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Experience in creating elements of automated systems for quality control microobjectives.

Vinogradova O. A. *, Cand.Tech.Sci.; Pavliy A.D. **, Frolov A.D. **, Frolov. D.N. *, Cand.Tech.Sci.

*** Firm "Focus", St.-Petersburg**

**** Saint-Petersburg State University of Information Technologies, Mechanics and Optics**

e-mail: fronda@list.ru

Abstract: The presentation confirms possibility of an automating assembly of the micro-objectives and monitoring of the image quality of micro-objectives.

Index Terms - *micro-objective, optical-mechanical design, adaptive selection, automating assembly of the micro-objectives, the virtual assembly.*

1.Introduction

One of modern technological trends and applications in the manufacture of optical devices is automate assembly of opto-mechanical assemblies and products in general. Such automation has some specific features caused by high accuracy characteristics of lenses, mechanical parts and their combinations when arranged in a single opto-mechanical design.

One of the first practical results of work conducted in this area by national experts, was the creation unified optical and opto-mechanical objectives design of the microscope, realizing the technology group designing and manufacturing lenses, mechanical components, opto-mechanical assemblies and lenses in general. The next step was find the appropriate rational methodology, consistent with the concept of group assembly microobjectives, which led to selection methodology ASA (adaptive-selective assembly), a well-proven before in other applications. It can be argued that method becomes the basis of ASA, "key" in the implementation of automated assembly microobjectives in general, and, as part of the production process, automation control of their image quality.

2. Using the tube "infinity" - a step towards automation of assembling and testing of objectives of microscopes.

The object is strictly in the plane of the front-focus lens - this is the most important thing in the concept of optical "infinity" of modern microscopes. The most important design feature of objectives and microscopes "to infinity" is the lack of interdependence between parameters of mechanical and optical length of tube, which allows very substantially increase the accuracy of assembling and testing of objectives, to achieve the quality their images in full accordance with the calculation.

3. "Virtual" quality and build microobjectives - steps to build automation assembly and control microobjectives.

Calculation and optimization is not overall and aberration characteristics of the optical system, and the magnitude of errors and necessary permits (for subsequent manufacture of optical and opto-mechanical components), accounting and the implementation of which ensures achievement of real manufactured system - a current picture quality.

Conception of "virtual quality" not only allows to optimize the values of tolerance, but also to assign (by a special technique) in scheme of adjustment of objective for correction of spherical aberration an air gap (in the most sophisticated microscope objective can be assigned two) and "agile" to correct off-axis aberrations a component . Furthermore, use of "virtual quality" led to study as combined effect deviations of set design parameters of the objective lens on the resulting image quality, and each of them separately. It was found that the most affecting are deviations from nominal values thickness of lenses, this parameter is an order of magnitude more strongly affects the image quality than others.

As a natural element of the concept of "virtual quality" can be considered "virtual assembly". Obviously, that need for a "virtual assembly" as an element of lens assembly automation and control of its image quality is caused by the inevitable appearance in manufacture of technological errors of optical and mechanical elements.

4. Elements of automation control opto-mechanical components.

Optical-mechanical component is a lens (single or bonded), mounted in a frame.

We assume that the opto-mechanical components are manufactured in accordance with the requirements of design and technological documentation, which is practically achievable at the present level of development of optical technologies. Automating the process of fixing the lens in the frame with the required accuracy characteristics also seems possible when using special equipment.

The problem creating elements of automation assembling and testing of objective for microscopes required to develop a special stand and equipment for the control opto-mechanical components based on single, double and tree bonded lenses (positive and negative in a wide range of focal lengths), whose operating principle is illustrated in Figure 1. Telecentric lighting system for Koehler provides uniform illumination of the test object with an aperture equal to aperture of investigated component, which required the presence of the aperture stops and removable condenser. Image-test object, to be determined aperture, aberration, and dimensional characteristics of the investigated component, projected onto the electronic receiver (CCD or CMOS structure) of the optical system, part of which is analyzed components, located on the "reference plane" and having the possibility of basing an external tool cylinder barrel. The receiver is located in the plane of the back focus tubes lens. To control long-focus, negative components, as well as in some other cases (increase or decrease scale projection) requires the use of additional optical elements.

In the proposed version of the image stand real test object, the image projected upon the receiver, then transferred to the computer screen, where “superimposed” on simulated using specialized software (in fact, an element of the program algorithm of optical calculations) a "theoretical" image is exactly the same test object, only in "virtual" form. Achievable accuracy of the comparison "to one pixel" receiver of the optical image provides the required reproducibility of results.

5. Elements of automation quality control microobjectives

The main distinguishing features of the microscope objective design, which stipulate the possibility of automating its assembly and quality control, the following: 1. Objective should be designed "on the infinite" optical length of tube 2. Opto-mechanical design of objectives should be at least two buildings, working and fair. In the working case, based on the inner cylinder, poured opto-mechanical components, or just lens, or as part of a construction of opto-mechanical components and lenses. Construction worker case must provide precision shifts described in the design and technological documentation components (one or several) along optical axis for adjusting lens "on the spherical aberration and precision movement components (one or several) perpendicular to optical axis for adjusting the lens "of a coma". The essential difference is that filling components into a working body is carried out only once. The special technological frame “consists whisker” of opto-mechanical components, which on top “dress” working case. This method avoids the distortions and "have a bite" frames components. In the process of assembling a working body of lens was pressing her weight and provides the necessary "dropping" components, helping to ensure the required accuracy of the displacement components. You can also build the lens in a special technology case, in which the maximum gain easier access to structural and technological elements, with which the moving components along and perpendicular to the axis. Finished case, which on the inner cylinder is inserted into the working (done with the alignment of components is actually collected by the lens) should provide not only a turn and the free movement of the body, but also the opportunity to commit while moving along the optical (combined with mechanical) axis within a small range - to fit the height of lens assembled as a whole. Figure 2 shows the basic block diagram of the proposed installation. In a working body "poured" proven earlier (by the above method) optical-mechanical components. Through the "exact" stepper motor is focusing the lens on a special test-object, located (with an accuracy limited depth of field) in the plane of the front-focus lens. With more tubes optical system image the test object is projected onto a receiver located strictly in the plane of the back focus tubes system. In this device, as opposed stand for the control of components requires a very precise focusing on the test object, and therefore must be developed an algorithm called AF, providing a few iterations of focus. Next in the stands control components is a comparison of real and theoretical images or quantitative analysis of real images. If image quality is not satisfactory, in automatic mode (without disassembling the lens) with the second "rough" stepper motor is designated by a slip in the documentation of components along and perpendicular to the axis. Then again, is focusing on the test object. Along with the assembly process by special algorithm monitors quality of the image as a function of feedback. When alternating the two stepper motors - build the objective can be achieved within a few minutes, with the major time cost of such automated assembly occur in the first iteration of focus. When the image quality is satisfactory, the components are fixed, the working body is inserted into the finish in the automatic mode also adjusts the microscope objective in height.

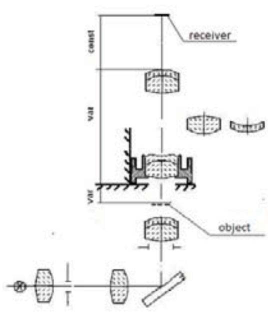

Fig.1

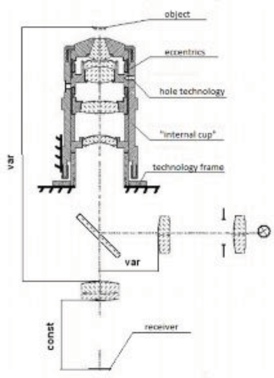

Fig.2

6. Conclusion

Assembly automation and control objectives for microscopes in the process of their production is very challenging. There is no doubt that it will be resolved, including through improved element basis of microelectronics products and system, which currently does not fully meet the criteria of quality specified by optical systems. The principle major opto-mechanical systems remains unchanged - the projection of images of test object on the receiver for further research.

7. References

1. Latuev S.M., Smirnov A.P., Voronin A.A., Padun B.S., Yablochnikov E.I., Frolov D.N., Tabachkov A.G., Teska P., Zoxer P. The concept of automated assembly lines microscope objective on the basis of adaptive selection of its components. Journal of Optical Technology. 2009. t. 76. № 7. p. 79–83.

2. Frolov D.N., Vinogradova O.A. Ease of Manufacturing and Definition of the Tolerances for Fabrication and Assemblies of Microobjectives. 50. Internationales Wissenschaftliches Kolloquium Technische Universität Ilmenau 19.-23. September 2005, p.93–94.

3. Latuev S.M., Smirnov A.P., Frolov D.N., Tabachkov A.G., Tezka P. Providing quality targets in the automation of assembly microobjectives. Journal of Optical Technology. 2010. T. 77. № 1. C. 49–53.

4. http://www.trioptics.com Automated Centering and Bonding Machine.

5. Ivanova T.A., Kirillovskii V.K. Design and control of optical microscopes, L., Mechanical Engineering. Leningrad Branch 1984