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Research on target capture probability calculation model of composite photoelectric detection imaging sensor system

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ABSTRACT

To improve the detection performance and detection capture probability of photoelectric detection imaging sensor system in the complex background, which affect and reduce the target detection capture probability, this paper proposes a new target composite detection capture probability calculation model based on the photoelectric detection system of infrared and visible light photoelectric detection sensor. From the target's radiation illumination and background's radiation illumination, we research the relationship between the threshold signal noise ratio and the false alarm probability, set up the false alarm probability function of composite photoelectric detection system, analyze the effect of false alarm probability to target capture probability in photoelectric detection imaging sensor system, and give the relation function of target capture probability and false alarm probability. Through calculation and experiment analysis, the results show that the target capture probability is inversely proportional to background's radiation brightness; While the false alarm probability increases, the target capture probability goes smaller.

1. Introduction

The infrared photoelectric detection imaging sensor system has been widely used in the military field, it has the advantage of completely passive working modes, high concealment, precise target discrimination ability, strong low altitude detection capability and anti-interference ability, however, there has significant difference between the actual detection capability and the theoretical detection capability of infrared photoelectric imaging sensor system under the complex background [1]. The visible light photoelectric detection imaging sensor system depends mainly on the reflected light of sun, whether the target is detected leans on the brightness of target itself, the performance of detector and the exposure time [2]. Under complex environment, there are factors which affect the detection performance of photoelectric detection imaging sensor system, such as the target's own radiation characteristics, the false alarm probability, the photoelectric detector response and ambient illumination, these factors constrain the improvement of photoelectric detection imaging sensor system, especially in the case of changing environment illumination, the false alarm probability changes greatly, seriously affects the detection performance of photoelectric detection imaging sensor system and reduces the target capture probability [3]. The detection target is high-altitude flying projectile, the high projectile flies height and is hard to be detected. As the detection distance increases, the contribution becomes smaller from the detection target to the detection device, the traditional visible light detector is easily affected by the environment, and it is difficult to recognize the target under the complex background. This

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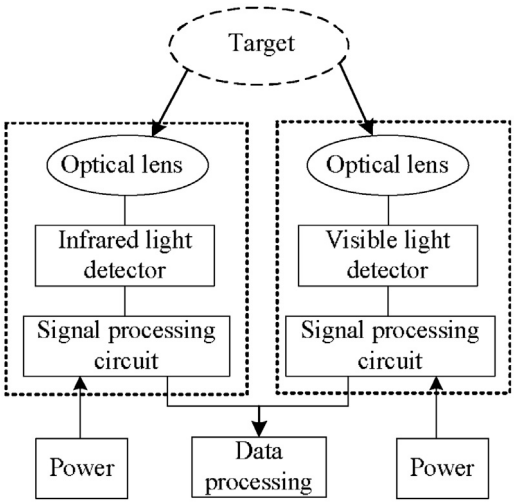

Fig. 1. Target composite detection principle by infrared detector and visible light detector.

paper proposes combined detection method by infrared detection sensor and visible light detection sensor, the composite photoelectric detection imaging sensor system consists of many photoelectric sensors, we establish the target capture probability model of composite photoelectric detection imaging sensor system under the complex environment, get the calculation function detection target capture probability, then obtain the flying projectile location, it can be beneficial to give the projectile near-blast position. To solve the problem of low detection capability, we use the visible light detection sensor, add the infrared detection sensor, improve the anti-interference capability of photoelectric detection imaging sensor system, the composite detection method obtains projectile near-blast position which can be influenced by the capture probability, it is necessary to do research on the detection capability of the photoelectric detection imaging sensor system and provide services for the detection projectile near-blast locations.

2. The principle of target composite detection and analysis

The influence of infrared radiation under complex background, which reduces sharply the target capture probability of infrared light photoelectric detection imaging sensor system in the theoretical distance, and leads to the detection mission not to be completed. In order to ensure the photoelectric detection imaging sensor system to obtain the higher target capture probability, this paper proposes composite detection method to determine the target capture probability by infrared detector and visible light detector, the principle shown in Fig. 1.

The composite photoelectric detection imaging sensor system is mainly composed of two sets optical lens, infrared detector, visible light detector, signal processing module, data processing module, and power module, the target detects by two different optical bands about infrared detector and visible light detector.

Due to the influence of the atmospheric decay and the atmospheric turbulence and the background light on the infrared band and visible light band, the target capture probability of two subsystems has significantly distinctive.

3. Composite detection capture probability model based on infrared and visible light detection sensor

3.1. Target detection capture probability model in infrared detection sensor

When the target becomes a point target in the infrared photoelectric detection imaging sensor system, the angle of target in the infrared photoelectric imaging sensor system is less than the instantaneous field of view, and can't fill the entire field of view [4]. Therefore, the system receives radiation that have not only the target radiation, but also a part from the background radiation [5].

Assuming that the radiation illumination of point target provides by the photoelectric detector in the infrared photoelectric detection imaging sensor system. Because the target is not full of instantaneous field of view, the background radiation can also get to the detector. Supposing the type of background radiation is single, the radiation illumination of background radiation generates from the infrared photoelectric detection imaging sensor system to the photoelectric detector.

Therefore, the total radiation illumination of infrared photoelectric detection imaging sensor system to photoelectric detector can be acquired by the formula (1).

$$F_1 = \frac{(C_1 H_0 + C_2(L^2 \varpi_0 - H_0))\kappa_0}{L^2} \tag{1}$$