THE CAMERA LENSES FOR HS2323 AERIAL CAMERA OF JOIF

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Abstract

A report was given for lenses HS88/23,HS152/23 and HS210/23 of HS2323 aerial camera of Jiangnan Optical Instrument Factory (JOIF) in Nanjing China, with which the photosize is 23x23cm^2. The image quality such as resolution power, distortion etc. are presented . The features of mechanical disign are also described.

Keywords: CAmera, Image quality, Optical, system design

1. Introduction

The progress of aerial camera of JOIF may be divided in two periods in recent 20 years. In the first period, JOIF developed suceessfully 航甲-17 aerial camera with photosize 18X18cm^2 before 1980. , It has two lenses,their fundamental optical parameters are: focal length 70mm and 100mm, field angle 122°and 90° respectively, the relative aperture is 5.6,the spectral rang from 500nm to 700nm,radial distortion less than 0.025mm, central photo-resolution power is 60pl/mm. It is preferably used for small or medium scale photograph. In view of various applications of aerial photogrammetry in china, togather with regard to precision and economical condition, JOIF has led to develop the HS2323 aerial camera since 1980, thus we call the second period as above, At that time, We adoptied the international standard format in our design and suceeded in 1985 two lenses HS88/23 and HS152/23 (HS210/23, HS305/23 lenses are still in develped), which will be described as follows.

To obtain a new high performance lens, it depends on many factors. The design of optical systems by mordern computer is in common used ,but it can not work well automatically. A good optical designer does not only write out a optimum program algorithms,but also has a rich experience to judge his solution whether or not meets the need of his users, besides he must consider thoroughly the chosen glasses to be favorable and no special manufacturing difficulty existed. After the optical system design has been finished, it is importance to have a regard to lens mechanical design. A suceessful mechanical design must be guaranteed with the centre alignment accuracy of the optical system, with the space distances constant between lens components,and the construction must be steady for inner orientation. moreover,the mechanical parts must be convenient to manufature and entire system must be easy to assemble in mass prodction. In fact, camera lens is a special fine art, each prodction step should be put in strict quality control.

2.The optical fundaments of the HS2323 aerial camera lenses

The quality of the lenses of the camera system is of primary importance in the image quality, all lenses possess of:

1) Negligible small distortion
2) High resolution over the whole picture
3) Low light fall-off in the corners of the image relative to the centre
4) Optimal chromatic correction for the visible and infrared regions of the spectrum.
5) High relative aperture

HS88/23, HS152/23, HS210/23 and HS305/23 lenses optical characteristics are given in table 1.

HS88/23 lens consists of 11 lenses forming 6 components (Fig.1), it is fully color corrected between 400nm to 900nm, and can therefore be used in combining with the proper filters for panchromatic, infrared, color and false-color photography. The maximum photo-resolution power is 66pl/mm on 航微-II film (of which the resolution power is 90pl/mm) and the minmum is not less than 18pl/mm. The average radial distortion referred to calibrated focal length is less than 10 microns. The light fall-off follows closely a curve of cosine α^3 ,where α is the hald-field angle, and is properly corrected by the antivignetting coating on the filters.

HS152/23 lens consists of 9 lenses in 5 components (Fig.2),just like HS88/23,the chromatic correction in the spectral range from 400nm to 900nm. The maximum photo-resolution power is 70pl/mm while minimum is not less than 25pl/mm on 航微-II film. The average radial distortion is less than 8 microns. The light fall-off also follows cos α^3 of the half field angle α ,and is corrected by antivignetting coating on the filters.

HS210/23 and HS305/23 lenses are in developing, they consist of 12 lenses respectively (Fig.3,4), their relative apertur is 4. The chromatic correction in the spectral range also from 400nm to 900nm. The maximum photo-resolution power is 70pl/mm and the minimum is not less than 35pl/mm on 航微-II film. the average radial distortion is no more than 5 microns.

3. the features of lens mechanical design

the requirements for the lens mechanical design are:

1) It should gurantee the needs of optical system especialty the centre alignment accuracy of the optical system, and the spaces between the optical components.

2) It should be easy to assemble and adjust the entire lens system, including lens calibration in order to ensure mass production of these lenses economically.
3) The mechanical structure must be stable for remaining the inner orientation unchanged in any working condition.

there are many kinds of lens mechanical design, our design is a mixed patern (FIG.5),the main features of this pattern are:

- Using a auxiliary metal mount to hold a single lens component or a cell to hold lens groups with cement.turning the outerside of the mount or boring the innerside of the call as well as the end surface in relation to the optical axis.
- Using a compensation device to compensate the undesired space between the lens-mount and lens-cell in diameter.
- The two lens-cell halves are fixed together by a common barrel with the compensation devices compensating the undesired space in diameter.
- The material of the mount, cell, barrel and associated mechanical parts are special alloy including nickel steel and other metals with a coefficient of linear expension as close to that of the glass in contact.

Because of using the compensation devices,it is easy to centre the lens components and lens groups to a common optical axis accurately, the centric accuracy can be achieve about 3 microns.

4. Summary

Fig5. 6,7,8,and 9. show the results of measurent in photo-resolution power and radial distortion of the HS88/23 and HS152/23 lenses. the measurmrnts were carried out on the optical bench developed by JOIF. The photo-resolution power was determined according to the ISP recommended procedures with three-line test groups, which is high contrast (log k=2.0). The test emulsion used is 航微-II film, its resolution power is 90pl/mm.We also tested the photo-resolution power of HS152/23 under inflight conditions to photography the terrain targets from an altitude 3344 meters, plan speed is 430km/h, exposuretime is 1/200 second,the AWAR is not less then 25pl/mm. Distortion was measured on the horizontal goniometer, the average standard error is ±2 microns. The calibration records show an extremely good consistency from one calibration to another calibration, even after four years. Our method of mounting the lens components and lens groups for these types is exceeddingly satisfactory, the image quality of these lenses meets the need of users in China.

References

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Table 1 the optical characteristics of lenses of HS2323

lens	focal length	field angle	relative aperture	spectrum	photosize
HS88/23	88mm	122°	5.6	400nm-900nm	23x23cm
HS152/23	152mm	90°	5.6	400nm-900nm	23x23cm
HS210/23	210mm	70°	4	400nm-900nm	23x23nm
HS305/23	305mm	54°	4	400nm-900nm	23x23nm

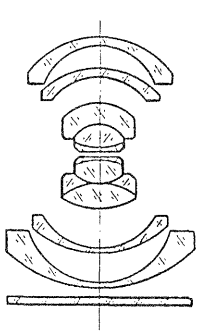

Fig.1 HS88/23 lens

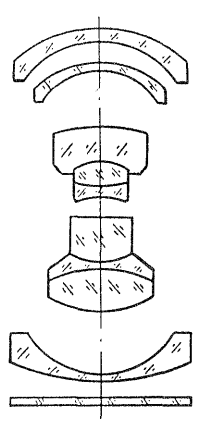

Fig.2 HS152/23 lens

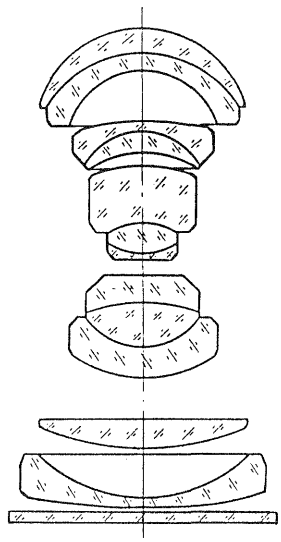

Fig.3 HS210/23 lens

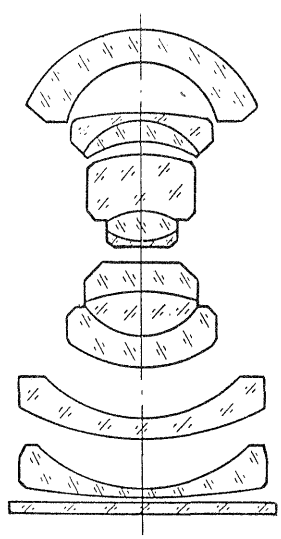

Fig.4 HS305/23 lens

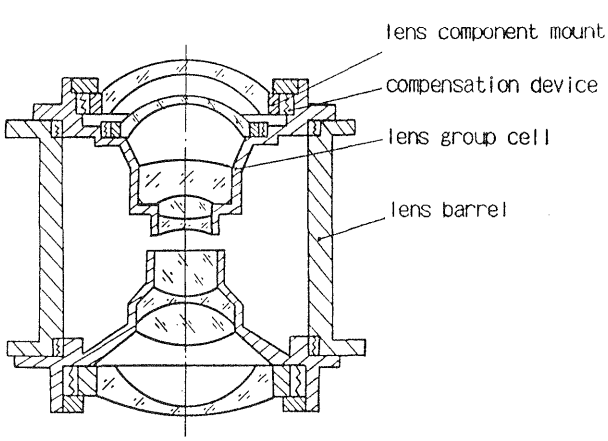

Fig.5 lens mechanical structure
with copensation devices

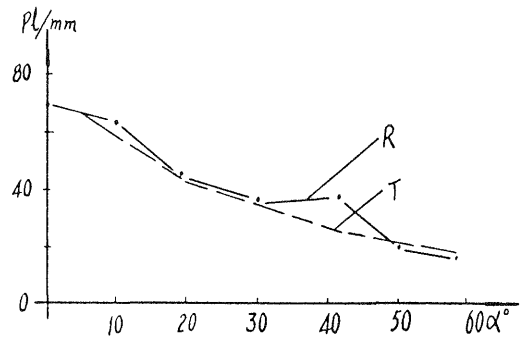

Fig.6 resolution power of HS88/23

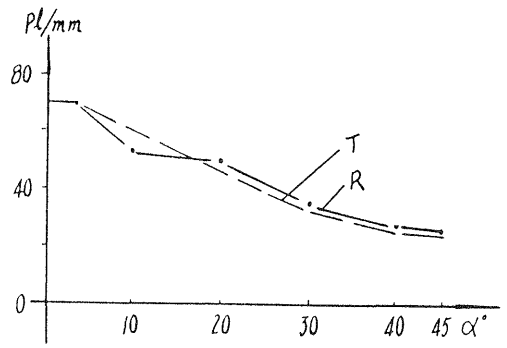

Fig.7 resoltion power of HS152/23

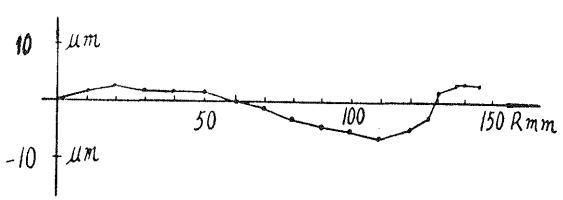

Fig.8 The average radial distortion
of HS88/23

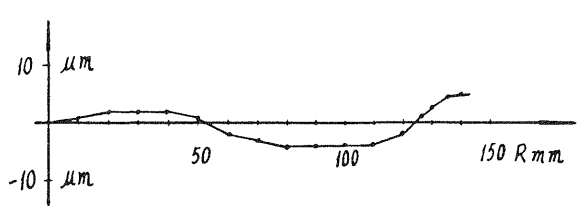

Fig.9 The average eadial disortion
of HS152/23