Software Design and Development Status of ARGO-M Operation System

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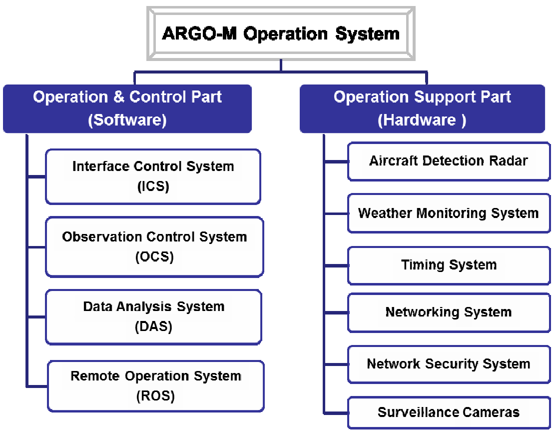
ABSTRACT

A satellite laser ranging system named ARGO-M, Accurate Ranging System for Geodetic Observation-Mobile, is being developed by Korea Astronomy and Space Science Institute (KASI) and critical design review was finished on 31 March, 2011. During the design phase, SLR software logic for the ARGO-M operation was established with the aid of Graz SLR observatory in Austria. Software analysis and design include real-time control algorithm for laser ranging, data screening and processing algorithm for normal point formation. This paper describes software design feature and test results performed in order to examine the function of ARGO-M operation system. Furthermore, status of installation of operation support equipment and test running results of that equipment are presented in this paper.

1 ARGO-M Operation System (AOS) Overview

ARGO-M consists of five main subsystems including optical subsystem (OPS), opto-electronics subsystem (OES), laser subsystem (LAS), tracking and mount subsystem (TMS) and ARGO operation system (AOS) in additions to a dome and a mobile container (Lim et al. 2010). Among these, AOS is the system that controls the entire subsystems needed for the laser observation, make a comprehensive judgment regarding the environment and eventually reflects the judgment to the observation (Seo et al. 2009). Moreover, it plays the role of integrating and processing the data obtained from actual observation. AOS can be considered as the core subsystem since it controls the overall observation operation and produces the result data based on a number of interfaces combining the components necessary to operate the SLR normally. This AOS can be divided into developed items in detail and the main categories are the operation and control system and the operation equipment. The software configuration items that belong to the operation and control system part are interface control system (ICS), observation control system (OCS), data analysis system (DAS) and remote operation system (ROS). The operation equipment part is composed of the radar for aircrafts detection, weather monitoring system, timing system, network system, network security solution, and surveillance camera.



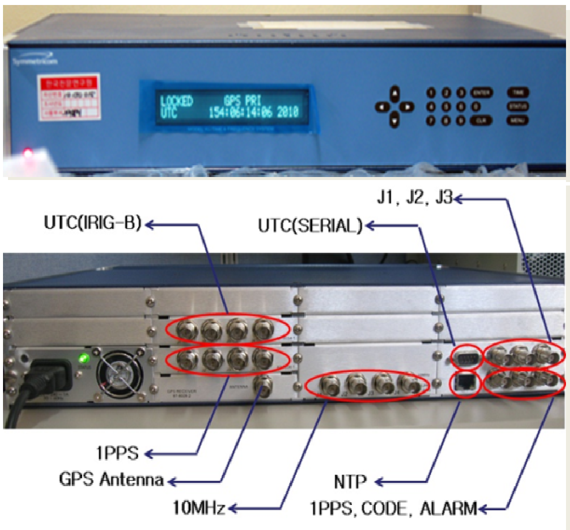
Part	Sub-part	Q'ty	Assemblies
Operation & Control Part	Interface Control System (ICS)	1	Software development & installed computer
	Observation Control System (OCS)	1	
	Data Analysis System (DAS)	1	
	Remote Operation System (ROS)	1	
Operation Support Part	Timing System	1	GPS Receiver & Antenna, Oscillator, Extended Modules
	Weather Monitoring System	1	Real-time Weather Transmitter, Visibility & Precipitation Sensor, Rain Sensor, Cloud Sensor
	Aircraft Detection Radar	1	Pedestal Assembly, Radar Transmitter, Radar Receiver, Parabolic Antenna
	Networking System	1	Router, Switch
	Network Security System	1	Firewall, VPN
	Surveillance Camera	1	Network Camera (5ea) Workstation & Software

2 Operation Scheme & Scenario

The operation status of AOS was distinguished into three statuses in terms of the functions that should be realized in the design process: pre-observation status, ground calibration status or actual observation status, and post-analysis status. In the pre-observation status, the operator who has undergone the previously permitted authentication procedure approaches ICS and OCS, and checks the operating state of the entire subsystem. Then, the calibration mode or observation mode is chosen through the mode control. In addition, the initial procedure is performed to verify the setting values including the previously prepared orbit data of the tracking target satellite. In the ground calibration status or the actual observation status, the ground target is managed under the setting that has been already completed or the real-time scheduling is performed for the satellite to observe. Additionally, initialization of the system that needs maneuvering or that is controlled by the AOS is carried out. After finishing the initialization, the mission is carried out or the observation is conducted with the input from the manual control of the operation, if necessary. Following the time of predetermined ground calibration or the time when satellite observation is possible, the observation result and the mode values are saved and then the system is shut down or the next task is performed in the same manner. In the post-analysis status, after a path of the satellite to observe is finished, the observation data save in OCS is transferred to DAS which independently performs analytical task including removal of noise. Following this, the normal point, the final output of the SLR observation, is generated and it is reported to international laser ranging service (ILRS) to complete the after-analysis procedure (Seo et al. 2010).

3 Operation Support Part

Complete products will be introduced for most of the operation equipments, and only the interface of the computer in the operating system that will communicate with the equipments will be developed for the establishment of the part. The establishment time depends on the time needed for the development, the time when the equipment is required and the installation environment and conditions of different equipments. Figure 2 and 3 show the timing system and weather sensors installed in KASI for ARGO-M development. Besides, other operational equipment such as the aircraft detection radar, network system, network security solution, and surveillance camera will be established according to the time to complete the mobile container.



4 Interface Check with Tracking Mount System

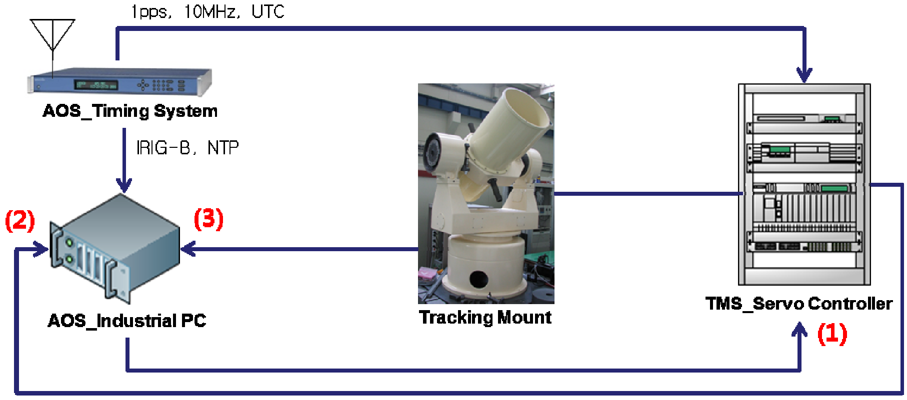


Figure 4 Test set-up for Interface check with tracking mount system

(1) Commended position data for TMS

- Check stored data in AOS local HDD
- Store commanded data(1) to the AOS local HDD before transferring to TMS
- Compare data(1) with (2) after finishing the test

(2) Actual tracking data from TMS

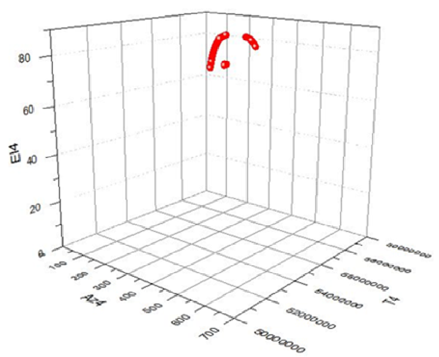
- Check stored data in AOS local HDD
- Store received data(2) from the TMS_Servo controller to the AOS local HDD
- Compare data(1) with (2) after finishing the test

(3) Status information from TMS sensors

- Monitor GUI in real-time
- Run a test to change each status value of TMS sensors subsequently
- Check if status changes are reflected on the GUI of the AOS_industrial PC

<u>Test Result 1</u>. Difference between commanded and actual position is less than 0.1arcsec.

<u>Test Result 2</u>. We checked the exceptional operation in Key-hole zone (El. > 87deg.). Figure 5 and 6 show the result data.



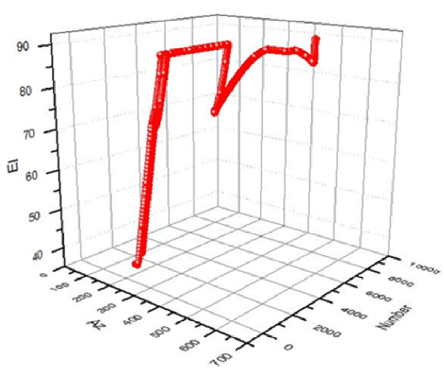


Figure 5 Commanded position data(AOS->TMS) : Azimuth vs. Elevation with time

5 Pilot Test – Ground Target Detecting

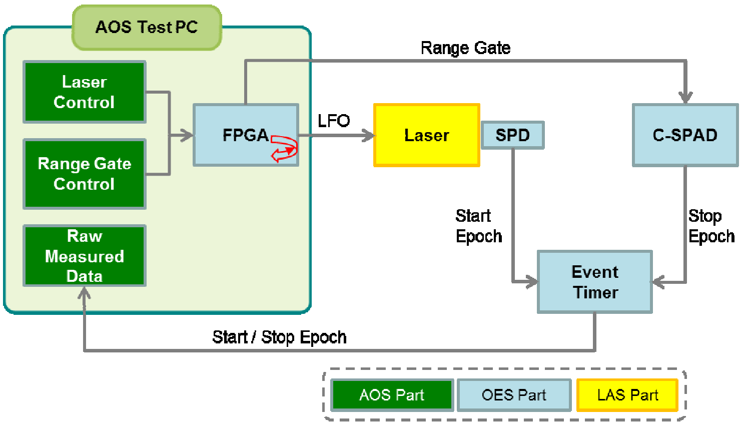


Figure 7 Test configuration for ground target detecting

Test Result. Function of newly developed AOS data processing software is checked by a ground target detecting test. The result showed that the average residual is about 128ns. This result is verified by comparing with the vendor supplied Event Timer (A032-ET) client software (Institute of Electronics and Computer Science Riga, Latvia 2009).

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References

Institute of Electronics and Computer Science Riga, Latvia 2009, "Event Timer A032-ET Manual"

Lim, H. C., Seo, Y. K., Na, J. K., Bang, S. C., Lee, J. Y., Cho, J. H., Park, J. H., & Park, J. U. 2010, "Tracking Capability Analysis of ARGO-M Satellite Laser Ranging System for STSAT-2 and KOMPSAT-5", JASS, 27, 245

Seo, Y. K., Rew, D. Y., Lim, H. C., Park, I. K., Yim, H. S., Jo, J. H., & Park, J. U. 2009, "A study on the deriving requirements of ARGO Operation System", JASS, 26, 279

Seo, Y. K., Lim, H. C., Rew, D. Y., Jo, J. H., Park, J. U., Park, E. S., & Park, J. H. 2009, **"**Study on the Preliminary Design of ARGO-M Operation System", JASS, 27, 393

SYMMETRICOM INC. 2008, SYMMETRICOM INC. **"**Technical Document (Xli Time and Frequency System)"

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