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Control System for the High Resolution Fiber Spectrograph of the SAO RAS 1-m Telescope

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Abstract. We introduce the control system for echelle fiber spectrograph developed in SAO RAS for 1m telescope.

The Echelle spectrograph of SAO RAS 1-meter telescope (Panchuk (2015)) consists of a suspended part, located in a movable telescope inside the dome, and a stationary part situated in a thermostat. The suspended part of the system includes an object capture and tracking system (Yakopov (2011)), the polarimetric unit with its control system, and a system for changing the optical fiber functions. All significant optical elements of spectrograf located in the stationary part. The following elements can be controlled by user: calibration spectrum preparation assembly (Panchuk (2014)), camera assembly, Echelle unit, gradient filter assembly, exposure meter assembly, optical fiber reverse illumination assembly. In the unit (Panchuk (2014)), the following elements can be controlled: line spectrum light bulb, continuous spectrum light bulb, optical attenuators turret for line- and continuous spectra. The elements, assemblies and components of the stationary part form a stable three-dimensional construction, authors are strictly not recommended to change the design of this part. The suspended and stationary parts of the spectrograph are connected by optical fibers which transmit the light beams generated in the telescope and in the calibration spectrum unit. Both spectra: from an investigated star and from the calibration spectrum unit, are exposed simultaneously which improves spectra calibration accuracy. The spectrograph is a complex space-distributed device with precision features, and its various parts are operated under different conditions. This places certain demands on reliability, fault tolerance and maintainability of the control system (CS). Therefore, it was decided to use the National Instruments industrial controllers as the basic hardware platform of the system, which include measurement and control modules. The software is implemented in LabView graphical programming environment, so this would be the first optical equipment in SAO RAS with control system fully designed in LabView. The spectrograph is controlled via the INTERNET.

Data collection and control over the suspended part is provided by a sensitive EMCCD camera (Samsung Techwin SHC-750), Movimed AF-1502 analog video grabber, and National Instruments cRIO-9068 controller along with a digital input, for data acquisition from limit switches and Hall sensors.

Centering the image of the star on the optical fiber input and its subsequent guiding, along with the control over the phase-shifting plates, the polarization analyzer and the calibrating prism is carried out by stepper motors controlled by NI-9501 drivers.

Guiding system control algorithms have been developed, and the system has been tested in the laboratory and on the SAO RAS 1-meter telescope. A star image simulator, which imitates its movements, has been developed for laboratory tests. Control algorithms for polarimetric optics turret, phase-shifting plates and calibration prism were also tested in laboratory conditions. The main program is designed to run remotely. The spectrograph control programs have been tested and debugged in SAO RAS directly, also remotely from Yerevan, via the INTERNET.

In the process of developing the control system for the fiber optic spectrograph of the 1-meter telescope we also made provisions to adapt the system for a similar control system for a high-resolution spectrograph (Panchuk (2009)) working on a 6-meter telescope BTA since 1998.

References

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