The Research of Rotating Shutter Control Method for 1.2m Telescope SLR System

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Abstract: Analyzed the phenomenon of Transmitting and Receiving Epoch Overlapping in Kunming Station's 1.2m Telescope Common Optical–Path High Frequency Laser Ranging System, and simulated this phenomenon by the computer. Simulation result indicated the overlap rate of the near-Earth satellite is about 7%, the high orbit target is slightly higher but still less than 8% and the lunar is about 10%. In order to decreace the overlapping events, to analyze and research the characteristics of rotation shutter, then the overlapping condition and new compter control methods of rotation shutter were obtained, which were tested by actual satellite orbit tracking experiments. As a result, the overlapping probability is greater than 5.0% when the rotation shutter was not controlled by computer, otherwise the overlapping rate is less than 0.5% and improve efficency of the co-optical path satellite laser ranging system.

1, Introduction

In the high frequency laser ranging system，there is a common phenomenon that the laser transmitting and receiving epochs overlap for co-optical path and separate-optical path system. The separate-optical path system usually adopts to delay the transmitting epoch of laser to avoid overlapping events [1] , of course, the co-optical path one also takes the same idea to deal with overlap but it will be very complicated. Yunnan Observatories 1.2m telescope Satellite Laser Ranging(SLR) is a co-optical path system, we use a Rotating Shutter(RS) to provide the laser transmitting synchronization signals and fulfill kHz laser ranging. Here will introduce how we control the RS by computer during the observation.

2, Rotating Shutter

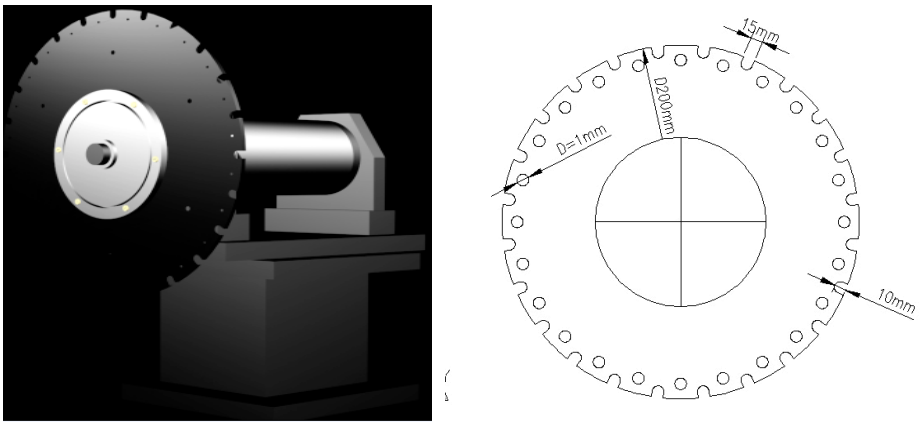

Fig1. a schematic diagram of the shutter

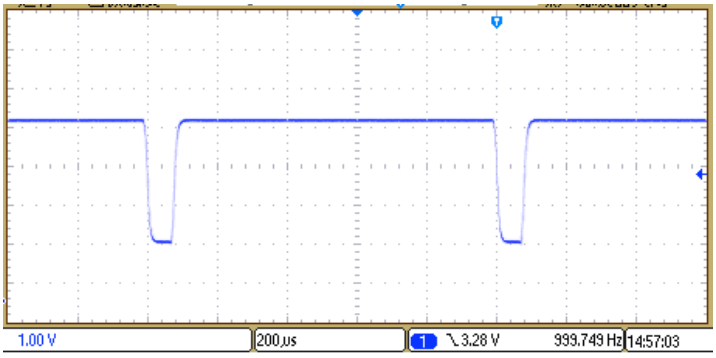

Fig2. Synchronization signal of the shutter

The shutter is a round plate with several slots at its edge, showed in Fig 1, during observing, it is running controlled by a motor. According to the relative position between the slots and the C-SPAD, i.e. it is in receiving optical path when the slots is in front of the C-SPAD, otherwise in transmitting optical path. Fig 2 indicates the laser outgoing synchronizing pulses from the shutter, which read by an oscilloscope, the low level voltage period means in receiving optical path(about 80μs in our system), and the high one is in transmitting position. Therefore, if the returns from the satellite arrives at inner the 80μs, the overlapping accident will happen.

3, Shutter Computer Control

Our SLR control system block diagram is showed as Fig 3, including RS, Industrial Personal Computer (IPC), Laser, PIN detector, C-SPAD detector and Event Timer, and so on. The RS can be running as freely (i.e. with fixed speed) or controlled by IPC.

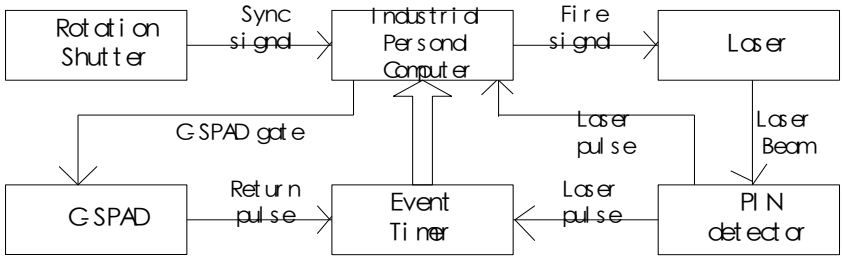

Fig3. Diagram of Satellite Laser Ranging Control System

According to computer simulation, the overlapping probability, in fixed speed condition, is around 7% for LEO satellites, about 8% for MEO satellites and 10% for the Moon.[2]Considering the RS characters, we choose to slow or speed up its running velocity to reduce the overlapping accident.

We have ever adopted a computer control method for the RS that can achieve only 0.5% overlapping probability, which uses an experimental formula to change the RS speed. [2] Here we combine the satellite's orbit prediction with the real time RS frequency measuring value to conduct the RS operating (let the return photons always arrive at the middle of the slots) and the result can also achieve 0.5%. Comparing to the former, this method depends on the real time measurement data and prediction, so it is more common for the all kinds of satellites.

4, Summary

Here we introduced our RS device characters, its computer control methods and the results. Although to carry out a high frequency SLR system in a co-optical path system is very complicated, it is possible by using the RS technique and the overlapping rate also can be ruduced.

References and Links

1. Kirchner G, Koidl F. Graz kHz SLR system: design, experiences and results[C]//Proceedings of 14th International Workshop on Laser Ranging, San Fernando, Spain. 2004: 501-505.

2. http://cddis.gsfc.nasa.gov/lw18/docs/presentations/Session12/13-0420-zhaidongsheng-revised.pdf