Correction of principle error of photoelectric helmet

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Abstract. The paper concerns itself with the specific structure of the optical system in a photo-electrical helmet-mounted sight scanning system, and makes analysis of the principle error caused by ten sides prism reflector non-direction fit axis rotation in measuring its head position ,it further derives two formulas for base line correction and goniometry correction. The former formula is in complete accordance with the results given in the theory technical materials, whereas the latter has been successfully applied in the improved photo--electrical helmet-mounted sight.

Questions

Head position measurement model,The premise condition is to measure the radiation source azimuth ψ_{Ai}、 $\psi_{Бi}$, That i infrared light-emitting diodes and ten prism projection $ИД_i'$ rotation center O_{CA}, $O_{CБ}$ connection with ($-X_{CA}$), ($-X_{CБ}$) axis angle folder.

The optical system of the scanning device according to the structure and size of the draw ratio analysis and calculation, we can see that the principle reason for angle measurement error generated, as shown in Figure 1.

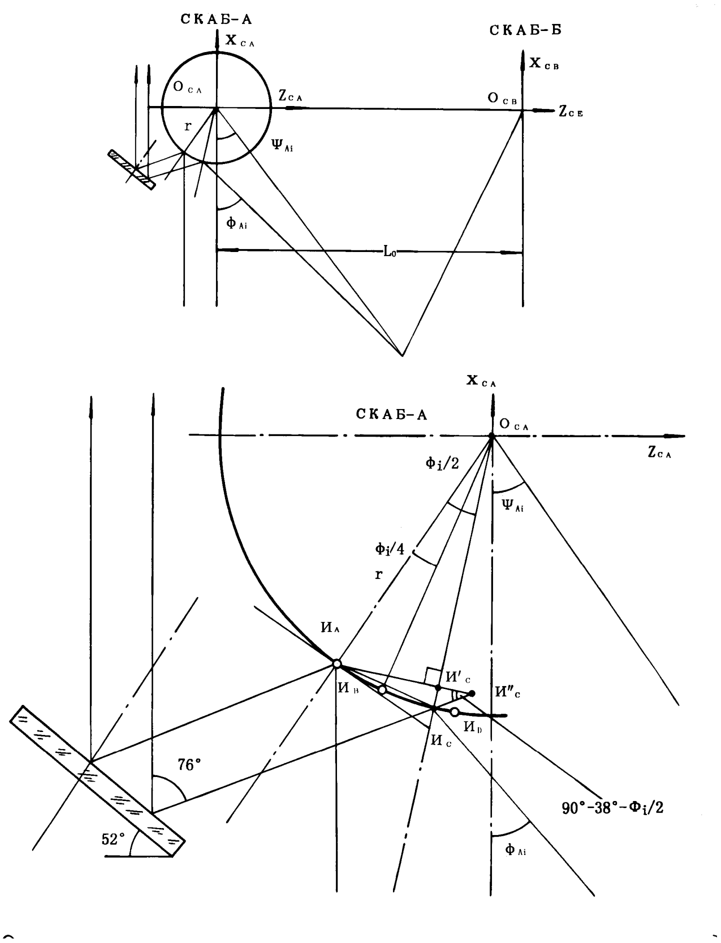

Fig. 1 error principle of head position

In the picture:

r - ten prism reflector radius.r=19mm;

α_0−−−Ten the theory of the normal of the prism reflector, α_0=38°;

α_i−−Ten prism surface normals and (-X_{CA}) axis.

φ_i---The i infrared light emitting diode connection for i and the ten part projection prism reflector center, and (-X_{CA}) axis angle.Known as the measured radiation source azimuth.
N_A、N_B、N_C、N_D----When the value of I angle respectively equal to 0^0, 16^0, φ_i , -20^0 , ten prism reflector center location;
S----Fixed mirror, fixed mirror normal and (X_{CA}) axis was 38°;
N_C'----When φ_i, position ten prism reflector N_C;
N_C''----When φ_i,Ten virtual position of the center of the prism reflector Nc.

According to figure 1, ten reflecting prism surface normals from α_0=38°of theory zero meter up around ten prism Y_{CA} is turn angle scanning α_0-α_i ,can calculate the measured radiation source azimuth φ_i =2(α_0-α_i).When the α_0 is turned from α_0-α_i to α_i I position, the center of the ten prism reflector is transferred from the N_A to the N_C position.

Since ten prism reflecting surfaces deviate shaft, during rotation, ten rotating prism reflecting surface both have to move, which we call non-coplanar fixed axis.

Because ten prism reflecting surface into a non-coplanar fixed axis of rotation, so in order to be able to scan to the infrared φ_i at the ten prism reflecting surface center N_c need to go at this coplanar with respect to the reflecting surface of the prism ten fixed shaft, bypassing the N_A vertical rotation axis point, the mobile location N_C difference of a distance N_C N_C'.

Then follow the angle φ_i determine the optical path of the reflecting surface of the virtual center position N_C ", so that you can find the actual center of the reflecting surface of the reflecting surface N_c virtual center N_C" error exists between N_C N_C ".For the error generation principle also can be understood that the assumptions ten prism reflecting surface normals turned the post into the infrared scanning angle α_0-α_i =φ_i/2 at φ_i, but this time if the incident infrared energy reflected by N_C'' enters the optical system, it N_A effects and the reflection at the equivalent, too, and if the reflecting surface is placed ten Y_{CA} reflection prism axis entering the optical system of the effect is equivalent. In this case, the measured azimuth radiation source is required to correct the azimuth radiation source, is the principle of non-existent errors.However, in practice, the reflective surface of the reflector center to N_c, while still maintaining 2(α_0-α_i)= φ_i relationship , but the reflection surface center position has a difference of N_C N_C'', which in fact, changed the baseline measurement of head position, so that the measured radiation the radiation source azimuth and azimuth need not equal, causing the head bit error measurement principle.

$$N_A N_C = 2r\sin\frac{\varphi_i}{4}$$
$$N_C N_C^{\bullet} = 2r\sin^2\frac{\varphi_i}{4} \qquad (1)$$
$$N_C N_C^{\bullet\bullet} = \frac{2r\sin^2\frac{\varphi_i}{4}}{\sin(\frac{\pi}{2} - 38^o - \frac{\varphi_i}{2})} = \frac{2r\sin^2\frac{\varphi_i}{4}}{\sin(52^o - \frac{\varphi_i}{2})}$$

Taking into account the zero count starting from the theoretical α_0, Φ_i of the edge of one side is 40° , while the other side edge of -20° , 16 ° mainly selected for this light, and therefore the equation (1) modified, then the N_C N_C'' is projected onto $(OXYZ)_{CA}$ coordinates to give the reflecting surface center position errors are:

$$N_C N_C^{\bullet\bullet} = \frac{2r\sin^2(\frac{\varphi_i}{4} - 4^\circ)}{\sin(\frac{\pi}{2} - 38^\circ - \frac{\varphi_i}{2})} = \frac{2r\sin^2(\frac{\varphi_i}{4} - 4^\circ)}{\sin(52^\circ - \frac{\varphi_i}{2})}$$

$$\Delta X_i = \frac{2r\sin^2(\frac{\varphi_i}{4} - 4^\circ)}{\sin(52^\circ - \frac{\varphi_i}{2})}\cos 76^\circ \qquad (2)$$

$$\Delta Z_i = \frac{2r\sin^2(\frac{\varphi_i}{4} - 4^\circ)}{\sin(52^\circ - \frac{\varphi_i}{2})}\sin 76^\circ$$

Ten prism reflecting surface coplanar reflection surface center position error generated by a fixed axis of rotation, head position will change from baseline measurements, infrared light-emitting diode coordinate values change, causing the head position error measurement principle, and therefore must be corrected.

Baseline correction

There are two ways to correct that baseline correction method and the correction method goniometer, Helmet uses a baseline correction method (Figure 3)

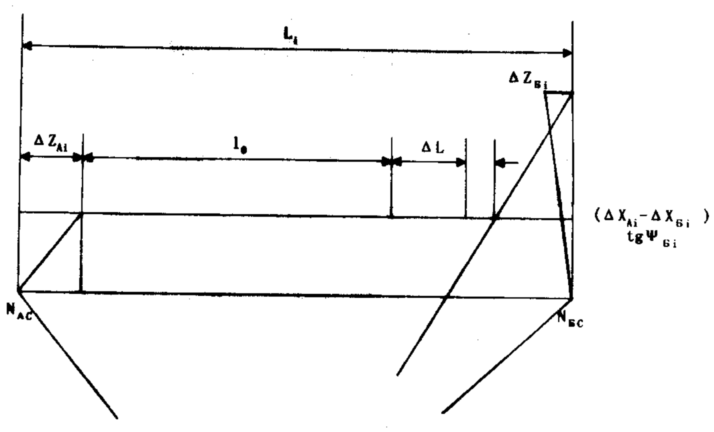

Figure 2 baseline correction method

The so-called baseline correction method is a method in the affirmative $2(\alpha_0-\alpha_i)=\phi_i$ under the prerequisite to calculate the infrared radiation infrared light emitting diode main locations in the virtual center ten prism reflective surface, and come to the actual position of the center of the reflecting surface error, again calculated baseline value, non-fixed axis correction method coplanar reflective surfaces. Specifically, an infrared light-emitting diodes for each i, by scanning devices and electronic devices can be obtained with the corresponding ten-reflecting surface of the prism through an angle $\alpha_{Ai}-\alpha_{Bi}$, then:

$$\psi_{Ai} = 2(\alpha_0 - \alpha_{Ai}) = \phi_{Ai}$$

$$\psi_{bi} = 2(\alpha_0 - \alpha_{bi}) = \phi_{bi} \qquad (3)$$

$$\Delta X_{Ai}=\frac{2r\sin^2(\frac{\varphi_{Ai}}{4}-4^{\circ})}{\sin(52^{\circ}-\frac{\varphi_{Ai}}{2})}\cos76^{\circ}\qquad \Delta Z_{Aii}=\frac{2r\sin^2(\frac{\varphi_{Ai}}{4}-4^{\circ})}{\sin(52^{\circ}-\frac{\varphi_{Ai}}{2})}\sin76^{\circ}$$

$$\Delta X_{bi}=\frac{2r\sin^2(\frac{\varphi_{bi}}{4}-4^{\circ})}{\sin(52^{\circ}-\frac{\varphi_{bi}}{2})}\cos76^{\circ}\qquad \Delta Z_{bi}=\frac{2r\sin^2(\frac{\varphi_{bi}}{4}-4^{\circ})}{\sin(52^{\circ}-\frac{\varphi_{bi}}{2})}\sin76^{\circ} \tag{4}$$

Figure 2:

L。----Theoretical baseline value;

ΔL---- ψ i=16° Standard values determined by the principal ray correction;

L----Baseline values after correction.

Figure 2 can be obtained:

$$L_i = L_0 + \Delta L + \Delta Z_{Ai} + \Delta Z_{bi} - (\Delta X_{Ai} - \Delta X_{bi}) tg\psi_{bi} \tag{5}$$

The (3) into (4), you can find both coordinates i in infrared light emitting diode (0XYZ) C A coordinates through the principle of error correction, which is:

$$X_i = \frac{L_i \cos\psi_{bi}}{\sin(\psi_{\text{Ai}} + \psi_{bi})}\cos\psi_{Ai} + \Delta X_i$$

$$Z_i = \frac{L_i \cos\psi_{bi}}{\sin(\psi_{\text{Ai}} + \psi_{bi})}\sin\psi_{Ai} + \Delta Z_i \tag{6}$$

Summary

After baseline correction performed head position measurement calculations, the resulting target indicating angle Φ_Y, Φ_Z, there will be no principle error ten prism reflecting surface non-coplanar fixed shaft produced to ensure the correctness of the calculation.

reference

[1] Wang, eds years, "helmet display / sighting system," National Defense Industry Press, 1992.10
[2] Lu Yan, Zhou Zhigang, Xiaying Ming series, "airborne fire control count technique", Defense Industry Press, 1994.6
[3] Chang An, Zhou Zhigang ed, "aviation integrated fire control principle", Northwestern Polytechnical University Press, 1997.6
[4] "Helmet large field of software design," Air Force Engineering College 93 Master Thesis Huang Changqing, 1995.12
[5] "a certain type of Helmet Testing System", the Air Force Engineering University, 98 Master Thesis He Jingfeng, 2001.01.12