Development the systems of digital quality control for microscope objectives

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Abstract. All components of the process of designing and manufacturing an objective must provide the aberration characteristics specified by optical design. Existing and applied in the practice of online control methods for assessing the quality of image of microscope objectives are based on their use by a person who has his own subjective view.
The solution of the task of creating automation elements for assembly and control of objectives for microscopes, development of a special stand and accessories for their control is proposed.

1. Introduction. The objective is the main and the most important part of the microscope. A large number of microscope applications require a broad range of objectives with different values of magnifications and numerical apertures. Objectives can vary in aberration correction, dimensions, weight and other characteristics. The construction some objectives was designed independent from other objectives or simply built from the scratch. There is no doubt, that this design approach is not quite rational, and technologically justified. The first step in designing of a new objective for microscope was the unification of the main design parameters. As a result of this work, a unified structure of the objectives was created. Automated assembly line of the objectives is based on the method of adaptive-selective montage (ASM) and computer modeling of the assembly.

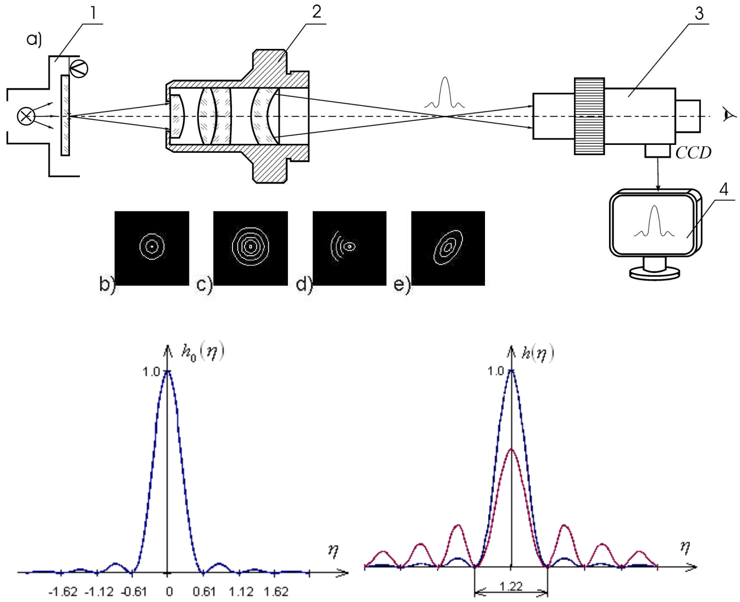

Figure 1. Functional scheme of the test bench.

2. Theory of the digital system building.
Functional scheme of the test bench is shown in Figure 1. Monitoring is carried out by observing the diffraction pattern of a point and scattering measurement of that point. If concentration of the energy in the central point (circle Airy) more than 80%, then the object is compiled correctly and does not require any adjustment. Otherwise, the micro-objective will be sent to the defective parts and further reassembled. Also shows diffractive images of the point in the optical system without aberrations and in the case of aberrations (figure on the right). These graphs characterize the so-called "of point spread function". In figure 1 position 1 is illuminator and a point, position 2 is controlled objective, position 3 is additional optical system with a digital receiver and position 4 is a screen.

3. Results of modeling in the MathCad.
The obtained image using the projection system with matrix was processed in MathCad. Using three-dimensional array the intensity distribution diagram in every point of the image and its cross-section chart are produced. Obtained picture can give us information about presence of aberration in the objective. These results shown on figure 2.

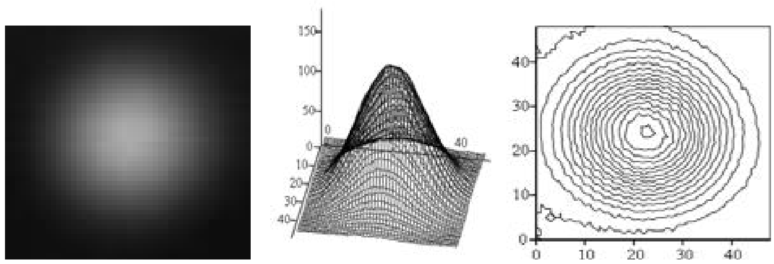

Figure 2. Results of modeling.

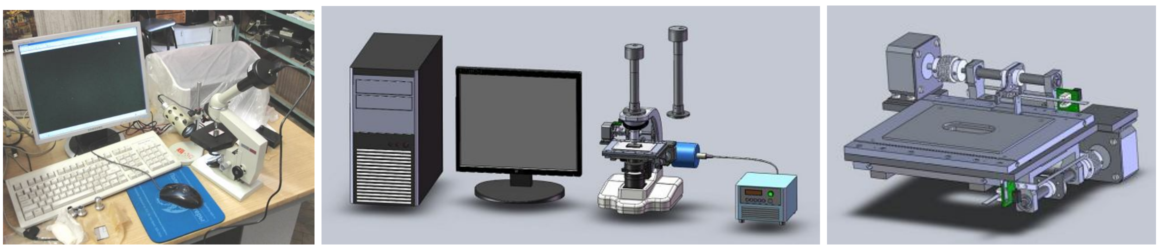

Figure 3. Digital quality control system.

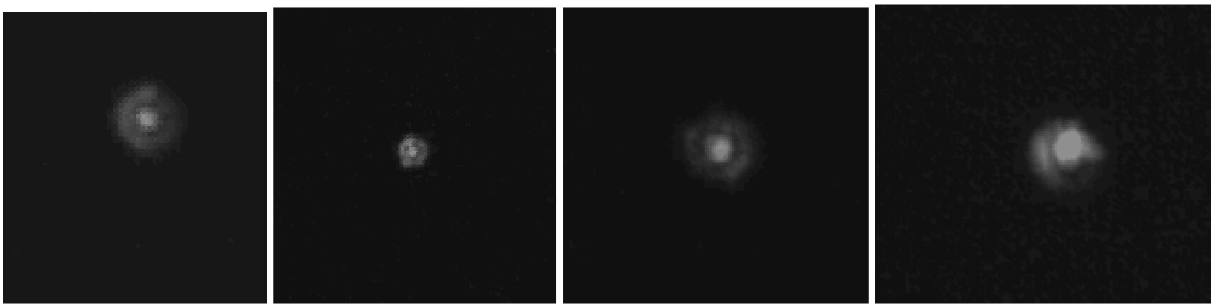

Figure 4. Images through objectives 3.7x/0.11, 10x/0.30, 20x/0.40, 40x/0.65.

4. Conclusion. We assembled a model of the installation for digital quality control of objectives for microscopes. As a stand, an ordinary light microscope was chosen. It was supplemented by some original elements, such as an additional optical system for projecting images on to a digital receiver, a digital camera. Stage underwent significant modernization, also the focusing mechanism was improved. In this case, stepping motors are used to achieve accurate positioning of the test object, as well as for micrometric focusing. Figure 3 shows a photograph of the installation layout, as well as sketches of the digital quality control system and the stage. Figure 4 show images through objectives 3.7x/0.11, 10x/0.30, 20x/0.40, 40x/0.65.