A CCD System of Monitoring KHz Laser in Daytime

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Abstract

On account of intensive background noise in daytime, we put forward a monitoring KHz laser solution with CCD system. This solution use high-speed CCD camera, modify the exposure time and integral exposure numbers etc. We successful obtained clear image of back scatter laser in this experiment and measured the key factor of this kind system. It means a lot to improve KHz satellite laser rang (SLR) system in daytime, and increase rang ability.

1、introduction

Separation light path telescope system is widely used in many SLR station. Use an isolate telescope to transmit laser pulse. As to the changes in ambient temperature, it's hard to keep parallel of transmit and receive telescope exactly in this kind of mechanical structure for a long time. So it's necessary to modify the laser pointing direction, especially in the daytime. Ordinary, we apply an EMCCD to monitor the laser backscatter from the main telescope in the night and modify the laser pointing direction timely. But in the daytime, the backscatter laser has embedded in the strong background noise. Furthermore, in the high repetition SLR system, the single laser pulse energy is low to the 1-2 mJ, it produce even weaker of the backscatter intensity. Classical way can't meet the need of daytime SLR. To address this problem, we introduce a new CCD system and got some encouraging result.

2、system description

In this experiment，we installed the CCD camera (PCO 1600) in our SLR system at the monitoring channel, replace previous EMCCD. Use a pulse signal generator (DG535) to synchronize the CCD camera exposure and the laser pulse emission. The system setup as bellow.

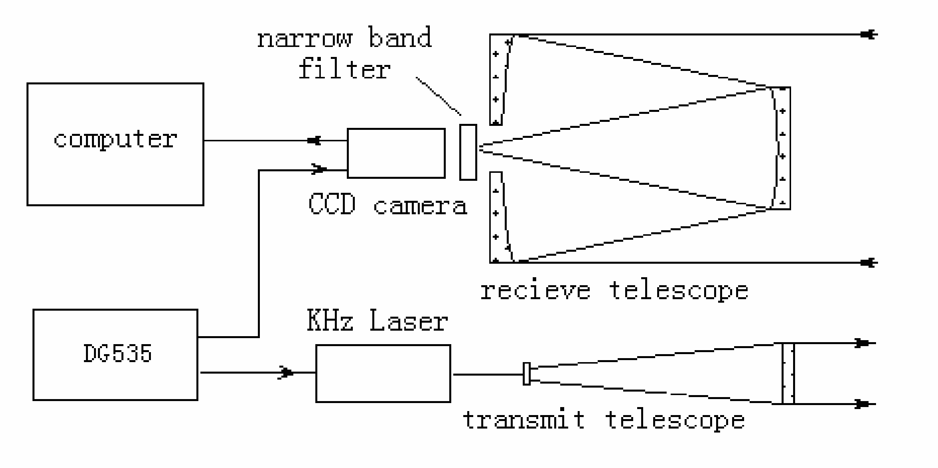

Fig.1. experiment setup

Fig.2. Photograph of experiment equipment

Table 1 indicate the main specialty of the CCD camera that we tested.

Table 1. CCD camera specialty (PCO 1600)

resolution (hor x ver)	1600×1200
pixel size (hor x ver)	7.4μm×7.4μm
sensor format（mm^2）	12.2×9.0
spectral range（nm）	320—1000
peak quantum efficiency	55%（500nm）
exposure time（s）	500ns—47days
max. exposures in one image	500000
max. modulation frequency	50KHz
data interface	IEEE1394

This diagram has described the sequential relationship. The emitted laser pulse will produce backscatter coursed by suspended particle in the lower atmospheric layer. This backscatter will last about 60 microseconds (according to changchun weather condition) along with laser transmit. So the CCD camera should exposure at this time interval.

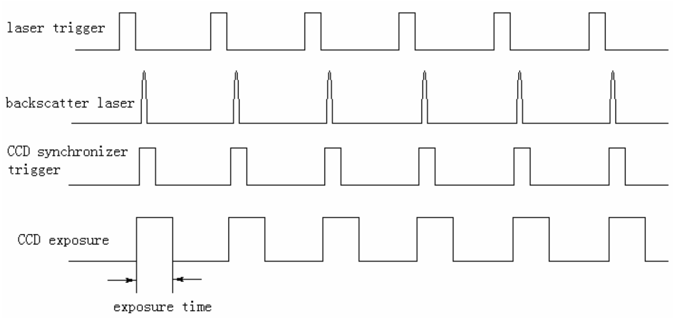

Fig.3. sequence chart

3、experiment result

Figures underneath are the representative result we got.

Fig.4. 100 times exposure modulation，exposure time 50μs

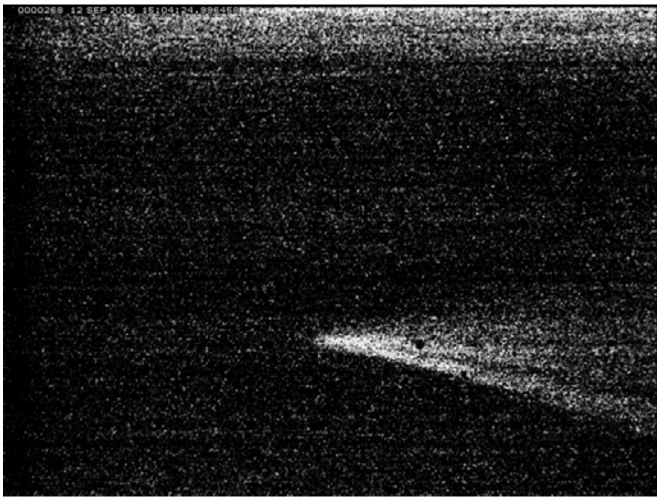

Fig.5. 200 times exposure modulation，exposure time 67μs

Fig.6. 1000 times exposure modulation，exposure time 67.5μs

4. conclusion

After repeatedly experiment, compared with the image we got, the result of Fig.5 is very exciting. The laser beam in this image we got in the daytime is clear as the one obtain at night. The parameters we set to this camera are suitable for ChangChun station satellite laser ranging in the daylight. According to the experiment result, we find that for monitoring the laser beam in the daylight, a camera should have these specialties below:

a. short exposure time achieve scores of microsecond and variable.
b. can exposure many times in one image, the number of that maybe up to thousands.
c. There will be a narrow band filter in front of the CCD camera.

Reference

G. Kirchner, F. Koidl, SLR Graz: Daylight CCD, Graz KHz SLR Meeting, Graz

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