Influence analysis of optical aberration to projectile burst location parameters and its correction algorithm in area array cameras across testing system

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To improve the testing accuracy of projectile burst location parameters, this paper researches and uses two area array cameras across testing method to gain the three dimensional coordinate and establishes the testing model, according to the image principle of area array cameras, analyzes the influence of optical aberration to projectile burst location parameters and the optical aberration characteristics on projectile burst imaging, sets up a scientific optical aberration correction algorithm by coma aberration on the light spot of projectile burst imaging, gives gray-level quantitative error. Through the calculation and experimental analysis, the calculation results show the correction algorithm can compensate the influence of optical aberrations to projectile burst imaging location in two area array cameras across testing system, and give the comparison experimental verification, the testing accuracy have improved significantly.

1. Introduction

With the development of the weapon test technology, the high-precision testing of the space projectile burst location is more and more important, we propose to use two area array camera across testing method to gain the projectile burst location parameters, this kind method can gain the three dimensional coordinate of projectile burst location[1], the testing equipment structure is simple, it can flexible layout in the test range, however, the accuracy of target information extraction of projectile burst images of two array camera are affected by the optical aberration of itself, it make the testing result have a large error. To improve the testing accuracy, it is very necessary to study its correction calculation method.

In addition, projectile burst location parameters are the main index of target damage assessment, on the testing method of projectile burst location parameters, some researcher have proposed the multi-screen sensors intersection testing method that use four or six photoelectric detection sensor to structure space across testing model, the reference[2] and [3] have given the detailed testing principle and calculation model, this kind method only can gain two dimensional coordinate of projectile burst location, it cannot ensure the real projectile burst location, and some researcher use the two line array CCD across testing method[4-5], this kind method also can gain two dimensional coordinate of projectile burst location, but, this method still cannot gain the three dimensional coordinate of projectile burst location. To gain three dimensional coordinate of projectile burst location, the two area array cameras across testing method is the best measure.

The two area array cameras across testing method use optical principle to design and set up calculation model, its optical aberration imaging on projectile bursting will affect testing accuracy, how to set up the correction algorithm of optical aberration imaging on projectile bursting, which will improve the two area array camera across testing system. To solve this problem that the optical aberration imaging on projectile burst affect the accuracy of measurement of two area array camera across testing system, this paper researches a correction algorithm of the projectile burst location parameters that optical aberration cause based on two area array camera across testing principle and analyze the influence analysis of optical aberration to projectile burst location parameters testing, gives the scientific calculation method and calculation model.

2. The testing principle of projectile burst location parameters and optical aberration characteristics on projectile burst imaging

2.1. Three dimensional coordinate calculation method and model of projectile burst location

Fig. 1 is the three dimensional coordinate calculation principle of projectile burst location by using two area array cameras across testing method.
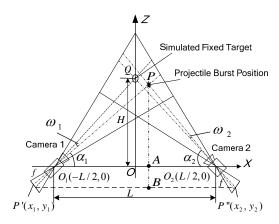
Fig. 1. The principle of projectile burst location by using two area array cameras across testing method

In Fig. 1, point P is the projectile burst location, the optical axis of camera 1 and camera 2 is across the simulated fixed target, the distance between the two cameras is L and their focal length both are f, point O is original coordinate , O_1 is the central position of camera 1, O_2 is the central position of camera 2, $P'(x_1, y_1)$ and $P''(x_1, y_1)$ is imaging position of projectile burst location in area array camera. According to the principle of pin-hole imaging and the principle of similar triangle, ΔPAO_2 and $\Delta PBP'$, ΔPAO_1 and $\Delta PBP''$ both are similar, their space geometry relation can be expressed by formula(1).

$$\begin{cases} \dfrac{x+L/2}{x-x_1} = \dfrac{z}{z+f\cdot\sin\left(\omega_1+a_1\right)} \\ \dfrac{L/2-x}{x_2-x} = \dfrac{z}{z+f\cdot\sin\left(\omega_2+a_2\right)} \end{cases} \tag{1}$$

According to their space geometry relation of two area array camera across testing system and formula (1), we derive the three dimensional coordinate of the projectile burst location, the formula (2) is their the calculation function.

$$\begin{cases} x = \dfrac{L\cdot\cot\left(\omega_1+a_1\right)}{\cot\left(\omega_1+a_1\right)+\cot\left(\omega_2+a_2\right)} \\ y = y_1\dfrac{z\cdot\sin\omega_1}{f\cdot\left(\omega_1+a_1\right)} \\ z = \dfrac{L}{\cot\left(\omega_1+a_1\right)+\cot\left(\omega_2+a_2\right)} \end{cases} \tag{2}$$

In (2), the coordinate original point is O , but, in weapon testing, the three dimensional coordinate parameter

of projectile burst location is relative to the simulated fixed target $Q(0,0,H)$, and then, the relative coordinates of projectile burst location will change to formula (3).

$$\begin{cases} x = \dfrac{L\cdot\cot\left(\omega_1+a_1\right)}{\cot\left(\omega_1+a_1\right)+\cot\left(\omega_2+a_2\right)} \\ y = y_1\dfrac{z\cdot\sin\omega_1}{f\cdot\left(\omega_1+a_1\right)} \\ z = \dfrac{L}{\cot\left(\omega_1+a_1\right)+\cot\left(\omega_2+a_2\right)} - H \end{cases} \tag{3}$$

In (2) and (3), H is the height of simulated fixed target, a_1 and a_2 is the angle between the optic axis and X-axis, ω_1 and ω_2 is the projection angle of the camera field of view.

From the calculation function of projectile burst coordinate, we find the optical aberration in two area array cameras across testing system will affect the projectile burst point imaging plane, the reason is the imaging view is very width, the distance between projectile burst point and the area array camera is relative length, it make the projectile burst point away from imaging plane, and lead to the projectile burst image is obscure, which bring to the calculation error, so, it is necessary to research the correction algorithm of optical aberration in two area array cameras across testing system.

2.2. Characteristics of optical aberration on projectile burst imaging

According to the principle of geometrical optics, in the near axis region, the light of projectile through the optical lens can be produce a perfect image on two area array cameras, but in practice, the projectile burst imaging present a dot or unstable spots on the two area array camera when the distance between projectile burst point location and the area array camera is relative length. At the same time, the optical aberration also makes projectile burst imaging obscure in optical imaging system, which will be bring to the calculation error of projectile burst location parameters. In fact, chooses the optical lens with different focal length to reduce the influence of the optical aberration on the position parameter of the projectile burst and improve the accuracy of optical testing system. However, the range of the imaging field of views can be reduced because of the long focus lens. It is unfavorable to improve the capture rate of the optical tasting system, so the optical aberration has a significant effect on the location parameters of the projectile burst while the accuracy and the capture rate are taken into account. So, it is necessary to analyze the characteristics of optical aberration on projectile burst imaging. Fig. 2, Fig. 3 and Fig. 4 show the influence of optical aberration to the projectile burst imaging in the camera 1.
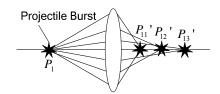
Fig. 2. The different imaging position of spherical aberration on projectile burst imaging
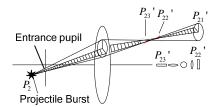

Fig. 3. The imaging position of astigmatism on projectile burst imaging
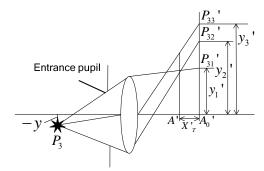

Fig. 4 The imaging position of coma aberration on projectile burst imaging spot

As shown in Fig. 2, the spherical aberration is the deviation on the axis, the light of projectile burst will converge at a difference points $P_{11}{}'$, $P_{12}{}'$ and $P_{13}{}'$ on the optical axis, these difference points make the projectile burst imaging present a brightness spot because of the spherical aberration and lead to the projectile burst imaging is obscure, which bring to the deviation of projectile burst imaging position.

As shown in Fig.3, astigmatism makes the projectile burst imaging become an elliptical faculty. The two light of projectile burst focuses into two focal points $P_{22}{}'$ and $P_{23}{}'$. The projectile burst imaging forms smallest dispersion circle at the central position of the two focal points, this phenomenon will affect light intensity of projectile burst imaging and reduce the image quality.

As shown in Fig.4, firstly, the two reflected light of projectile burst focuses into A'. $A_0{}'$ is projectile burst point imaging plane, X_T' is the distance between A' and

A_0', $P_{31}{}'$, $P_{32}{}'$ and $P_{33}{}'$ is difference focal point, $y_1{}'$, $y_2{}'$ and y_c' is respectively pixel pitch, $-y$ is distance that projectile burst deviates from optical axis. The coma aberration makes the projectile burst imaging forms a speckle that like a comet, it not only affects light intensity of projectile burst imaging but also makes position of projectile burst imaging deviated from actual position of projectile burst imaging, which will cause the calculation error of projectile burst location parameters.

3. Influence analysis of optical aberration to projectile burst location parameters

According to a time diffraction theory of optical aberration[6], the focal plane of optical field is proportional to Fourier transform phase distortion function [7], the relationship between light intensity and optical aberration can gain by formula (4).

$$E(x,y) = \iint_{\Sigma} C \exp\left[ikW(\rho,\theta) \right] \exp\left[-i\frac{2\pi}{\lambda f}(x\rho + y\theta) \right] d\rho d\theta \quad (4)$$

In formula (4), C is constant, $W(\rho,\theta)$ is aberration function, the relationship between root mean square (RMS) and optical aberration on normalized surface can gain by formula (5).

$$f_{RMS}^2 = \left[\frac{1}{\pi} \int_0^{2\pi} \int_0^1 \Delta W^2(\rho,\theta)\rho d\rho d\theta \right] - \frac{1}{\pi^2}\left[\int_0^{2\pi} \int_0^1 \Delta W^2(\rho,\theta)\rho d\rho d\theta \right]^2 \quad (5)$$

The aberration function can gain by formula (6) when the signal light enters into the optical system and it is received by the CCD.

$$W(\rho,\theta) = W_{11}\rho\cos\theta + W_{20}\rho^2 + W_{31}\rho^3\cos\theta + W_{22}\rho^2\cos^2\theta + W_{40}\rho^4 \quad (6)$$

In formula (6), ρ is aperture coordinate vector, θ is rotation angle in the image plane relative to the meridian plane, right side of formula (6) represent tilt, focus, coma aberration, spherical aberration and astigmatism [8-9].

The intensity of the pixels is proportional to the light intensity of projectile burst imaging on the focal plane, it can gain by formula (7).

$$I(x,y) = E(x,y)E^*(x,y) \quad (7)$$

Optical aberration will produce position deviation for the projectile burst imaging and make the projectile burst imaging is not centered on a spot but become a blurred spot on several pixels. We use the sub-pixel interpolation method to calculate center position of projectile burst imaging, in the case of digital image, the central position of projectile burst imaging can be regarded as weighted center position with gray value, the central coordinate parameters

of the projectile burst location on camera 1 can gain by formula (8).

$$\begin{cases} x_{10} = \dfrac{\sum\sum x_1 I'(x,y)}{\sum\sum I(x,y)} \\[4mm] y_{10} = \dfrac{\sum\sum y_1 I'(x,y)}{\sum\sum I(x,y)} \end{cases} \quad (8)$$

In formula (8), $I'(x,y) = I(x,y) - T$, $I(x,y)$ is pixel intensity, T is threshold[10-11]. Similarly, the central coordinate parameters of the projectile burst location on camera 2 can gain by formula (9).

$$\begin{cases} x_{20} = \dfrac{\sum\sum x_2 I'(x,y)}{\sum\sum I(x,y)} \\[4mm] y_{20} = \dfrac{\sum\sum y_2 I'(x,y)}{\sum\sum I(x,y)} \end{cases} \quad (9)$$

Optical aberration will affect the position parameters of projectile burst imaging, the deviation of projectile burst imaging position can gain by formula (10), (11), (12) and (13).

$$\sigma^2_{x_{10}} = \sigma^2_{x_{10},x} + \sigma^2_{x_{10},I}$$
$$= \sum_{i=1}^{n} \left[\left(\frac{\partial x_{10}}{\partial x_i} \right)^2 \sigma^2_x + \left(\frac{\partial x_{10}}{\partial I_i} \right)^2 \sigma^2_I \right] \quad (10)$$

$$\sigma^2_{y_{10}} = \sigma^2_{y_{10},y} + \sigma^2_{y_{10},I}$$
$$= \sum_{i=1}^{n} \left[\left(\frac{\partial y_{10}}{\partial y_i} \right)^2 \sigma^2_y + \left(\frac{\partial y_{10}}{\partial I_i} \right)^2 \sigma^2_I \right] \quad (11)$$

$$\sigma^2_{x_{20}} = \sigma^2_{x_{20},x} + \sigma^2_{x_{20},I}$$
$$= \sum_{i=1}^{n} \left[\left(\frac{\partial x_{20}}{\partial x_i} \right)^2 \sigma^2_x + \left(\frac{\partial x_{20}}{\partial I_i} \right)^2 \sigma^2_I \right] \quad (12)$$

$$\sigma^2_{y_{20}} = \sigma^2_{y_{20},y} + \sigma^2_{y_{20},I}$$
$$= \sum_{i=1}^{n} \left[\left(\frac{\partial y_{20}}{\partial y_i} \right)^2 \sigma^2_y + \left(\frac{\partial y_{20}}{\partial I_i} \right)^2 \sigma^2_I \right] \quad (13)$$

In (10), (11), (12) and (13), σ_x and σ_y are gray-level quantitative error. The optical aberration can bring a certain errors of projectile burst imaging position. The optical aberration will not only affect the light intensity of projectile burst imaging position and make the projectile

burst imaging become blurred, but also cause the deviation of the projectile burst imaging position and affect the accuracy of the space position parameters for projectile burst. Therefore, in order to improve accuracy of the space position parameters for projectile burst, it is necessary to research the correction algorithm of optical aberration.

4. The correction algorithm of optical aberration on burst location imaging

It can be seen from Fig.2 and Fig.3, the spherical aberration and astigmatism make the position of the projectile burst imaging have a small affection, but it has a great influence on the brightness of the projectile burst imaging position. As shown in Fig.4, Coma aberration not only makes the shapes of projectile burst imaging changed but also makes the position of projectile burst shifted and the light intensity of projectile burst imaging is dulled. To two area array cameras across testing system, spherical aberration and astigmatism have less influence on the position of the projectile burst imaging, therefore, we just think about the correction algorithm of optical aberration to projectile burst location parameters. In camera 1, the coma aberration can be approximated as a diamond to calculate its center position, as shown in Fig.5.
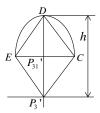

Fig. 5 Coma aberration on the light spot of projectile burst imaging

All lights pass through the optical system is distributed in the common tangent line that goes through the image point P' and the angle is 60°. The center position of the projectile burst imaging must deviate from the ideal position because of the coma aberration [12-13]. If the coma aberration is described by Seidel polynomials, it can gain by formula (14).

$$W_{31} = \sum_i W_{131i} \left[\left(H_f - \sigma_i \right) \cdot r/h \right] \cdot r^2 \quad (14)$$

In formula (14), H_f is normalized field height, h is pixel pitch, r indicates that the actual normalized aperture height at the pupil, σ_i is the position deviation of the projectile burst imaging on coma aberration. $a_{131} = \sum_i W_{131i} \sigma_i / W_{131}$, the formula (14) turns to (15).

$$W_{31} = W_{131} \left[\left(H_f - a_{131} \right) \cdot r/h \right] \cdot r^2 \quad (15)$$

In formula (15), a_{131} is coma aberration with a value of zero in the imaging plane, $W_{131}|H_f - a_{131}|$ is coma aberration size, $H_{131} = (H_f - a_{131})$ is the direction of the coma aberration [14].

We use a rough way to correct the deviation of projectile burst imaging position on coma aberration. As shown in Fig. 5, P_{31}' is the central position of projectile burst imaging spot on coma aberration, $P_3'CDE$ can be seen as a diamond, P_3' is ideal position of projectile burst imaging. According to the geometrical position of the light spot of projectile burst imaging, we can determine the position P_{31}' is half of the whole imaging position of projectile burst that affect by the coma aberration, so we only need to along with the direction of the ideal spot move 1/2 times value of the whole imaging position to get the real the imaging position of projectile burst. Therefore, we need to let the central position of projectile burst imaging moves $1/2 W_{131}|H_f - a_{131}|$ along $H_{131} = |H_f - a_{131}|$ towards the direction of P_3'. The central position of deformed light spot position of projectile burst imaging can be corrected to ideal spot position, which reduces the calculation error.

5. Calculation and experiment analysis

5.1. Influence analysis of optical aberration to the . projectile burst location parameters

According to formula (8), (9), when the size of the optical system and the size of detection target are determined, the deviation of the optical aberration to the location parameters for projectile burst is mainly related to gray-level quantitative errors, pixels intensity and the central coordinate of projectile burst imaging. We use the RMS to measure the size of the aberration, Fig.6 gives the relationship between light intensity and center light spot position.

From Fig. 6, the influence of spherical aberration and astigmatism on light intensity of the projectile burst imaging are same when the value of RMS is less than 0.1, the influence of these three aberrations on the light intensity of projectile burst imaging position is inconsistent when the value of RMS more than 0.1. Comparing (a) and (b) in Fig.6, the influence of coma aberration on the position of the projectile burst imaging is great, spherical and astigmatism almost is no change. Due to the astigmatism and spherical aberration is a symmetrical distribution aberration along with the direction of optical axis. Center position of projectile burst imaging for astigmatism and spherical aberration must be on the optical axis, the influence of astigmatism and spherical aberration on the location parameters for projectile burst imaging is small and it only affects the light intensity of projectile burst imaging. Too excessive light intensity is not conducive to improve the extraction of projectile burst point information.

However, Coma aberration is asymmetric aberration, it not only effects the center position of the projectile burst imaging but also effects the light intensity of projectile burst imaging. Therefore, we only analyze the coma aberration when analyzing the position deviation of the projectile burst imaging. The relationship between the coma aberration and the ideal position can show in Fig.7.
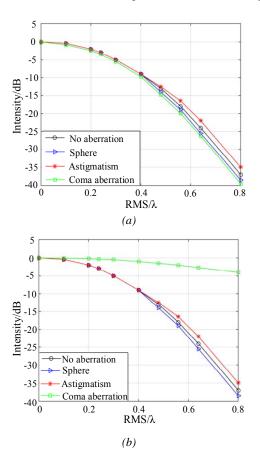

(a)

(b)

Fig. 6 The relationship between aberration and light intensity of the receiving surface: (a) Pixels position of projectile burst imaging and (b) Center position of projectile burst imaging

As shown in Fig. 7, the coma aberration causes central position of the projectile burst imaging to be offset from the actual position of projectile burst imaging, resulting in an increase in the errors of the position. Coma aberration causes the position errors are changed with the optical aberration changes and the position errors of spherical aberration was S type. The errors of position parameters on projectile burst imaging is increased when the value of coma aberration is increased. Thus, according to the influence of aberration on the position and the light intensity, it is necessary to correct the errors caused by aberration.
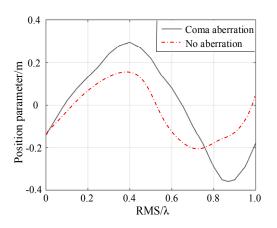
Fig. 7. The deviation of coma aberration on projectile burst imaging position

5.2. The analysis correction algorithm of optical aberration on projectile burst location parameters

According to formula (10), (11), (12) and (13), we can get the direction and distance of the deviation on the location parameters for projectile burst imaging, moving the 0.5 times value of the coma aberration in the direction of the center position for the projectile burst imaging to get the ideal position with the geometric model shown in Fig. 5. But too strong light intensity is not conducive to improve the extraction of projectile burst point information. Therefore, the light intensity needs to be moderate in order to weaken the influence of the strong light intensity. Fig. 8 gives the correction of position errors of projectile burst imaging on coma aberration in the moderate light intensity.
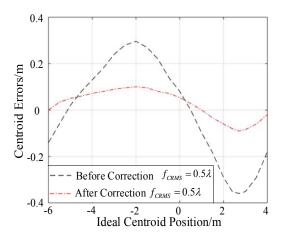

Fig. 8. The correction of center positioning error on coma aberration

As the Fig. 8 shows, corrected position errors of projectile burst imaging on coma aberration is significantly reduced. In the process of experimental analysis, the coma aberration has the greatest effect on the position and the light intensity of the projectile burst imaging position, the influence of astigmatism and spherical aberration are smaller. Thus, this paper uses the mutual compensation

relationship of coma aberration to explore whether aberration and spherical aberration will reduce the position errors of the coma aberration.
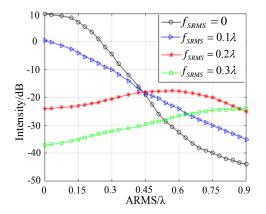

Fig. 9. The relation between stigmatism and spherical aberration on the central light intensity compensation

As Fig. 9 shows that the light intensity of projectile burst imaging position will become smaller with the value of coma aberration increases, using corresponding spherical aberration to adjust parameters for different values of the coma aberration. With the increase of the coma aberration, the correction of the spherical aberration is weaker.
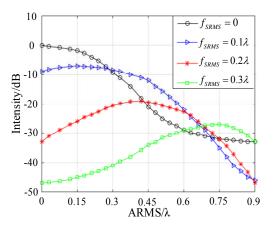

Fig. 10. The relation between coma aberration and spherical aberration on the central light intensity compensation

Fig. 10 shows that the influence of astigmatism on the light intensity of projectile burst imaging position is weakened with the value of coma aberration increases. Comparing Fig. 10 and Fig. 11, it can be concluded that the correction effect of astigmatism is better than the correction effect for the coma aberration of the spherical aberration.

5.3. Experiment and analysis

According to the testing principle of projectile burst location parameters and the correction algorithm of optical aberration on burst location imaging. In two area array cameras across testing system, we choose the CCD detector

resolution is 1024 ×1024, its the pixel size is10um×10um, the focal length of lens is 125mm, the experimental conditions is that the height of simulated fixed target is 38.8m and the distance between two area array cameras is 33.2m. Under those experimental conditions, we test ten projectiles in one experiment, Table 1, Table 2 and Table 3 give the calculated experimental data, among them, Table 1 is the five experiment data of projectile burst location in two area array cameras and corresponding correction experiment data; Table 2 and Table 3 is contrast data between two area array cameras across testing system that and multi-screen sensors intersection testing system, but, table 2 is the data without correction by using the correction algorithm of optical aberration, Table 3 is the calculation data under correction algorithm of optical aberration.

Table 1. Experiment data of projectile burst location in two area array cameras

NO.	U		V		RMS	δ_{x_1,y_1}		δ_{x_2,y_2}		U'		V'	
	$x_1(m)$	$y_1(m)$	$x_2(m)$	$y_2(m)$		δ_{x10}	δ_{y10}	δ_{x20}	δ_{y10}	$x_1(m)$	$y_1(m)$	$x_1(m)$	$y_1(m)$
1	-2.21	-3.17	-1.31	-3.27	0.10	0.22	0.19	0.19	0.24	-2.28	-3.27	-1.47	-3.62
2	-2.63	-4.23	-2.35	-2.78	0.35	0.32	0.29	0.35	0.26	-2.69	-4.36	-2.65	-3.16
3	-3.21	-3.72	-3.12	-2.00	0.27	0.22	0.24	0.19	0.28	-3.51	-3.82	-3.40	-2.35
4	-2.41	-4.92	-2.97	-2.67	0.76	0.45	0.48	0.54	0.47	-2.72	-5.32	-3.48	-3.02
5	1.87	3.92	-3.14	-2.89	0.54	0.42	0.39	0.37	0.30	1.53	-4.12	-3.42	-3.43

Table 2. The contrast data between multi-screen sensors intersection testing system and two area array cameras across testing system that without correction

NO.	multi-screen sensors intersection testing method		two area array cameras across testing system			Errors	
	x(m)	z(m)	x(m)	y(m)	z(m)	$\left|\Delta X\right|$ (m)	$\left|\Delta z\right|$ (m)
1	-4.78	-3.32	-5.03	3.12	-3.53	0.25	0.21
2	-3.34	-2.73	-3.52	-1.72	-2.92	0.18	0.19
3	-4.08	-3.04	-4.43	4.34	-3.26	0.35	0.22
4	-3.92	-2.58	-4.23	-1.77	-2.81	0.31	0.23
5	-3.78	-1.83	-4.10	-2.28	-2.09	0.32	0.26

Table 3. The contrast data between multi-screen sensors intersection testing system and two area array cameras across testing system that has corrected

NO.	multi-screen sensors intersection testing method		two area array cameras across testing system			Errors	
	x(m)	z(m)	x(m)	y(m)	z(m)	$\left|\Delta X\right|$ (m)	$\left|\Delta z\right|$ (m)
1	-4.78	-3.32	-4.84	2.88	-3.37	0.06	0.05
2	-3.34	-2.73	-3.43	-1.65	-2.84	0.09	0.11
3	-4.08	-3.04	-4.21	4.11	-3.13	0.13	0.09
4	-3.92	-2.58	-4.01	-1.66	-2.62	0.09	0.04
5	-3.78	-1.83	-3.82	-2.12	-1.95	0.04	0.12

In Table 1, U denote the pixels coordinate of camera1, V denote the pixels coordinate of camera2, U' is corrected pixels coordinate of camera1, V' is corrected pixels coordinate of camera2. Based on the data of table 1, table 2 gives the calculation results. From Table 2, the multi-screen sensors intersection testing method[15] only can gain two dimensional coordinate of projectile burst location, it cannot ensure the real projectile burst location, two area array camera across testing system can gain three-dimension coordinate of projectile burst location. From the data of x and z in Table 2 and Table 3, and contrast Table 1 and Table 2, we found that the test data, the average error is close to 0.3 meters; contrast Table 1 and Table 3, the average error of testing data is less than 0.1 meters, the results show that the correction algorithm of optical aberration can effectively improve the test precision in two area array cameras across testing system.

6. Conclusions

This paper presents a method for measuring the three-dimensional position of the projectile burst point by using the spatial intersection model of two cameras. Use the geometric model of the intersection between the camera and the target and the angle between the camera and the target extrapolate the three-dimensional information of the projectile burst point, using the coplanar camera to get the depth information of the projectile burst point, and get the third dimension coordinate parameter. It avoids the problem of non-coplanar by the traditional cameras direct use the intersection optical axis to establish the linear equation. To solve the problem that the optical aberration of projectile burst location affect the testing accuracy in two area array cameras across testing system, this paper researches a correction algorithm of projectile burst point imaging based on two area array cameras across testing principle and analyze the influence of optical aberration to projectile burst location parameters, gives scientific calculation method and calculation model. Through experiment and analysis, and find that the correction algorithm of optical aberration can effectively improve the test precision in two area array cameras across testing system, the optical aberration can also be corrected to reduce the error caused by the aberration in the optical system. Optical aberration can also be corrected to reduce the error caused by the aberration in the optical system. Two area array camera across testing system can gain three-dimension coordinate of projectile burst location, this kind of test methods can more scientifically describe the real location of projectile burst point, it has high application value. The calculation and analysis ensure that the damage efficiency analysis of high-altitude targets provides more scientific data.

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