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Study on a Pallarax Error and Its Dispersion on the Target

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***Abstract*- There are many errors to affect the system hit probability. Fixed bias, variable bias and random error are main categories for many errors. In this paper, a parallax error is considered. The parallax error belongs to the fixed bias. The fixed bias cannot be controlled by the shooting control device. The parallax error depends on the distance between the positions of the EOTS (electronic optical tracking device) and the gun. We calculate the error effect at the target by using the mil unit. The definition of a mil is based on a unit circle with a radius of one and 6400 mils mean the circumference in one turn. This analysis for the parallax error is a good guideline for design of the combat vehicle with gun having good system hit probability.**

***Keywords*—system hit probability, combat vehicle, target, gun, fixed bias.**

I. Introduction

To obtain system hit probability, we study error identification. The errors [1] are divided into three sets: fixed bias, variable bias and the random error. The fixed bias cannot be controlled by the shooting controlled device. The variable bias varies among different shot groups, while random error depends on the shooter and unexpected error. The parallax error belongs to the fixed bias. The fixed bias may be transferred to a mean value at the target. We want to calculate the error at the target due to the parallax error. The prediction of the system hit probability is obtained by using the normal distribution of the bullets on the target. The mean value of the normal distribution depends on the parallax error. The standard deviation values depend on the errors belongs to the variable bias and random error [2]. In Section II, we divide the errors into three categories. In Section III, we calculate the error at the target due to the parallax error. Conclusions will be followed in Section IV.

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II. Three Kinds of Errors

Each error[1] resulting in the hit probability of system can be divided into a three kinds of errors: fixed bias, variable bias and the random error. The fixed bias is the set of errors which cannot be controlled by the fire control device. A variable bias is the set of errors which are constant among single shot group and varies among different shot groups. The random error is a set of errors which result in random shots on the target. Fixed bias includes parallax error and drift error. Variable error includes aerodynamic jump error, cross wind error, range wind error, trunnion cant error and muzzle velocity error. The random error includes lay target error and round to round dispersion. In Table I, important errors are tabulated.

TABLE I. THREE TYPES OF ERRORS

Fixed Bias	**Variable Bias**	**Random Error**
Parallax eror	Aerodynamic Jump error	Lay Target Center error
Drift error	Cross Wind error	Round to Round Dispersion
	Range Wind error	
	Trunnion Cant error	
	Muzzle Velocity error	

III. Main Results

There is an error in the elevation angle due to the difference between the aiming device EOTS (Electronic Optical Tracking System) and the weapon equipment gun. The error in this case is referred to as the parallax error. If we can derive the parallax error in the figure 1. The parallax error is

$$E_{PAX} = g - f \qquad (1)$$

In the figure 1, the equation is obtained

$$r(p\,tan(f) - h) = p(rtan(g) - h) \qquad (2)$$

Rewriting the above equation

$$g = tan^{-1}(\left(\tan(f) - \frac{h}{p}\right) + \frac{h}{r}) \quad (3)$$

The parallax error is $g - e$, but compensating by $f - e$, the resulting parallax is $(g - e) - (f - e) = g - f$. The angle f is

$$ptan(e) = ptan(f) - h \quad (4)$$

Rewriting the equation (4),

$$f = tan^{-1}\left(\tan(e) + \frac{h}{p}\right) \quad (5)$$

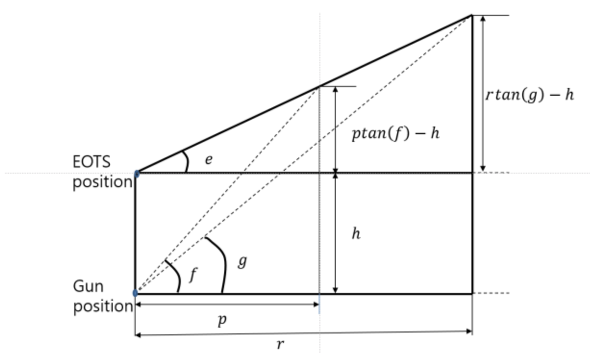

Figure 1. Parallax error with Gun and EOTS

Thus

$$g - f = tan^{-1}\left(\left(\tan(f) - \frac{h}{p}\right) + \frac{h}{r}\right) - tan^{-1}(\tan(e) + \frac{h}{p}) \quad (6)$$

Using the equation

$$r\ tan(f) = (h + p\ tan(e))/p \quad (7)$$

we obtain

$$g - f = tan^{-1}\left(\left(\tan(e) + \frac{h}{r}\right) - tan^{-1}(\tan(e) + \frac{h}{p})\right) \quad (8)$$

Thus the parallax error equation with mil unit is

$$E_p = \frac{6400}{2\pi} tan^{-1}\left(\left(\tan(e) + \frac{h}{r}\right) - tan^{-1}(\tan(e) + \frac{h}{p})\right) \quad (9)$$

We assume that the parallax error is zero at range of 1200m. Table II tabulates the parallax error at the target for different ranges and elevation angles.

TABLE II. PARALLAX ERROR VAUES

Range Distance[a] (m)	**1000**	**1500**	**2000**
Elevation angle	5		
$E_p[mil]$	0.1804	-0.3207	-0.4059
Elevation angle	10		
$E_p[mil]$	0.1762	-0.3133	-0.3966

a. Distance Between Gun position & EOTS Distance: 1200m

IV. Conclusions

In the case of a fixed bias parallax error, a high angle error occurs when the position of the EOTS and the gun are apart. If the positions of the EOTS and the gun are apart in the vertical direction, the error according to each elevation angle is obtained. For example, if the range is 2000 and the elevation angle is 10 degrees, an error of about -0.3966 mil appears. This analysis for the parallax error is a good guideline for design of the combat vehicle with gun having good system hit probability.

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