A Photo-electricity Target for Testing Photoelectricity Trackers

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Abstract: The performance of Photoelectricity Trackers is usually required to be tested in the process of developing or repairing. A simple revolving photo-electricity target is realized based on a collimator, and it can be used to test the Photoelectricity Trackers' performance. The photo-electricity target is mobile, and convenient to test lots kind of Photoelectricity Trackers. The testing results show that the orientation angle error (average square root value) of the photo-electricity target is 9.8″, and the pitch angle error is 9.1″. It is suitable for testing common Photoelectricity Trackers.

Introduction

Photoelectricity Trackers are used widely in applications of missile's guidance, aerial surveying and artillery controlling, etc. [1,2]. The Photoelectricity Trackers, bearing of many excellent characters such as high precision, immunizing of disturbance, are used to search and track spacial objects instead of radars in heavy electromagnetic environment. Television guided missiles and homing missiles are all equipped with photoelectricity tracking systems for searching and locking the objects. The missiles do not require high precision of the photoelectricity tracking systems for their tracks can be modified in the flying process. But the artillery weapons need very high precision of the Photoelectricity Tracker for the bomb's track in the air is determined by the shot parameters, and the shot parameters are produced primary according the object's orientation angles and distance, which are measured by the Photoelectricity Tracker So the Photoelectricity Tracker's measure precision is one of the key factors which determine whether the bomb can hit the object exactly or not.

The Photoelectricity Tracker's measure precision can be considered in static and movement states. In the static state, the orientation angular precision is primary to be tested; however, the angular velocity and angular acceleration are mainly tested in the movement state. In order to test the Photoelectricity Tracker, a motive and trackable target should be provided. The range of the target's rotational angle, angular velocity and angular acceleration should fulfill the requirement of the tested Photoelectricity Tracker. The ideal method is to tracking an airplane in the sky, and the airplane's position data can be acquired by GPS. This method, costing high expense for it requires huge field, a many people and much expensive equipment, is usually used in the in the finalize-the-design experimentation of the Photoelectricity Tracker and is not suitable for common examinations in the Photoelectricity Tracker's developing or repairing process. For the common testing, a low cost target which occupies small field is needed. Document [3] brings forward a method in which simulative images are injected into the tracker to test the tracker's performance. The image-injecting method occupies small field and cost is low. The target's position in the simulative image relies on the tracker's output angular data, but the tracker's output angular is not suitable for testing reference as it is just the tested object. Document [4] introduces a method to test the photo-electricity theodolite by using a photo-electricity target. The photo-electricity target method can be modified to test a Photoelectricity Tracker.

Revolving Photo-electricity Target

A photo-electricity target can be constructed by a collimator. When a Photoelectricity Tracker receives the directional light from .the collimator, a cross image will be seen which is sourced from the cross mark in the collimator. A revolving photo-electricity target may be realized by rotating the collimator around an orientation axis and a pitch axis, and the controlling system gives out the target's accurate angles. Fig.1 shows the revolving photo-electricity target equipment which includes a collimator, a bracket, a base plate, an inner frame, an outer frame and a collimator clamp. The collimator is set on the inner frame by the collimator clamp. When the inner frame and outer frame are driven by electric motors, the collimator rotates around the orientation axis and pitch axis, and the target (collimator)'s angles (orientation angle and pitch angle) are measured by angular sensors set on the axes.

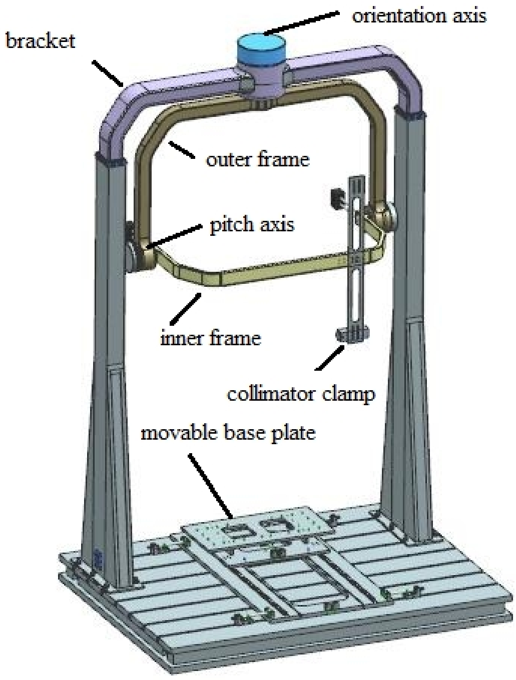

Fig.1 Revolving photo-electricity target

The revolving photo-electricity target as shown in Fig.1 has the following characters.

Firstly, a photo-electricity object with orientation and pitch freedoms is simulated. An electric motor set on the bracket drives the outer frame to rotate around the orientation axis; another electric motor set on the outer frame drives the inner frame around the pitch axis. The collimator is set on the inner frame and rotates around the two axes.

Secondly, the photo-electricity target accommodates many types of Photoelectricity Trackers. The tested trackers are set on the base plate. The base plate is designed to be movable. This character guarantees that tracker and the target have almost the same orientation axis. Furthermore, the position of the collimator clamp set on the inner frame is adjustable which ensures that the target's height can be modified to adapt the height of different trackers.

Lastly, the target is mobile. The whole equipment is not required to be fixed on a given ground and can be move to any needed places. This flexible character guarantees that one target can be used to test many trackers on different places.

Experimental results

The photo-electricity target is designed to test the angular precision of Photoelectricity Trackers. The target's angular precision should be more accurate than the tested trackers. An autocollimator is used to test the target's angular precision. The reflector of the autocollimator is a polyhedron with 23 reflecting surfaces and the angular error of each surface is less than 0.7″. Table 1 gives the testing results of the target's orientation angle and Table 2 gives the pitch angle testing results. The testing results show that the orientation angle error (average square root value) of the photo-electricity target is 9.8″, and the pitch angle error is 9.1″.

Table 1. The Photo-electricity Target's Orientation Angle Errors

Reflecting surface position	1	2	3	4	5	6	7	8
Orientation angle error [″]	-12.4	-12.2	-11.5	-12.6	-10.8	-8.4	-8.9	-12.4
Reflecting surface position	9	10	11	12	13	14	15	16
Orientation angle error [″]	-10.5	-9.4	-7.5	-6.9	-5.7	-6.8	-7.5	-7.9
Reflecting surface position	17	18	19	20	21	22	23	
Orientation angle error [″]	-8.4	-8.7	-9.4	-8.9	-10.1	-11.5	-12.1	

Table 2. The Photo-electricity Target's Pitch Angle Errors

Reflecting surface position	1	2	3	4	5	6	7	8
Pitch angle error [″]	8.5	8.9	10.2	11.4	9.6	8.7	12.9	12.2
Reflecting surface position	9	10	11	12	13	14	15	16
Pitch angle error [″]	12.3	13.0	12.5	11.6	8.2	8.3	8.3	1.5
Reflecting surface position	17	18	19	20	21	22	23	
Pitch angle error [″]	-0.5	2.7	6.5	-4.2	-4.2	7.8	8.6	

Conclusion

In conclusion, a revolving photo-electricity target is designed to test the Photoelectricity Tracker’s tracking errors of orientation angle and pitch angle. The designed target is mobile, and is flexible to test many types of Photoelectricity Trackers. The experimental results show that the orientation angle error (average square root value) of the photo-electricity target is 9.8″, and the pitch angle error is 9.1″. It is suitable for testing common Photoelectricity Trackers.

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