U.S. Department of Energy
HelioCon
Heliostat Consortium for Concentrating Solar-Thermal Power

Heliostat Consortium Seminar Series

Brought to you by the Resource, Training, and Education (RTE) topic area

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Host: Dr. Brooke Stanislawski

Title: Heliostats Inspection with Polarimetric Imaging: Optical Errors, Mirror Cracks and Mirror Soiling

When: Oct. 23rd
1-2 PM MT

Zoom:
https://nrel.zoomgov.com/j/1613923544?pwd=HOLoh3cOrQV78681WXHk10JLcxWCBd.1

Abstract:

To maintain the high efficiency of reflectors in concentrated solar power (CSP) plants, fast and cost-effective inspection methods are desired. Existing methods for the inspections on optical errors and soiling levels of the mirrors have several limitations such as heavy labor requirement, high cost, complex installations, slow speed, etc. In recent years, UAV-based approaches show advantages of fast scanning over large areas and being non-intrusive to field operation with well-designed waypoints. In this work, we developed an integrated polarimetric imaging drone to capture polarization information. Based on the Rayleigh scattering model, the natural skylight forms a unique pattern of Polarization based on the location of the Sun. In the optical errors and cracks detection part, we developed models to calculate the Stokes Parameters for incident light, reflected light from the mirror surface and ground. These simulation models guide us to design flight paths and capture desired polarization images to enhance contrast for scenarios that are difficult for conventional imaging. We carried out field tests at Sandia National Solar Thermal Test Facility (NSTTF) for optical errors inspection with pol-UFACET, and the results acquired from these field tests validated our method and show the feasibility of applying the polarimetric imaging technique to the CSP field inspection as a method to enhance contrast. In the soiling detection with polarimetric imaging section, we developed a simulation model and measurement method based on Mie Scattering to both qualitatively and quantitatively determine the relation between the relative reflectance and Degree of Linear Polarization. The field test carried out at NSTTF showed mean absolute error for reflectance less than 5% compared to the reflectometer measurement. This method has the potential to be applied to different studies in acquiring reflection from a soiled surface.

Bio:

Mo Tian is a PhD student in Electrical Engineering at Arizona State University. Mo acquired his master's degree in Electrical Engineering from Arizona State University in Dec 2020 and joined Dr. Yu Yao's group to continue his study in May 2021. His research interests include the application of polarimetric imaging technology in energy, ocean, microscopy, and biomedical fields. He has been working on utilizing polarimetric imaging in various aspects of field inspection in a concentrated solar power plant at Sandia National Laboratory.