Form 8

Research Result Report
ICRR Inter-University Research Program 2023

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

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Summary of Research Result：

This project is devoted to the implementation of the high-level control system ("Telescope Control Unit" or TCU) for the Large Size Telescopes (LSTs) of the next-generation CTA North Observatory, presently under construction at the Canary island of La Palma in Spain. TCU version developed here in FY 2020-2022 automatizes day-to-day operations of the LST-1 prototype and enables semi-robotic operations of the telescope. It is designed to be fully compliant with CTA array control framework.

In FY2023 developers from ICRR and the University of Geneva have improved internal TCU logic and realized the successful integration test with the CTA array control and data acquisition (ACADA) system. As the success of this test is an important milestone for both LST and CTA collaborations, developers have traveled to the LST1 site to supervise the test in person. Corresponding TCU improvements and achievements in FY2023 are outlined below.

<u>Improvement of CTA/LST robotic observations efficiency</u>

- TCU logic was optimized to skip the configuration steps that do not change between the subsequent observations, substantially reducing the required set up time;
- automatic fault-handling logic was updated to both shorten the required telescope recovery time and cover the rare edge cases. It presently undergoes

the testing with regular operations on-site with the goal to serve as a less time-consuming and human error-prone default recovery approach for LST-1.

- LST-1 downtime due to TCU updates and on-site testing was further reduced improving the telescope emulation and extending off-site code tests

Integration with CTA/ACADA

- TCU compliance with CTA requirements was tested during a two-week-long integration tests at LST-1 site, performed by TCU and ACADA developers with a participation of LST-1 telescope crew. The tests were preceded by two months of both off- and on-site verification activities by TCU and ACADA teams. Final on-site tests included both basic preparation of telescope for observations following ACADA commands and more sophisticated operations, such as repositioning, configuration and observations following the predefined schedule in a robotic mode. With only a few bugs found and fixed on both TCU and ACADA sides, no critical issues have been identified, demonstrating compliance of TCU with CTA specifications.
- In few edge cases shortcomings of the CTA-defined control API have been identified. These are expected to be corrected in the subsequent interface change requests, prepared by ACADA team with participation of TCU developers.
- Few issues, not critical for these tests, have been found on TCU side and will be corrected before the these integration tests are repeated again.

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