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The Detection of Solar Array Failures with Guided Thermal Image Filter

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Abstract

The development of green technology achieves acceptable improvement. Especially, concerning with the production of green energy to decrease pollution effect worldwide. One of the most important thing concerning with green energy is the development of solar panel plants to generate electricity. The building plants is very large with uniform arrangement, the size, color and high are the same. So that, the failures and mal-operation of solar panel will be a big problem. There were many method available to detect the failures. The use of signal from network current and voltage can be detected the effect of failures, some other method applied IR and visual image to study the characteristic of failures. The proposed method use both IR and RGB images to detect and identify the location of failures. So, It make easier to find the solution to handle the problem. The results show the proposed method has high accuracy and feasible at any place. Since it is very cheap and efficient components. Furthermore, the proposed method can be implemented everywhere.

Keywords: *failures detection, solar panels plants, guided thermal image filter*.*.*

1. Introduction

In the last ten years, the development of Solar Array (PV) infrastructures grew rapidly. These alternative electrical sources become popular choices around the world. Many countries attempt to build big and several PV installment quickly to increase electricity[1]. The Solar energy is the third selected renewable energy sources beside water and wind energy as the first and the second selected respectively. The advantages of Solar energy that make it very popular is the low level of carbon emission. Furthermore, the Solar energy decreases the global warming phenomena. However, the Solar panel that produced by Solar energy to satisfy energy need is very expensive[2]. It is needed thousands of Solar panel plants to be build. Every Solar panels connected to form a solar panel network. The network consist of thousands similar solar panels in color, shape and other features. Consequently, the failures of one solar panel become very difficult to detect[3]. The failures might be caused by cracked PV cells and dirty on the panels. This problems decrease the efficiency of the plants significantly. Anyway, there were many methods exist to handle the problems in scientific articles nowadays. The first is using comparing a pair of residual signal of each network manually[3]. Then, the installment of Wireless Censor Network (WSN) nodes at every solar panels is able to detect the anomalies[4]. Hence, the using expensive thermal camera to measure the temperature and view the solar panel clearly[5]. The other method is using thermal camera to view the profile temperature of solar panel[6]. The use of gray image form of visible image used in detecting solar panels satellite problem[7]. Furthermore, the applying of data irradiance of the scene and temperature of the solar panel used to model the PV modules. The data is then trained with ResNet model[8]. Finally, the method used visible image to detect physical damage of PV panel with CNN[9]. The use of image included thermal image is used to detect failure and mal-operation of the Solar panel plants. In accordance with the availability the censor devices in the market, this method is feasible to handle the common physical problem of PV panels. The rest of the paper consist of Materials and Method, The Result and at the end is conclusion part.

2. Materials and Method

2.1 Materials

The proposed method is intended to detect the failures of PV panel in the electric energy plants. The main component of the method is a thermal and RGB camera. Those two camera are installed on the drone. The drone flight will take photoshoot on the solar panel plants.
The price of the devices is not expensive and available in common market. Then, it easy to obtain the main components to handle the very important problem in maintaining and monitoring continuity operation of solar energy plants. The applying drone to capture the image scene of Solar energy plants is very efficient. It can grab very large scene region. The drone used is as shown in the Fig. 1(“Drone with thermal and visual”) below:

Fig. 1 Drone with thermal and visual

Fig. 2 The set of thermal and RGB camera

The pair set of camera, thermal and RGB camera is placed side by side as shown in the Fig. 2(”The set of thermal and RGB camera ”). The setting of camera position makes object view for both camera be different. Then, the both cameras also have different focus region. Since, the distance from camera to the object is very long, the images have potential distortion effects. The setting camera parameters become an important stage to be done.

2.2 Method

The proposed method consist of many stages. Since, the setting of camera position is not in one place, the Thermal and RGB cameras have misalignment. The image of both IR and RGB to a same object is as shown in Fig. 3. The scene of the image between IR and RGB have shifted position left and right. Since, the Thermal camera on the right and RGB one is on the left part or front and rear (cause of the drone have ability to turn over and over). The pair of images will be an input image of the proposed method.

Image Alignment: This processing generates the two images become align. Therefore, they can synthesis each other. The aligned images is as shown in Fig. 3("The pair of Thermal and RGB image").

Fig. 3 The pair of Thermal and RGB image

Both images also have different scalability and misalignment each other. In order to make both images feasible to be processed, they should be align. The alignment process is done manually. The proposed method used input image as in figure 4 ("4 RGB image of dataset 1") and in figure 5("Thermal image of dataset 1") following:

Fig. 4 RGB image of dataset 1

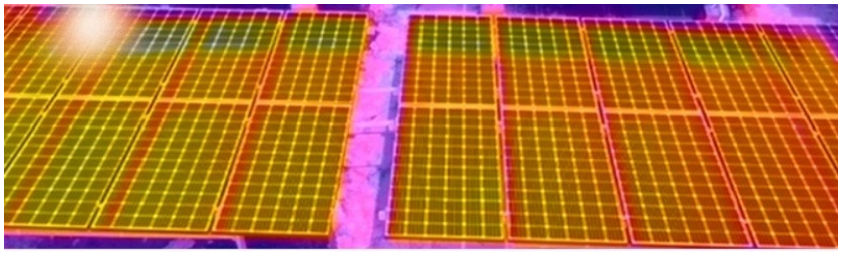

Fig. 5 Thermal image of dataset 1

The first is creating registered images pair. This process is to handle the setting two different position of cameras.

Morphological Filter: The opening operation is also a sequence of morphological operations. The opening operation consists of dual procedures, dilation and erosion operations. It performs dilation and erosion operations consecutively[10].This operation generates predicted heat map. It is shown in figure 6(“he predicted anomaly map”).

Fig. 6 The predicted anomaly map

Guided Image Filter: Guided image filter is a filtering process in image processing that the output influenced by the capacity of guidance image. The guidance image is a kind of reference image which comes from input image or another image. Furthermore, the process using guided image filter involves two images and produces one filtered image[11]. The optimization based on Guided Image Filter is shown in figure 7(“Optimization of predicted anomaly map”).

Fig. 7. Optimization of predicted anomaly map

The Anomaly map: It is a map that consist of anomaly information from IR image. It presents the location of anomaly on the map. It is as shown in figure 8(“Anomaly map”).

Fig. 8 Anomaly map

The Detection and Identification: This process involves both thermal image and visual image[12]. The process generates properties of anomaly thermal on the spatial map. It shows the clear information about the location of the failures solar panels. It is as shown in figure 9(“Failures of solar panel map”).

Fig. 9 Failures of solar panel map

The second, generating the anomaly region and finally, performing optimization process to the anomaly regions. The block diagram of proposed method is as shown in the Fig. 5.

3. Results

The use of proposed method to other dataset is as shown in figure 10(“A pair of IR and RGB image of dataset 2”).

Fig. 10 A pair of IR and RGB image of dataset 2

The figure 11(“The anomaly map (left) and the failure map of solar panel (right)”) presents anomaly map and the output of proposed method. It can place the anomaly map to spatial map of visual image.

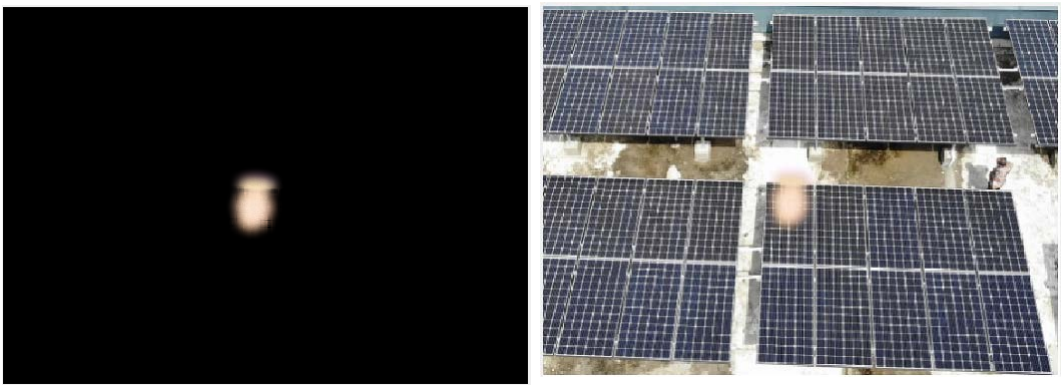

Fig. 11 The anomaly map (left) and the failure map of solar panel (right)

4. Conclusions

The development of solar energy increases rapidly in the recent years. Many new big solar panel plants build at many countries around the world. The large and high building of solar panel possible to receive photon energy from the sun efficiently. However, the failure of solar panel operation become a serious problem. The proposed method is a kind of a new method to detect the failures of solar panel with high accuracy. The proposed method have applied in the mini solar panel plants. The results show that it robust to any noise and instability because of irradiance. Finally, the method can be implemented in the very large of solar panel plants.

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