOS). When the anomaly or failure depends on a PV module, two case can happen: the PV module produces no energy or PV module produces less energy than the expected one. In the last case, an effect of the reduced energy production is an abnormal heating of the PV module. Usually the abnormal heating of an area of the solar device is due to the presence of defects, called shunts [1]. Defects act as a parasitical resistance connected to the cell; they may be due to some fabrication steps or else to the features of the substrate itself or to the normal/abnormal ageing. The defected area shows a temperature increase (hot spot) with respect to the remaining cell that could be small or strong depending on different factors. Often, it may be very difficult to highlight hot spots related to defects because of their reduced dimensions. The advanced thermography allows performing an efficient, systematic and non destructive [2] investigation on typical defects in solar cells [3]-[4] and the identification of possible hot spots that may also be conducted in an automated way [5]. Some typical defects have been implemented and simulated in COMSOL environment [6]. Nevertheless, sometimes it is not possible to obtain sufficient information from an IR image because thermo-cameras have low resolution. In fact, an *high resolution* thermo-camera has a resolution of only 640x480 pixel. Moreover, sometimes IR images are dirty, then it is not easy to understand the cause of an overheating. For these issues a proper processing of the acquired IR images has to be performed [7]. The paper proposes tools to pre-processing and processing IR images, when the acquired image cannot give satisfactory information about the health of a PV module. Particularly, the paper proposes the application of both median and Gaussian filters and then the edge detection. The procedure has been implemented in a Matlab Graphical User Interface (GUI) in order to fast the whole procedure.

## 2. Proposed algorithm

The main functions of the proposed algorithm are reported in Fig. 1. Let us study the single steps.

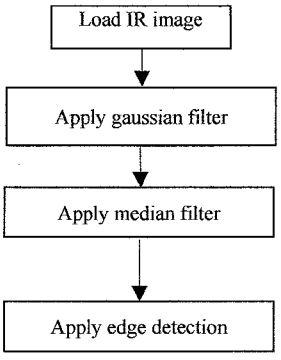


FIG. 1. THE PROPOSED ALGORITHM