Methods of Obtaining Miss distance Based on Image Measurement Technology

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1 Introduction

In the future war, with the constant improvement of moving velocity and mobility of the shooting target, the shooting precision of the weapon system has been seriously challenged. Closed loop shoot emendation is an effective method to improve the shooting precision of weapon system whose key problem is the measurement of projectile miss distance. During the spotting process using conventional method, miss distance is mostly observed by optical sight or visualization in which equipment is simple, human factor has great influence and dependence on personnel quality is great. Therefore it cannot guarantee high firing accuracy. In recent years many domestic scholars proposed various methods to measure miss distance by using photoelectric sensor [1~3]. With the advantage of good confidentiality, great accuracy and reliable stability, photoelectric sensor is getting more and more prominent in the measurement of miss distance.

2 Summary for the Measurement of Miss Distance

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2.1 Definition of Miss Distance

Miss distance is the shortest distance between projectile and target in the relative motion process. It is not convenient for this kind of miss distance which is generally definite to be measured and processed. Two kinds of equivalent miss distances can be definite from the aspect of closed loop shoot emendation: ① Equidistance miss distance: When projectile and target are in the relative motion process whose distance is equal to shooting origin (slant distance), then we define the distance between projectile and target as the equidistance miss distance; ② $t_f$ moment miss distance: When projectile’s flying time equals to the forecasted flying time $t_f$ in relative motion process which involves projectile and target, then we define the distance between projectile and target as $t_f$ moment miss distance. Equidistance miss distance is the closest to general-definite miss distance. Meanwhile it is convenient for equidistance miss distance to be done practical measurement. Therefore definition of $t_f$ moment miss distance is generally used when research of miss distance measurement is carried on.

2.2 Measuring Method of Miss Distance

The methods of measuring miss distance is tracking and surveying the target and projectile with electro-optical tracker through which movement model of the goal and projectile can be estimated and their path equations can be separately established. Then distance between shooting origin and the projectile and target in relative motion process can be calculated. When time equals to $t_f$, distance between projectile and target equals to that of shooting origin. At present sampling frequency of electro-optical tracker is 40 frames/s, which means target and only one projectile will appear in the moment miss distance image in which any confusion will not come into being. This projectile's miss distance is the distance between target and projectile at this moment. This paper uses the second measuring method.

2.3 Theory of Image Measurement

The main information from image measurement system could be divided into two broad headings: First, image; Second, positional information of target. The former is the real-time recorded distribution of shape, brightness spatial and so on of entire or partial target contour; the latter is mainly used in automatically tracking capture and real-time measurement. Miss distance measurement is the key technology among image measuring technologies. The photoelectric image is extracted by tracking sea and air targets through electro-optical tracker in which the work principle of CCD camera is shown in Figure 14.1. The CCD camera optical system image the goal in the CCD target surface. CCD could do light-electronic switch with the elements in the whole field including background and carry accumulation of electric charge. After an accumulation is