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Development of outdoor luminescence imaging for drone-based PV array inspection

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Abstract— **This work has the goal to examined experimentally PV module imaging methods under natural light conditions, that will be used in a fast, accurate and automatic drone-based inspection system for PV power plants.**

Keywords— drone-based PV inspection; electroluminescence; photoluminescence; image processing; outdoor defect detection

I. INTRODUCTION

Regular fault detection for effective maintenance is highly important to ensure expected return on investment (ROI) of small and large-scale photovoltaic (PV) installations. Present day PV panels are designed to operate for 25-30 years, however field experience shows that after 11-12 years of operation 2% or more of all PV panels fail [1].

In practice, the frequency and inspection detail level is often limited by manpower and cost. Presently, drone-based infrared (IR) thermography inspection of solar plants is a reality [2], [3]. The accuracy of thermographic fault detection though, presents limitations – primarily related to deconvoluting the failure signature into failure type and severity, which can be overcome when performed in combination to electro-(EL) or photo-(PL) luminescence imaging of the panels. The combination of defect detection techniques has been already tested in laboratory [1], [4], although many limitations still need to be addressed in order to obtain image acquisition outdoors and integrate, automate and optimize the imaging system in a drone. The concept of PL/EL in a drone is illustrated in Fig. 1.

Fig. 1. Sketch of the concept of automatized drone inspection.

In this work, we present the results corresponding to the development of two luminescence-imaging strategies for PV modules defect detection in outdoor conditions, with the aim of choosing the most suitable method for implementation on a drone-based PV plant inspection system.

II. SUMMARY

The experimental tests performed in this work are focused on investigating EL and PL imaging techniques that are suitable for implementation into a drone-based inspection system. The PL technique avoids the need for electrical contact into the solar panels, which is a time limiting factor for drone-based inspection, especially in large-scale solar plants.

First, we investigate a modulated EL imaging method under daylight conditions, to determine the necessary camera and measurement parameters. A sequential image acquisition system was implemented in order to enhance the quality of the EL images obtained at high noise level during the day.

In the second part, we examine a PL imaging method under natural low light conditions, using a line-scanning laser for PL excitation. The PL signal acquired with such light source would be feasible for outdoor PL imaging, as the optical power is concentrated in a line as the image is build up with image processing.

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REFERENCES

[1] M. Köntges *et al.*, "Review of Failures of Photovoltaic Modules," 2014.

[2] S. Dotenco *et al.*, "Automatic detection and analysis of photovoltaic modules in aerial infrared imagery," *2016 IEEE Winter Conf. Appl. Comput. Vis.*, pp. 1–9, 2016.

[3] D. Kint and S. Muñoz-Guerra, "A review on the potential biodegradability of poly(ethylene terephthalate)," *Polym. Int.*, vol. 48, no. 5, pp. 346–352, May 1999.

[4] S. Johnston and T. Silverman, "Photoluminescence and Electroluminescence Imaging Workstation," *NREL*, 2015.