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Research on target information optics communications transmission characteristic and performance in multi-screens testing system

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ABSTRACT

To enhance the stability and reliability of multi-screens testing system, this paper studies multi-screens target optical information transmission link properties and performance in long-distance, sets up the discrete multi-tone modulation transmission model based on geometric model of laser multi-screens testing system and visible light information communication principle; analyzes the electro-optic and photoelectric conversion function of sender and receiver in target optical information communication system; researches target information transmission performance and transfer function of the generalized visible-light communication channel; found optical information communication transmission link light intensity space distribution model and distribution function; derives the *SNR* model of information transmission communication system. Through the calculation and experiment analysis, the results show that the transmission error rate increases with the increment of transmission rate in a certain channel modulation depth; when selecting the appropriate transmission rate, the bit error rate reach 0.01.

1. Introduction

At the shooting range, the flight parameters of dynamic target are closely parsed as scientific issues in weapon testing system, current, the testing methods on dynamic targets have many methods, such as, laser screen target testing system, sky-screen target testing system, CCD intersection testing system, and so on [1]; these testing systems have played a key role, and promoted weapon development, however, with the development of high-tech weapons, the stability and reliability of shooting range testing equipment are put forward higher requirements, such as, the data acquisition of remote sensors, real-time monitoring of remote dynamic target information, automation of multiple network testing equipment, and so on [2]. It needs to meet the test of each interval in the ballistic trajectory, especially the space position parameters in the long-distance ballistic range [3], in order to realize the above demands; we need to improve data transmission in laser screens target testing system, sky target testing system and CCD intersection testing system [4–5]. Based on laser multi-screen testing system, this paper studies multi-screens target optical information long-distance transmission link characteristics and transmission performance, provides a theoretical calculation method for long distance optical information transmission and the signal extraction.

2. Target location measurement method of laser multi-screens testing system and target information transmission characteristics

2.1. Target location measurement method of laser multi-screens testing system

In order to obtain target location parameters of ballistic flight target, we use four laser screens intersection measuring model to set up its testing model, as shown in Fig. 1, M_1-M_4 are the designed four laser detection screens, laser detection screen mainly consists of slit diaphragm, array emitting laser, array receiving detector and signal processing circuit, the specific working principle is detailed in reference [6], as indicated in reference [6], when a flight target passes detection screen M_1, and gets out from screen M_4, A_1, A_2, A_3 and A_4 are the intersection points when target passes through laser screen detection area, array receiving detector can sense target information, and then, the target information can be collected after amplification and identification circuit. Through collection system and remote transmission system, the terminal computer can obtain transient signal when targets pass though laser screens, by method of signal filtering algorithm and target extracting moments in the computer, we can find the starting time of each target passing every screen, according to the sampling frequency, the interval time value of four laser screens can be calculated, combining with the four laser screens intersection measuring model, target location and transient speed can be calculated.

Assume that t_1-t_4 are the M_1-M_4 screens' starting time, M_1 and M_4 screens are parallel and perpendicular to the horizontal plane, S is their

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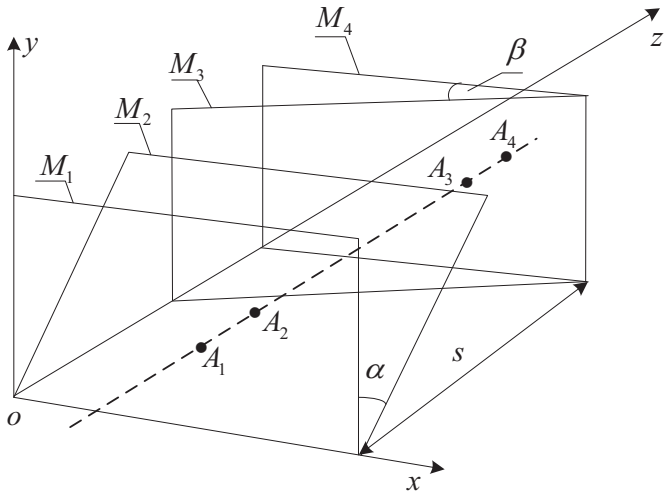

Fig.1. Screen layout diagram of laser multi-screens testing system.

distance, M_2 and M_1 intersection angle is α, both M_3 and M_4 screens are perpendicular to the horizontal plane, and their screens angle is β, we can calculate the location parameters by formula (1) and (2).

$$x = ctg\beta \cdot S \cdot (t_3 - t_1) \cdot (t_4 - t_1)^{-1} \quad (1)$$

$$y = ctg\alpha \cdot S \cdot (t_2 - t_1) \cdot (t_4 - t_1)^{-1} \quad (2)$$

According to (1) and (2), if we want to reliably obtain information of four-laser screens in a safety distance, target information needs to be transmitted to the terminal processing computer at a safety distance in the laser detection system, the transmission distance is more than 200 m, even than 3000 m. Therefore, in order to transmit target information without distortion, we must research optical information transmission performance. Fig. 2 is laser multi-screens target information testing system of optical communication principle.

In the optical communication system, first, we collect the signals of four laser detection screens, transmit the target information with optical communication target signal transmitter module, and receive the information of laser screen detector in optical communication target signal acquisition module; second, we use received module to collect the signal, and obtain target recovery signals after restoration processing; at last, according to laser multi-screens test system, we filter and identify and extract the target information, combining with Fig. 1, we may obtain the target location parameter in terminal ballistic.

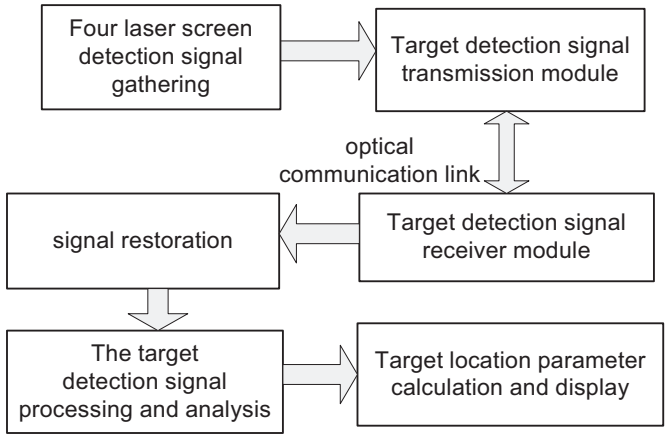

Fig.2. The Diagram of the optical communication principle of laser multi-screens testing system.

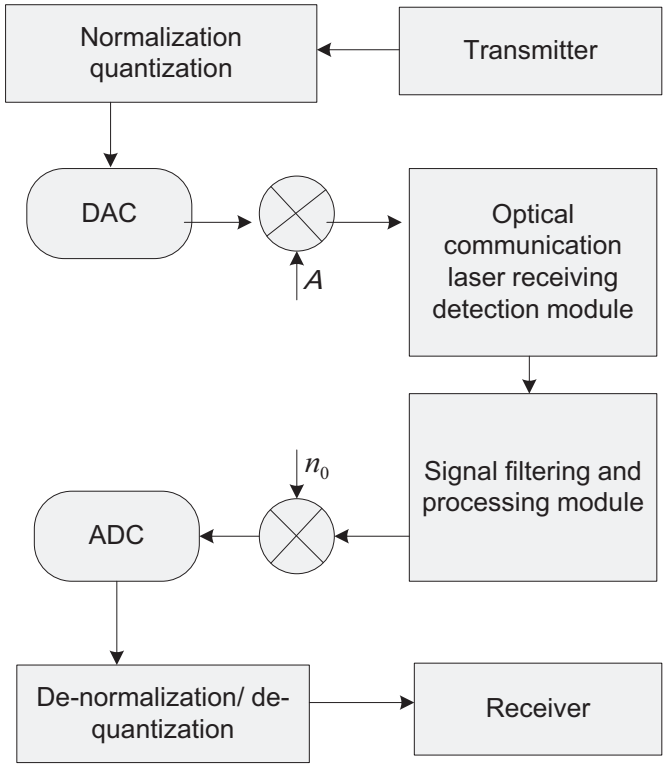

Fig.3. The principle of laser multi-screens target information communication system.

2.2. Discrete multi-tone modulation of visible optical information communication theory

According to the principle of laser multi-screens testing system for remote communication transmission, each laser screen output terminal has signal sender, at the same time each terminal system has the signal receiver [7]. To improve the transmission system reliably, we use the transmission method of Multi-Tone Discrete (MDT) [8], it can effectively suppress the inter symbol interference and inter carrier interference caused by channel fading and multi-path delay, communication quality and capture rate of the system have improved. Laser multi-screens target information communication system principle is shown in Fig. 3, which is mainly composed of two parts named transient signal transmitter and receiver, its basic principle is, firstly, the target signal transmitter module sends instant state of target information, the information is processed into DAC after normalization, and then passes the laser receiving detection module in optical communication, through long distance optical fiber transmission system, target information processes by the filter at the end of optical transmission systems; second, the processed information through ADC with standardize and quantitative processing; finally, target transient information is obtained on the terminal receiver in optical communication system. A is the amplification factor of the transmission system, n_0 is the ambient noise.

3. The analysis of target information transmission characteristic

3.1. Light intensity spatial distribution of optical communication system channel

According to the principle of laser multi-screens testing system, we gather the four laser detection screens' output signals, and sent