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Geometrical calibration of photographic cameras against test objects

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In view of constantly growing application of aerospace remote research techniques of the Earth to study and monitor natural and technogenic objects, imaging systems are required to demonstrate high metric accuracy of the picture which can be provided through preliminary geometrical calibration of photographic cameras. Being defined as a result of the geometrical calibration, parameters of internal and external orientation of the cameras are needed while solving such problems of image processing, as orthotransformation, geometrical correction, geographical coordinate fixing, scale adjustment and image registration from various channels and cameras, creation of image mosaics of filmed territories, and determination of geometrical characteristics of objects in the images. The geometrical calibration also helps to eliminate image deformations arising due to manufacturing defects and errors in installation of camera elements and photo receiving matrices as well as those resulted from lens distortions.

Designing calibration test objects and elaborating methods of the geometrical calibration is a necessary stage in the process of creating and operating systems of remote sounding of the Earth. In research institute of applied physical problems of Belarus State University, a complex of the geometrical calibration of aerospace remote sounding instrumentation with a three-dimensional calibration scene, having dimensions 3,2x2,0x1,5 m and containing more than 200 point markers in the scene volume, is currently devised. To determine space resolution and modulation transfer function of image systems, the corresponding test patterns, arranged within the scene, are being constructed. Furthermore, images of special test patterns will be formed by an optical collimator of the complex in the focal plane of a system undergoing calibration. The procedure of photogrammetric calibration is based on test object filming (the three-dimensional scene of the complex with markers location being accurately measured), determination of the pixel coordinates of the scene marker points in the image, and solution of equations combining the objective and pixel coordinates of the points with respect to unknown parameters of the camera.

To comparatively study and improve existing methods of the geometrical calibration, filming with a few serial photographic cameras of a created two-dimensional test object has been made, and such parameters of the cameras as a focal distance, location of the main point, a pixel size, distortion, etc, have been calculated. The computations are performed employing both the three known methods of the geometrical calibration, and the elaborated procedure which is based on the solution of collinearity equations.

In the report, the structure and characteristic features of the designed photogrammetric complex as well as results of calculations of the above specified parameters of the tested cameras, obtained by various techniques, are presented. Comparison with the values declared by a manufacturer (and for parameters of external orientation - with the data of direct measurements) is accomplished, and the resulting errors are analyzed. Advantages of the proposed calibration method are shown.