Research on Constructing a Platform of Solar PV Module Position Identification and Image Health Diagnosis Information

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Research purpose：

TPC has cooperated with the government's energy transition policy and actively invested in green energy development. Since the completion of the phase I 18 MW solar PV system at the end of 2014, the company successively built the phase II rooftop solar PV systems in TPC's own buildings in 2016, the phase III 100 MW solar PV systems - Zhangbin Solar Power Plant, the fourth phase of floating solar farm and the fifth phase of Tainan Salt Flats Solar Power Plant with 150 MW. Among the said, the 100 MW Zhangbin Solar Power Plant has been operating since 2019 which is the largest solar PV system in Taiwan, and has made considerable contribution to alleviating peak loads in summer and supplying green power.

Over time, solar modules will suffer from various defects. The common defects include solar module hotspots, shaded cell or module and short-circuited bypass diodes, etc., leading to unfavorable problems such as low power efficiency. Therefore, how to efficiently maintain and operate solar PV systems is not only about cost, but also a demonstration of overall competitiveness. Especially for the 100 MW Zhangbin site with 340,000 PV modules, if the PV modules information system is not introduced, new maintenance personnel or drones are likely to get lost in the site, and thus do harm to maintenance efficiency.

In view of this, this project aims to build a "Solar PV Modules Position Identification and Image Health Diagnosis Information Platform" for Zhangbin Solar Power Plant, to accurately locate the PV module position and file the infrared thermal image of modules as the basis of PV modules health diagnosis.

Research results：

The main results of this research project are comprised of the following five major items:

(1) Solar PV module image acquisition: Including drone route planning and aerial photography of visible light and infrared thermal image of solar PV module in J area of the site.

The first phase of aerial photography started on 2020/08/24 (Figure 1). The flight planning software was used to set the drone aerial image overlap rate, camera shooting interval, and GSD resolution.

The flight altitude of the visible light image was set to 120 meters, the front and rear overlap rate 80%, and the left and right overlap rate 70%; the thermal image flight altitude was set to 75 meters, the front and rear overlap rate 80%, and the left and right overlap rate 80%.

Improper overlap rate setting, too low or too high, has a bad effect on the subsequent image stitching. A continuous image overlapping rate of 60~80% can produce better stitching results.

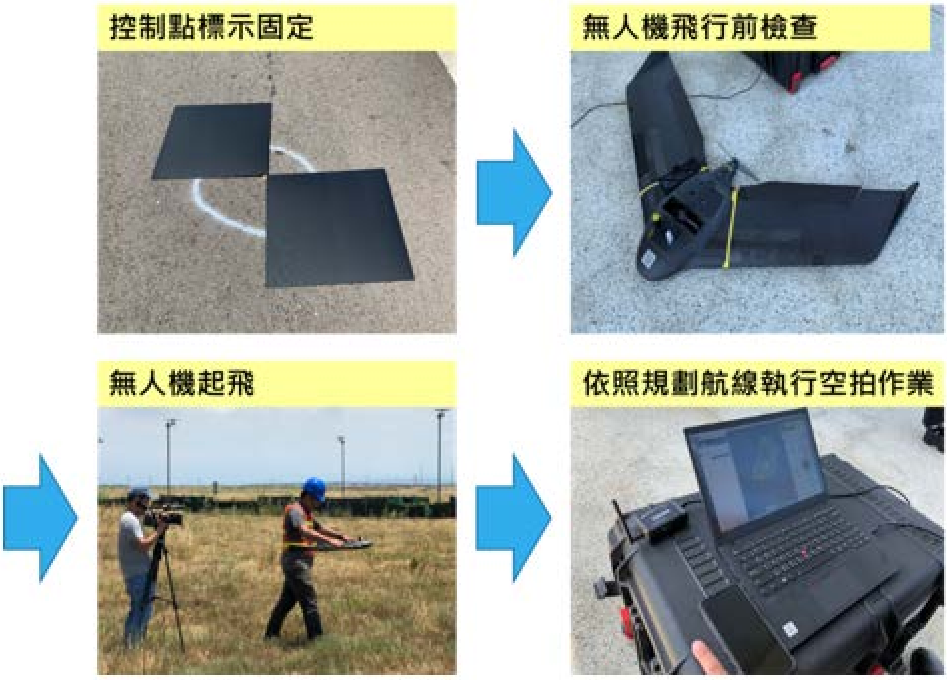

Figure 1 PV drone photography workflow

(2) Image processing: Including surface modeling, image stitching, image orthography, infrared thermal image automatic classification, and thermal anomaly image detection.

The image obtained by aerial photography is a perspective image. The image processing software is used to read the ground elevation of each pixel of the image. Through the establishment of a 3D model numerical correction method, the projection displacement, terrain fluctuations and height difference displacement of the center projection of the aerial image may be eliminated to create orthographic projection images (Figure 2).

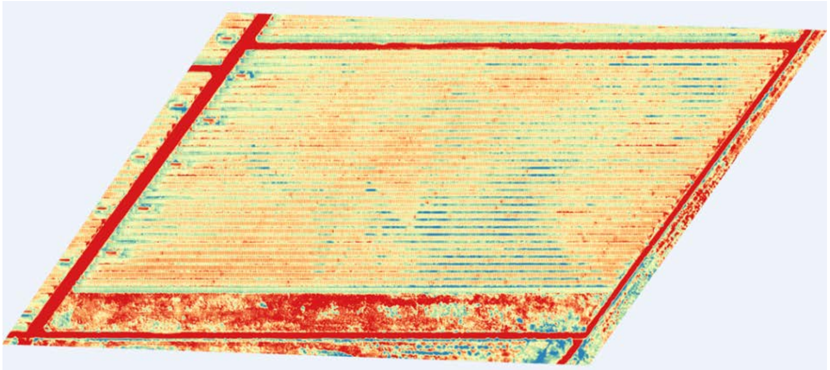

Figure 2 Aerial thermal orthophotos of the J area in Zhangbin site

(3) Geographic Information System (GIS): Including the creation of vector diagrams of PV modules and the creation of a list of image fields of PV modules. After digitizing the positions of all solar panels by GIS, the row and column coordination of each module can be accurately identified, and coding can be performed according to the fields of SHP files(Figure 3-4).

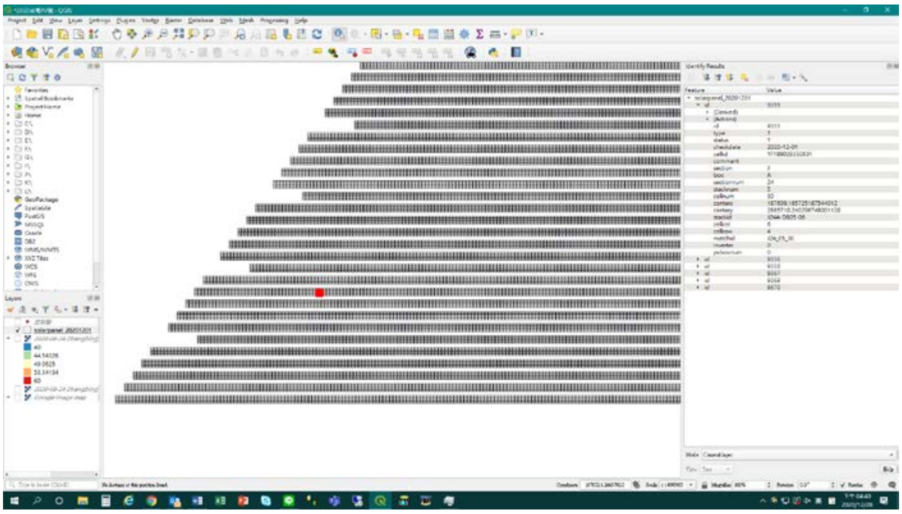

Figure 3 Solar module GIS vector graphics

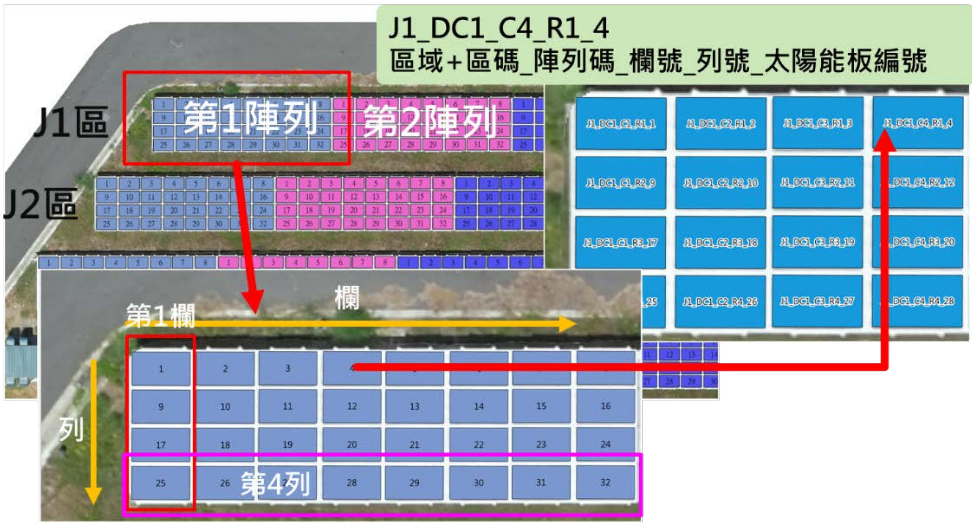

Figure 4 Coding formula for solar panels by GIS

(4) Solar PV module inspection: Three reference panels and a data logger had been set up to capture the IV output of the reference panels (Figure 5). At least 10 solar PV modules for thermal abnormalities had been spot-checked according to IEC TS 60904-13, IEC 61829 outdoor EL defect testing standards (Figure 6). After 30 days of outdoor testing, the reference modules will perform EL testing in the laboratory according to IEC TS 60904-13, IEC 61829, and thermal image testing according to IEC 62446-1.

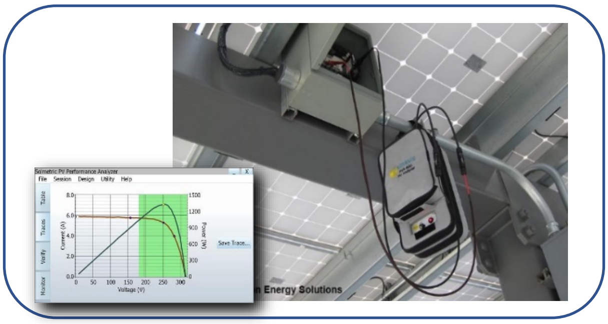

Figure 5 Solar PV module I-V curve testing

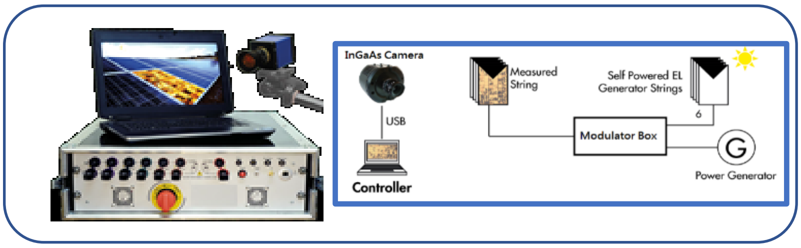

Figure 6　Solar PV module EL testing

(5) Solar PV Module Information System: Including solar module record data, image data, vector graphics, online query/report subsystem.

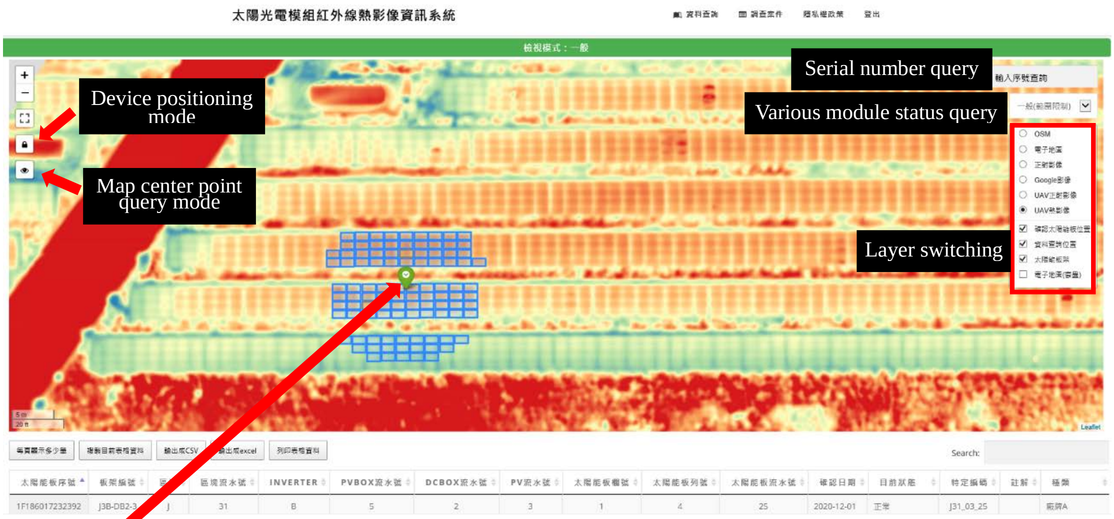

Figure 7　Solar PV module infrared thermal image information system

Future prospect：

This is a pilot project. In the future, we will incorporate the thermal images of the remaining nine districts of the Zhangbin site. The PV information system can be expanded with coordinate correction, target list, inspection route, barcode scanning/serial number scanning, temperature query, fault code labeling, etc., providing maintenance personnel with more diversified real-time data update and query functions. In addition, combining the PV information platform with meteorological data such as rainfall, wind speed, wind direction, and sunshine at the site to accumulate big data may be served as important reference for solar panels cleaning and estimation of power generation.