

Research Report
ICRR Inter-University Research Program 2020

Research Subject: Development of the CTA/LST telescope control system

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Summary of Research Result :

Purpose of this project is to develop the central telescope control system (“Telescope Control Unit” or TCU) for first Large Size Telescope (LST) of the CTA project, presently under commissioning at La Palma, Canary Islands, Spain. TCU is expected to take care of the low-level orchestration of the telescope subsystems, implementing a high-level interface, that can be further integrated to the CTA array control system.

Telescope Control Unit in FY2020 has seen its first version, suitable for the LST1 control on a regular basis. It integrates the control of the telescope’s main “drive” (responsible for pointing), “camera” (data acquisition) and “AMC” (automatic mirror control – light focusing) subsystems. TCU implements low-level coordination of these subsystems including the error detection logic – along with the routine calibration operations executed nightly. It allows to largely eliminate the error-prone manual subsystems configuration, reducing the stress on the telescope operators and improving the efficiency of observations.

LST TCU also includes real-time logging of the telemetry of all connected subsystems to the central database, enabling experts to perform comprehensive review the telescope state.

Access to TCU is realized via a password-protected web-interface, that can be open in any browser and auto-adjusts even to the screen layout of smartphones. This interface provides access to all essential control elements, real-time

telemetry on the telescope “health” as well as the graphical displays of several key parameters. It’s eventual aim is to provide a comprehensive yet simple LST control from any authorized point on the globe.

TCU-based LST1 operations became even more important during the COVID-19 pandemic as they substantially facilitate remote operations the telescope and, in fact, became routine in FY2020.

Active Mirror Control (AMC) is one of the LST1 subsystems, integrated into TCU in FY2020. This integration required a substantial revision of the AMC software to add the necessary functionality and facilitate its control during observations. Internally, AMC control system was improved following the Finite State Machine machine paradigm, facilitating its synchronization with other subsystems connected to TCU. We have also added high- / low-level interface improvements aimed at simpler operation and smaller telescope downtime in case of issues. We have further created a dedicated testing environment to facilitate the development and verification of the future AMC software releases.

To improve the LST1 performance, a dynamic re-adjustment mode of the mirror positions was added. Previously, AMC operation was based on configuring mirrors to 1-2 predefined positions, optimized for observations at specific altitudes. However, inevitable bending of the telescope structure leads to small displacements of the camera and mirror faces, capable of degrading its optical point spread function. The dynamic re-adjustment mode allows re-configure AMC without interruption of observations, compensating for this displacement and improving the LST1 light collection power during regular observations. Control of this dynamic AMC mode was also integrated to TCU, allowing it to be fully automatic.

To ensure proper day-to-day AMC performance, a detailed real-time telemetry of the system state was added; it is used to generate automatic daily status reports that are then reviewed by the AMC experts.

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