New Control Architecture for Central Receiver Power Plants. Application to CESA I Tower System.

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1. Introduction

Commercial central receiver power plants typically have an Supervisory Control and Data Acquisition (SCADA) system, not designed as a whole for the entire plant, but integrated by subsystems for each of the individual parts of which they are composed: heliostat field, solar receiver, heat storage and power block, for their proper monitoring, operation, control and maintenance.

The current control strategy present in commercial central receiver plants is based on the development of individual controls for each of the subsystems, with little automatic interaction between them, mostly limited to the exchange of emergency signals between subsystems, and with still significant dependence on the presence of human operators to transfer orders from one control system to another.

In any case, commercial solar power plants are more closed and robust systems than some of the tower pilot plants installed around the world, where great versatility is required due to the continuous changes that exist in heliostats, receivers, heat storage system, etc., as it depends on the projects that are being developed at any given time in the facilities. The control system must be sufficiently flexible to be able to adapt quickly and easily to the constantly changing R&D environment.

In addition, the irruption of new tools, such as cloud computing or IoT systems, as well as the availability of new information thanks to the smart heliostat concept development [1], makes it possible to improve the control strategy of the entire system, where traditional SCADAs do not have sufficient capacities to make use of all these advantages.

For all these reasons, the Plataforma Solar de Almería (PSA) proposes in this work a new architecture for the control of solar tower systems with the ability to adapt rapidly to different environments, while ensuring commercial robustness to meet security and reliability requirements. This control architecture is currently under development and implementation in the CESA I tower system at PSA.

2. Proposed control architecture

The proposal presented in this article is based on the establishment of an OPC server as an intercommunication system between the different subsystems of the plant, so that all the individual controls of each of them are able to publish variables on the server and, at the same time, read those variables of interest published by other subsystem controls (Figure 1).

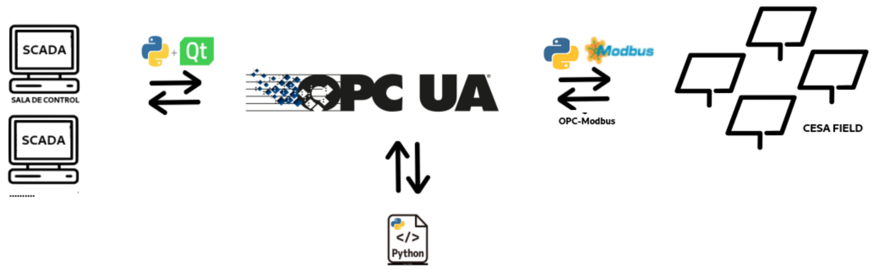

Fig. 1. Control architecture implemented in the CESA I solar field at PSA

With this scheme, the heliostat field can be controlled by a Graphical User Interface (GUI) application running on a local workstation in the control room or even on a web server. And, in parallel, other subsystems can directly operate the heliostat field control by automatically modifying the values of the variables published in the OPC Unified Architecture (OPC UA) server. As an example, an adaptive temperature control algorithm on the receiver surface may automatically modify the aiming points of the heliostats in the solar field.

The chosen implementation is based on open software, using Python and PyQt library for the development of the SCADA (Figure 2), OPC UA as exchange of data server and Python to program the interconnection with the Modbus system that is already installed in the plant to communicate with the heliostat field.

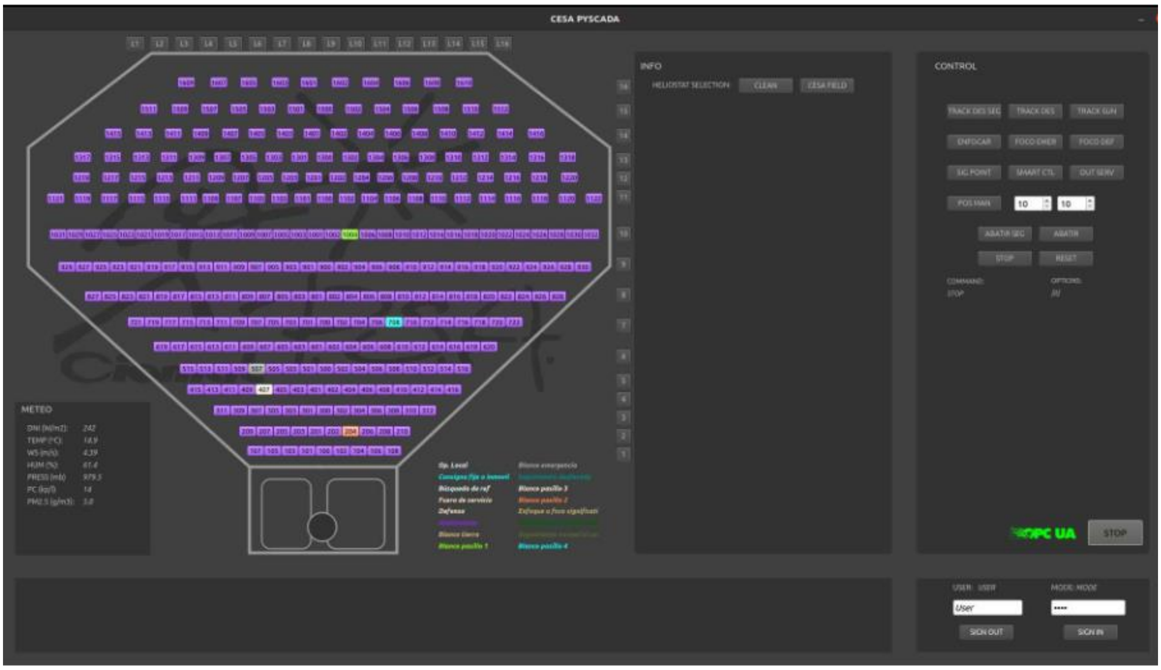

Fig. 2. CESA I heliostat field GUI

The whole manuscript will include details of functionalities and performance of the control architecture under development and validation.

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References

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