Daedeok Station Receive Optical System Upgrade

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Abstract

Daedeok station (7359) in Korea has operated SLR system since 2011 but was difficult to track satellites in the daytime. Korea Astronomy and Space Science Institute (KASI) designs new receive optical system for more efficient daytime track. The new optical design improves three points: 1) The new design divides the optical path for observation and the laser direction monitoring having different field of view. 2) The new design change from transmissive to reflective dichroic filter to divide optical path. 3) The new design has the temperature controller to keep constant temperature.

Introduction

Korea Astronomy and Space Science Institute (KASI) has been developing two SLR (Satellite Laser Ranging) systems, one mobile system (0.4m, ARGO-M) and one fixed system (1m, ARGO-F). The development of ARGO-M was completed in 2011 and the system was registered as an active validated station (Daedeok, 7359) in 2014 to the International Laser Ranging Service (ILRS)(Fig. 1). KASI is upgrading the Daedeok station by implementing: 1) the Automatic Transmitter/ Receiver Alignment System (ATRAS), 2) the operating software and ARGO Range Gate Generator (A-RGG) for 10 kHz laser ranging and 3) the new optical receiving system for more efficient daytime tracking.

Fig. 1. Daedeok station

Current Receiving Optical System

The receiving optical system of Daedeok station is 400mm Ritchy –Chretien type telescope with the Detector Box(Fig. 2). The field of view (FOV) of the telescope is ~80 arcseconds (night) and ~10 arcseconds (day). The Detector Box detect the reflected laser light from satellite and monitor laser tracking in the daytime and nighttime. Detector box is comprised of C-SPAD, 532nm bandpass filter, daytime camera, nighttime camera, 532nm transmissive dichroic filter, and day/nighttime switch mirror(Fig. 3).

Fig. 2. Receiving Telescope

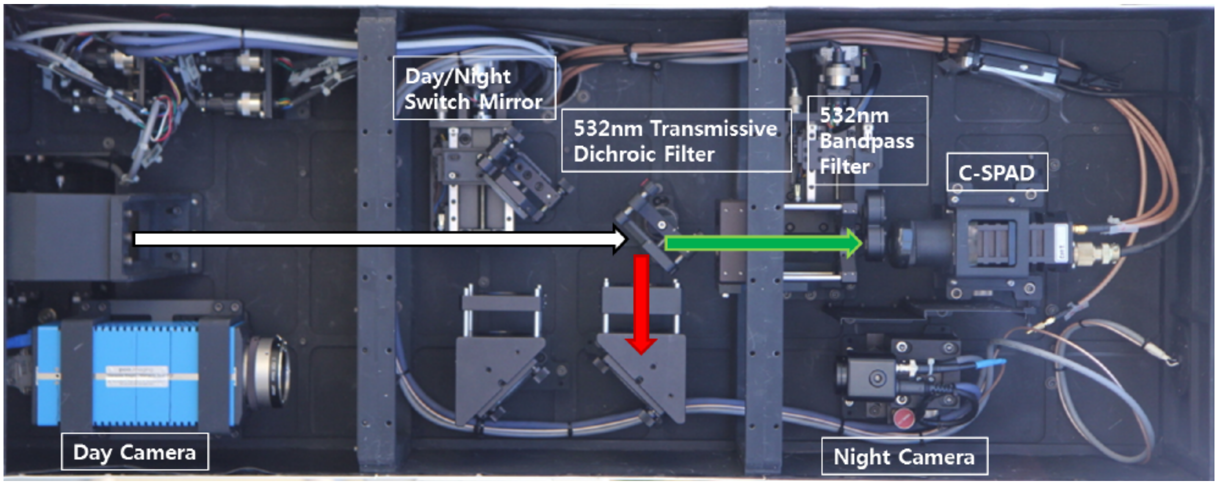
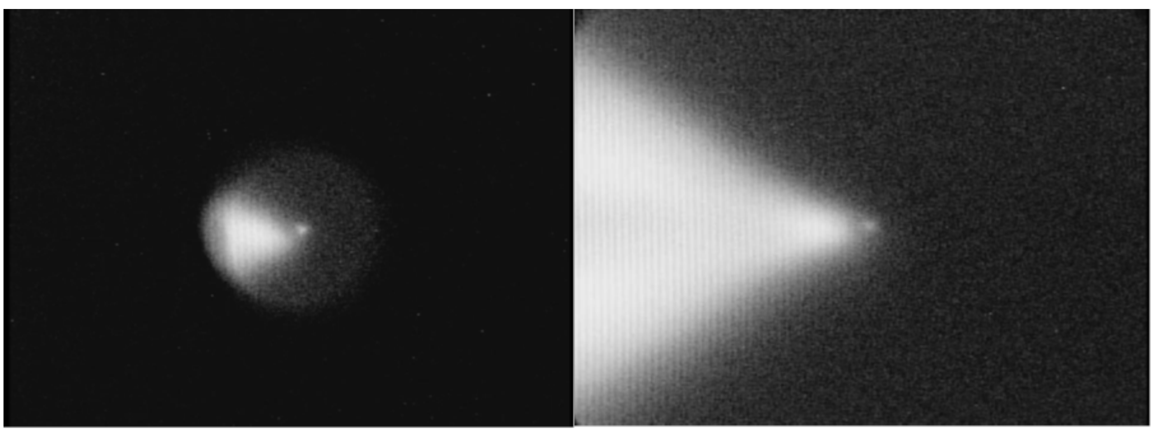


Fig. 3 Detector Box

Design Motivation

In the case of the old optical design (Fig. 5(a)), the monitoring has the same FOV as the C-SPAD because the iris is located at the common optical path. In the daytime tracking, it is difficult to operate ATRAS.



(a) 60 arcseconds **(b) 300 arcseconds**

Fig. 4 Night Camera FOV change for C-SPAD FOV changes

The transmissive dichroic filter was used for diving optical path between observation and monitoring in the old design. The transmissive dichroic filter is influenced by the surrounding temperature (Fig. 3). Also, narrow bandpass filter is influenced by the surrounding temperature because transmission changes by temperature decreases the returned signal rate.

KASI designed with the following condition economically and efficiently:

- C-SPAD FOV : 95(Night), 47.5, 10(Day) arcseconds
- Daytime Camera FOV : 300 arcseconds
- Nighttime Camera FOV : 300 arcseconds
- Constant Daytime/Nighttime FOV for C-SPAD FOV change
- Make Space for installing the thermostatic device of narrow bandpass filter to keep

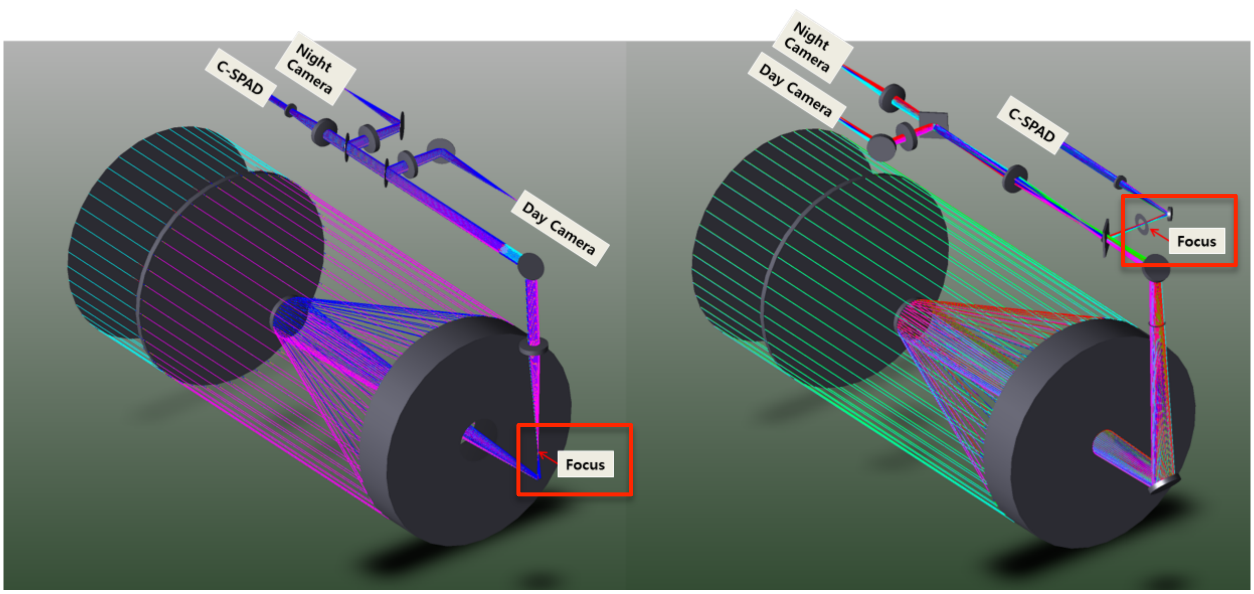
constant temperature

- Use as possible of the existing optical parts

New Design of Receiving Optical System

The new design improves three points: 1) The new design divides the optical path for the observation and the laser direction monitoring. In the case of the old optical design, the monitoring has the same FOV as the C-SPAD because the iris is located at the common optical path. This case makes it difficult to operate ATRAS only in the daytime tracking because the C-SPAD FOV is small, about 10 arcseconds. But the new design keeps the constatnt monitoring FOV even though the C-SPAD FOV changes. 2) The new design uses the reflective dichroic filter instead of the transmissive dichroic filter. The implemented transmissive dichroic filter in the old design can be influenced by the surrounding temperature because the center wavelength of the transmissive filter is shifted depending on temperature. 3) The new design adds a temperature controller(thermostatic device) to the bandpass filter for constant temperature. Like the transmissive dichroic filter, the center wavelength of the bandpass filter also changes depending on surrounding temperature.

New design modifies secondary mirror to move focus position for using the reflective dichroic filter instead of the transmissive filter sensitive to temperature and securing the constant daytime/ nighttime FOV for C-SPAD FOV change (Fig. 5). Also new design installs filter oven & controller to keep constant narrow bandpass filter temperature. (Fig. 6)



(a) Old optical design **(b) New optical design**

Fig. 5 Optical Design

The new design modifies Detector Box configure to satisfy the conditions. The new mechanical design uses commercial lens for economical modification and uses existing optical parts (Fig. 6).

So the new design will increase the return rate and ranging precision for both daytime and nighttime tracking.

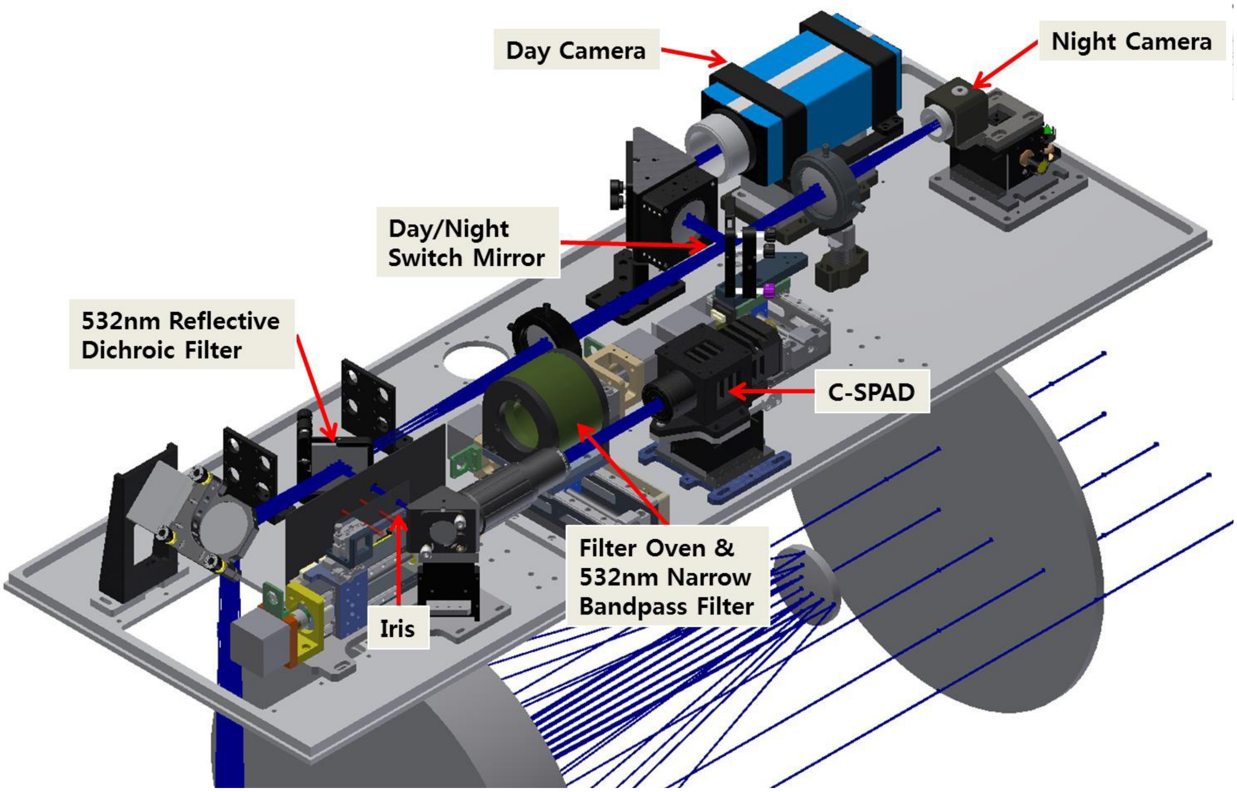


Fig. 6 New Mechanical Design

References

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