4.5　SAFETY AND SURVEILLANCE SYSTEM

by

Futaba KATSUO, Hiroo KUNIMORI, and Hideyuki NOJIRI

Keywords: Laser, Eye-safe, Surveillance

Running Title: Safety and surveillance system

ABSTRACT

When using a satellite laser ranging (SLR) system, it is important to be careful because laser beams, which can be harmful to human eyes, are fired at sky and ground targets. It is also important to protect the SLR system facilities from natural disasters and trespassers. All facilities of the Keystone project (KSP) SLR system can be operated remotely from the central station using the safety and surveillance system.

1. Introduction

Laser beams can be harmful to the human body especially to the eyes because the human's crystalline lens concentrates the beam energy on a point on the retina. In the SLR system, laser beams are fired at sky and ground targets. Therefore, care should be taken to keep areas illuminated with laser beams safe. We adopted the aircraft detection laser (ADL) in order to prevent the eyes of pilots and passengers on airplanes from being damaged. A beam block was built around the telescope dome in order to block laser beams emitted within an elevation angle of 15 degrees and the sub block protects the objects in the area of the elevation angle higher than 15 degrees as well.

The KSP-SLR system was designed to be operated remotely from the central station(1), so no one oversees the system directly at the observation site. Therefore, the surveillance system, which monitors the conditions of the remote stations and informs an operator in the central station of these conditions, is needed to prevent damage caused by natural disasters and trespassers.

2. Safety system

The system was designed to ensure the safety of humans and equipment under the following conditions.

2. 1 Safety of human eyes and skin

A beam block was set up surrounding the telescope dome in order to prevent irradiation by and scattering of laser beams within an elevation angle of 15 degrees. A shield cover for the ground target(2) was also set up to prevent the reflection and scattering of a beam when it is used to range a ground target. When lasers are fired at ground targets, power is limited to the maximum permissible exposure (MPE) level as defined by Japanese Industrial Standard C-6802 (1997).

Using monitoring cameras, an operator should check the trailer in the observation station, and the area around the telescope tower before ranging to make sure there are no people. Laser emission warning fire outside the telescope tower is activated during ranging. Trespassers in the telescope tower or in the trailer are monitored by a door sensor and a passive sensor. When a person is sensed, a warning appears on a screen, an alarm goes off, and laser emission and telescope movement will be stopped. The telescope pedestal is stabilized during maintenance in order to protect workers in the dome.

Monitoring cameras located in the remote stations enable an operator in the central station to confirm that the areas around and inside the observing facilities in the remote stations are safe or to confirm that there is a person in the building.

2. 2 Safety of aircraft

The ADL was adopted to prevent injuring the eyes of pilots and passengers on airplanes. The peak power of laser pulses transmitted to the sky is more than 1 GW, and injury to the eyes of pilots or passengers in aircraft is possible. Therefore, we use an ADL which monitors aircraft using a laser with a wavelength of 1.572 μm[(3)]. 1.572 μm is an eye-safe wavelength and has a higher MPE level for human eyes than visible wavelength. A 1.572-μm laser can be absorbed by moisture in the cornea of the eye and does not reach the retina.

Fig. 1 shows the ADL optical system which is located in the trailer. The beam divergence of the ADL transmission is greater than 30 arc seconds while that of the SLR laser is a few arc seconds. Fig. 2 shows the ADL receiver which is installed in the telescope. The field of view (FOV) of the ADL receiver is 2 arc minutes. Specifications of the ADL are summarized in Table 1.

2. 3 Safety in the event of excessive light

An optical perceptive sensor was installed, and when excessive light (such as a sunbeam) is sensed, the main mirror shutter closes in order to protect the optical system equipment. When excessive light is sensed, a control computer in a remote station informs the central station and a warning message is displayed on a screen in the central station to alert the operator.

2. 4 Safety in the event of earthquakes

If an earthquake with a seismic intensity of less than six occurs, the KSP-SLR system prevents the building from collapsing and the equipment from falling and prevents damage from broken glass and dangerous objects. The buildings have earthquake-proof structures and equipment storage racks are attached to the floor.

2. 5 Safety in the event of lightning

A lightning conductor was installed on the telescope tower to protect the equipment. To protect delicate electric devices from high-voltage impulses, connectors with lightning arresters were used to connect the external cables with the cables connected to equipment in the building.

2. 6 Safety in the event of fire

Temperature sensors were installed in the trailer, in the telescope tower, and in the optical system, in order to detect unusual temperatures. When the sensor senses any abnormality, a warning message is displayed on a screen, an alarm goes off, and laser emission (ranging) is stopped automatically.

2. 7 Safety in the event of changes in the weather

Weather information is provided by the weather observation subsystem and image information is provided by the image monitoring subsystem. When the severity of the weather is judged to reach a level hazardous to the equipment, the rotor stops and the main mirror shutter and dome shutter close in order to protect the equipment.

2. 8 Safety of the power supply

Unexpected power failure can cause damage to electric equipment. When the power supply is interrupted, power is supplied via the uninterruptible power supply to equipment such as computers which can be easily damaged by sudden power failures.

2. 9 Safety in the event of an unusual situation

When something goes wrong in the system, the operator must turn on a red warning light outside the trailer and try to get attention. An alarm will go off and a warning will be displayed on a screen when warning fire is activated.

3. Surveillance system

Four cameras were installed in each remote station. The two outside survey cameras are dedicated to the surveillance of the area around the station and of weather conditions. One telescope survey camera was installed in the telescope dome to monitor the condition of the telescope. The laser survey camera was installed in the same room as the laser system and monitors the laser's condition. The outside survey cameras were installed on the top of a tower or on the roof of a building and can be rotated by remote control from the central station. Video signals output from the cameras are received by a site image computer located in a remote station and are compressed in the computer. The compressed image data are transmitted via network[1] from this computer to an image transfer computer located in the central station, at a transmission rate of 64 kbit/second which enables us to transmit an image (640×480 pixels) every one or two seconds.

At the central station, four image processing computers were designated to process and display the images from each remote station. An example of a displayed image is shown in Fig. 3. There is an image supervising computer as well as four image processing computers. The operator can see images from every remote station using these image computers.

The "Himawari" weather satellite receiving system was installed in the central station and is used to survey weather conditions. A 70-inch-wide screen was also installed in the station. The images displayed on this screen can be selected with the image selection unit from the images displayed on every computer screen located in the central station.

4. Conclusions

The safety and surveillance system used in the KSP-SLR system was designed to ensure the safety of humans and equipment. Using the system, all facilities of the KSP-SLR system can be operated remotely from the central station.

References

(1) T. Gotoh and T. Otsubo, “4.6 Observation Software,” in this issue.

(2) F. Katsuo, T. Otsubo, J. Amagai, and H. Nojiri, “4.8 A Concept of Monitoring the Telescope Reference Point by Using Multiple Ground Targets,” in this issue.

(3) J. Amagai and H. Kunimori, “4.4 Timing System,” in this issue.

Figure captions

Fig. 1 ADL optical system.

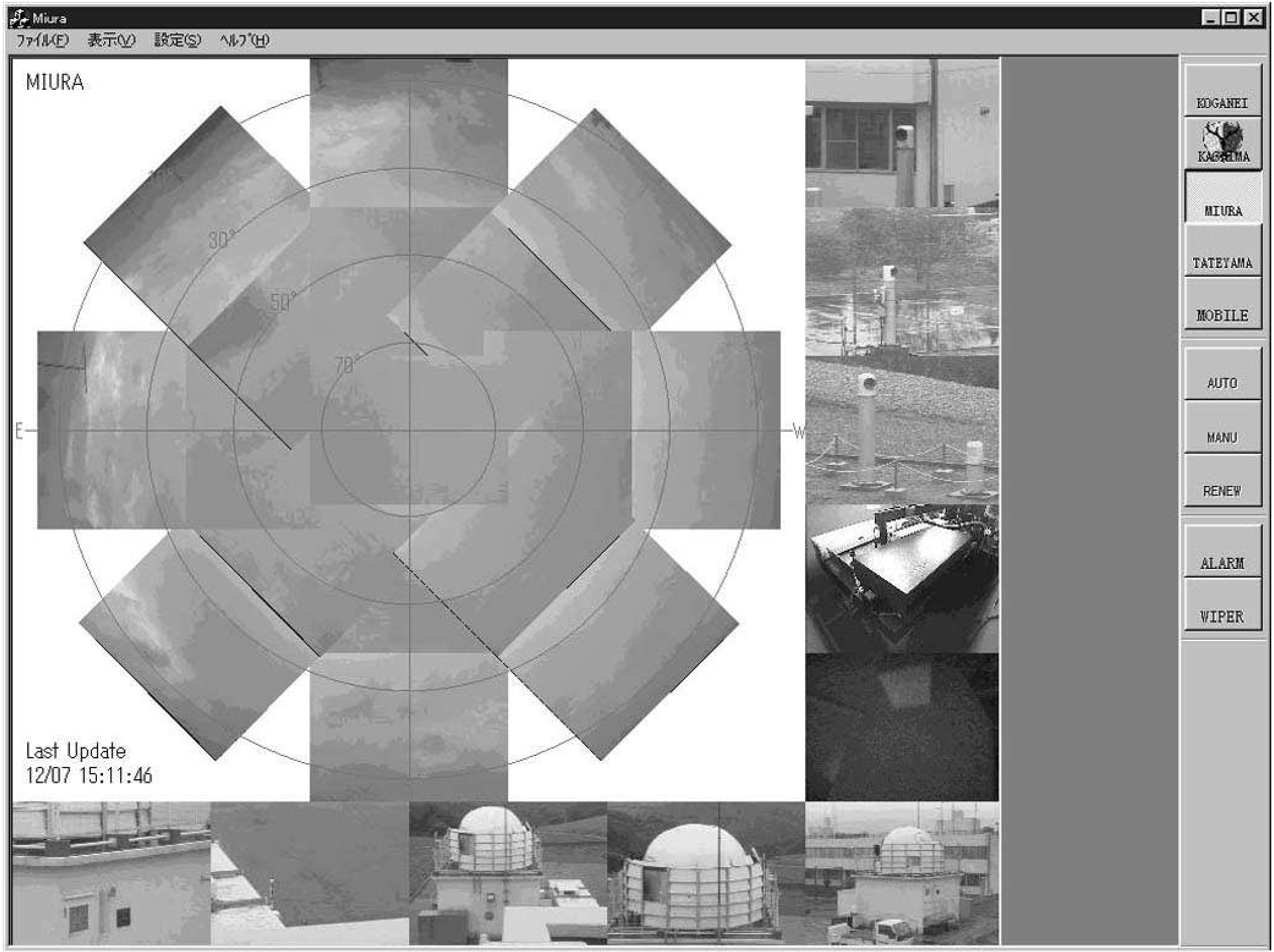
Fig. 2 ADL receiver.

Fig. 3 An example of a displayed surveillance image.

Table 1 Specifications of ADL

Laser	
Wavelength	1,572 nm
Energy	30 mJ
Pulse width	3.2 ns
Maximum repetition rate	100 Hz
Transmit system	
Transmission efficiency	19 - 33%
Beam diameter	690 mm
Beam divergence	> 30 arc seconds
Receiver	
Objective aperture	90 mm
Field of view	2 arc minutes
Objective efficiency	63%
Detection threshold at 6dB SNR	148 nW


FOCUS PRESET
DO NOT ADJUST


Miura
ファイル(F) 表示(V) 設定(S) ヘルプ(H)
MIURA
30°
50°
70°
E
W
Last Update
12/07 15:11:46
KOGANEI
KAGOSHIMA
MIURA
TATEYAMA
MOBILE
AUTO
MANU
RENEW
ALARM
WIPER