Software and hardware system for automatic recognition of continuity defects during magnetic particle testing.

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Magnetic particle method is one of the mostly spread methods of flaw detection in articles of ferromagnetic materials. Its main stages are: magnetization of an article; application of magnetic powder of suspension; and inspection of article in order to reveal places of powder deposition. If first two operations can be automated quite well, the last one – inspection operation – is performed, as a rule, visually by operator. Prolonged inspection process during the work shift and, especially, search of small defects affects negatively the vision of nondestructive testing operator, results in his/her weariness and reduces attentiveness. As a result of so-called "human factor", probability of the omission of real defects in the process of testing becomes higher.

Reliability of magnetic particle testing can be improved for the account of process automation through delegation of some functions like inspection of tested surface and decision-making to impartial electronics that could not only detect defects, but record test results and form in objective manner the quality passport for articles as well.

Modern multi-media means allow image to be reproduced with quite high resolution. However, recognitions of defect images and their separation on the background of false deposits of magnetic powder appears to be very complex problems. During elaboration of the software and hardware system for automatic recognition of continuity defects during magnetic particle testing, we were trying to resolve these problems namely.

Software and hardware system consists of high-resolution video cameras with variable-focus lenses, personal computer with specialized frame-capture board and software.

Software and hardware system makes it possible to output color image on a display from 4 cameras simultaneously with 768[576 dots of real resolution for every camera and to process obtained video image in the real-time scale.

First of all, this system was oriented toward upgrading of automated installation for fluorescent magnetic particle inspection of the ends of pipes during their production at pipe plants. Therefore, starting window of software in question implies data entry for the pipe testing protocol.

Prior the beginning of operation, following data are entered into the software memory (Fig.1):

 - number of shift;

- name of nondestructive testing operator;

- parameters of tested article;

- limit dimensions (minimal length and maximal width) of detected defect;

- width of not testable marginal area;

- value of maximal deviation of the pipe position from normal one due to vibrations, irregularities and other factors;

- number of video cameras connected to the given computer.

Both images from all 4 cameras simultaneously and increased image from one camera selected by user can be displayed. In addition, processing of video image from all cameras continues. When continuity defect in the form of deposited magnetic powder is detected within the testing area, audio alarm is activated and defect position is marked on a display with flashing box (Fig.2). At discretion of the nondestructive testing operator, audio signal can be switched off. Obtained image is stored on hard disc in the form of a report stating testing date, shift index, operator's name, reference number of normative documentation for testing, number of test object, size of defect. Report can be saved both by operators' command and automatically. Software makes it possible to view and analyze obtained reports, to complete them with comments, to measure all interesting dimensions (for example, from some basic point to a defect) with accuracy of not less than 0.1 mm, and, then, to issue final conclusion on the presence of real defect, rather than false one. Example of such report is presented in Figure 3.

Software allows operation with quickly moving test objects following up their position in relation to video camera. Setting of software and hardware system by brightness and contrast of detected continuity defect in automatic, semi-automatic and manual modes allows operation with different levels of ultraviolet and visible illumination, while given limit dimensions of defects make it possible to reject point-like false defects with length smaller than minimal length of a defects and large areas of powder deposition with width exceeding maximal width of a defect. False powder deposits with dimensions comparable with defect dimensions (on some filaments or long dust particles, for instance) will be rejected by brightness and contrast thresholds, since larger quantity of powder is deposited over real defect, while its brightness and contrast in respect of the background is higher than ones with false defects. Example of system setting by brightness, contrast and defect dimensions is presented in Figure 4. Verification mode for set parameters makes it possible to evaluate the defect detectability and background noises tuning-out, as well as to perform final adjustment of all parameters for reliable detection of defects. Example of parameters verification is presented in Figure 5 demonstrating standard defect (marked with yellow box) detected by brightness and contrast; besides, background bright spots are not identified as defects, since they do not meet criteria of limit defect dimensions.

Thus, application of algorithms of filtration by dimensions, brightness and contrast of deposited powder allows defects to be detected reliably in automatic mode using magnetic particle test method. Application of elaborated software and hardware system makes it possible to improve reliability and speed of magnetic particle testing of continuity defects like delaminations and cracks of any configuration coming to the surface of test object.
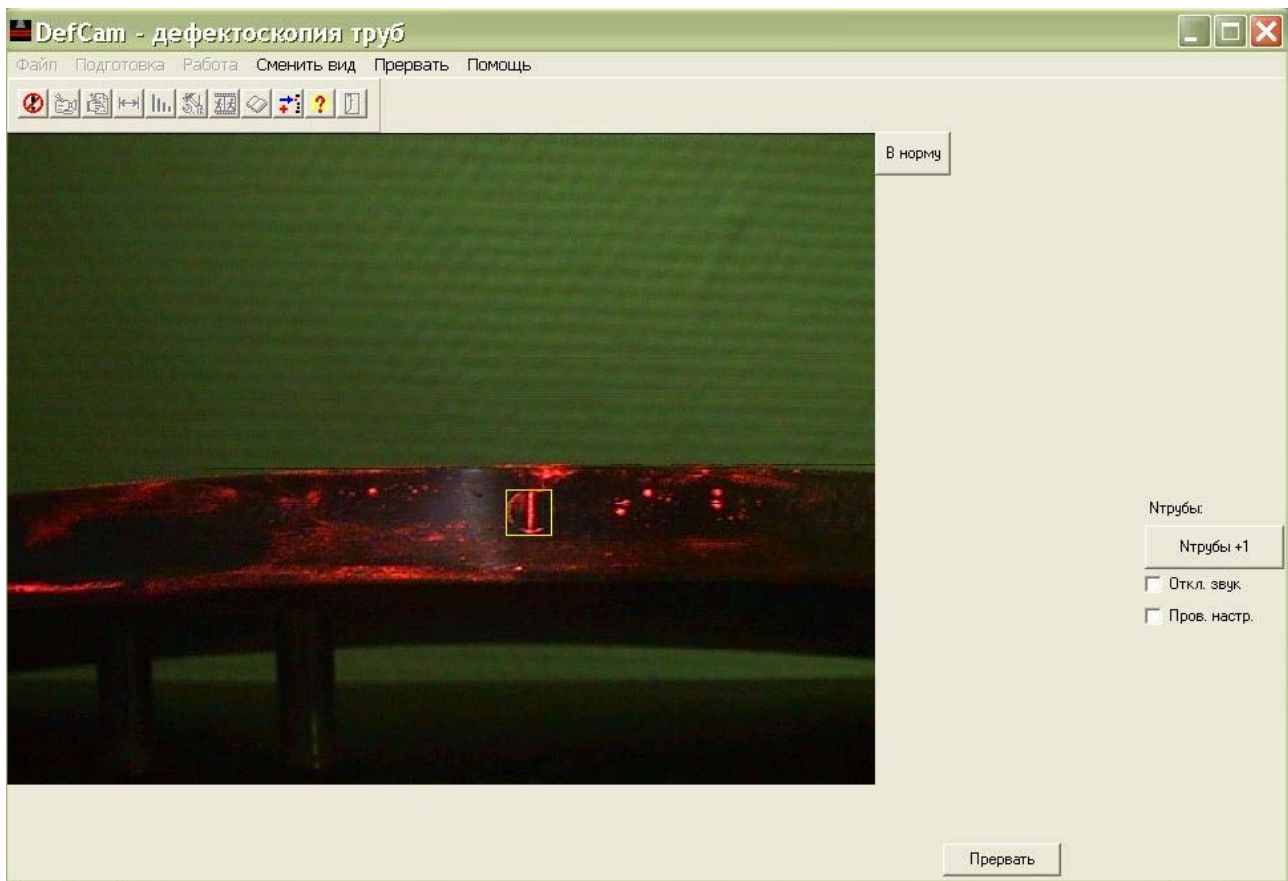

Fig.1. Window to enter source test data.

Fig.2. Continuity defect detected in the test process (marked with yellow box).
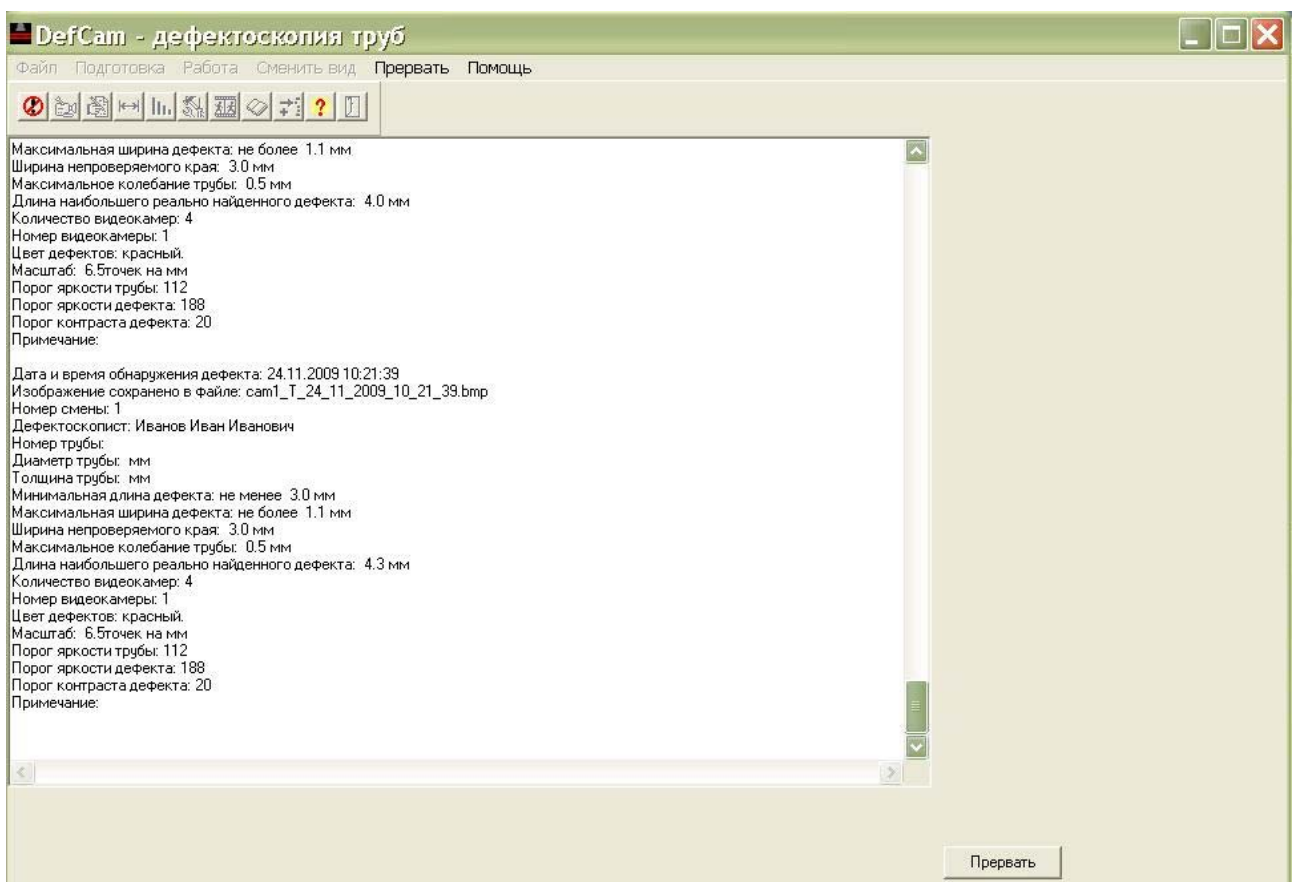

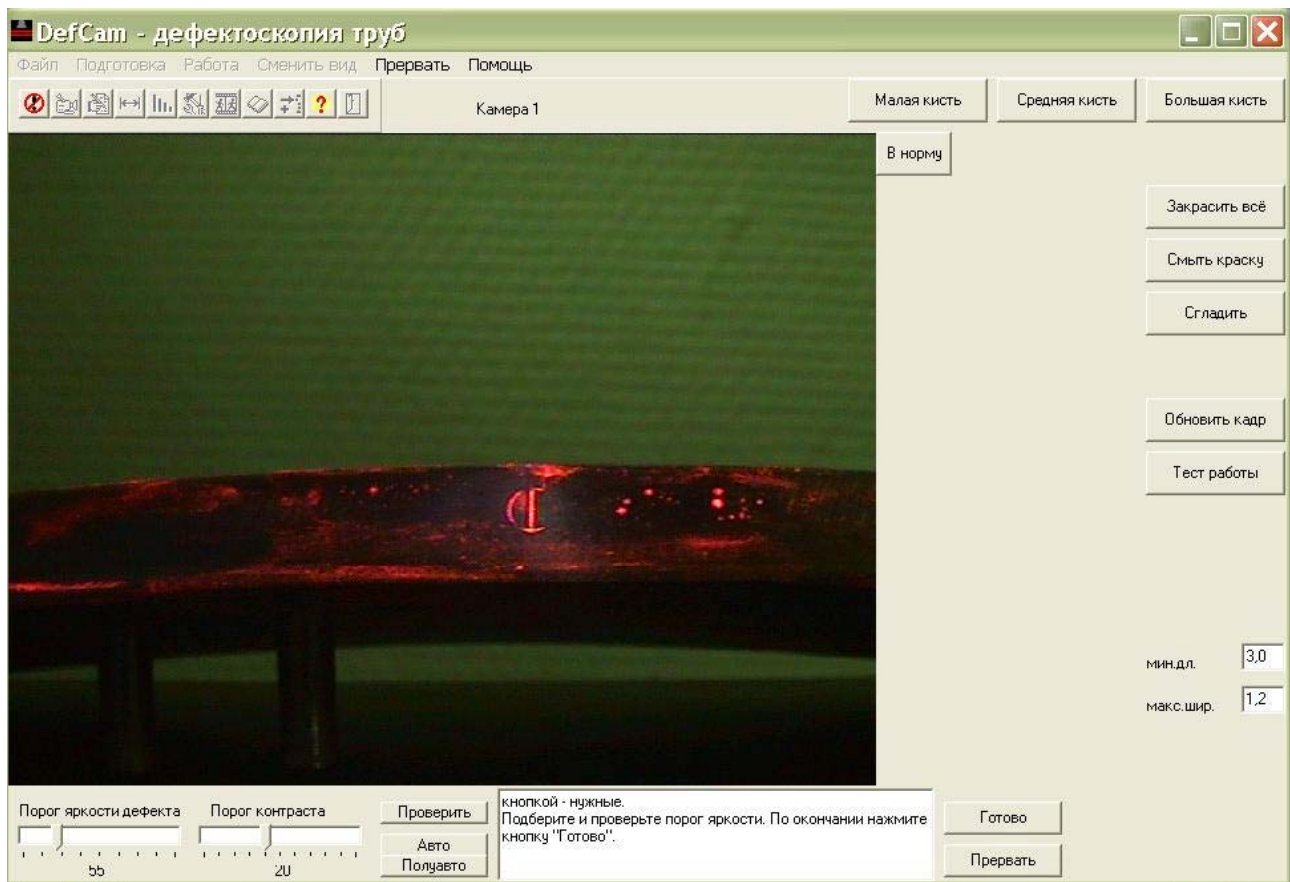Fig.3. Report page on performed testing stating all test parameters and data on detected defect.
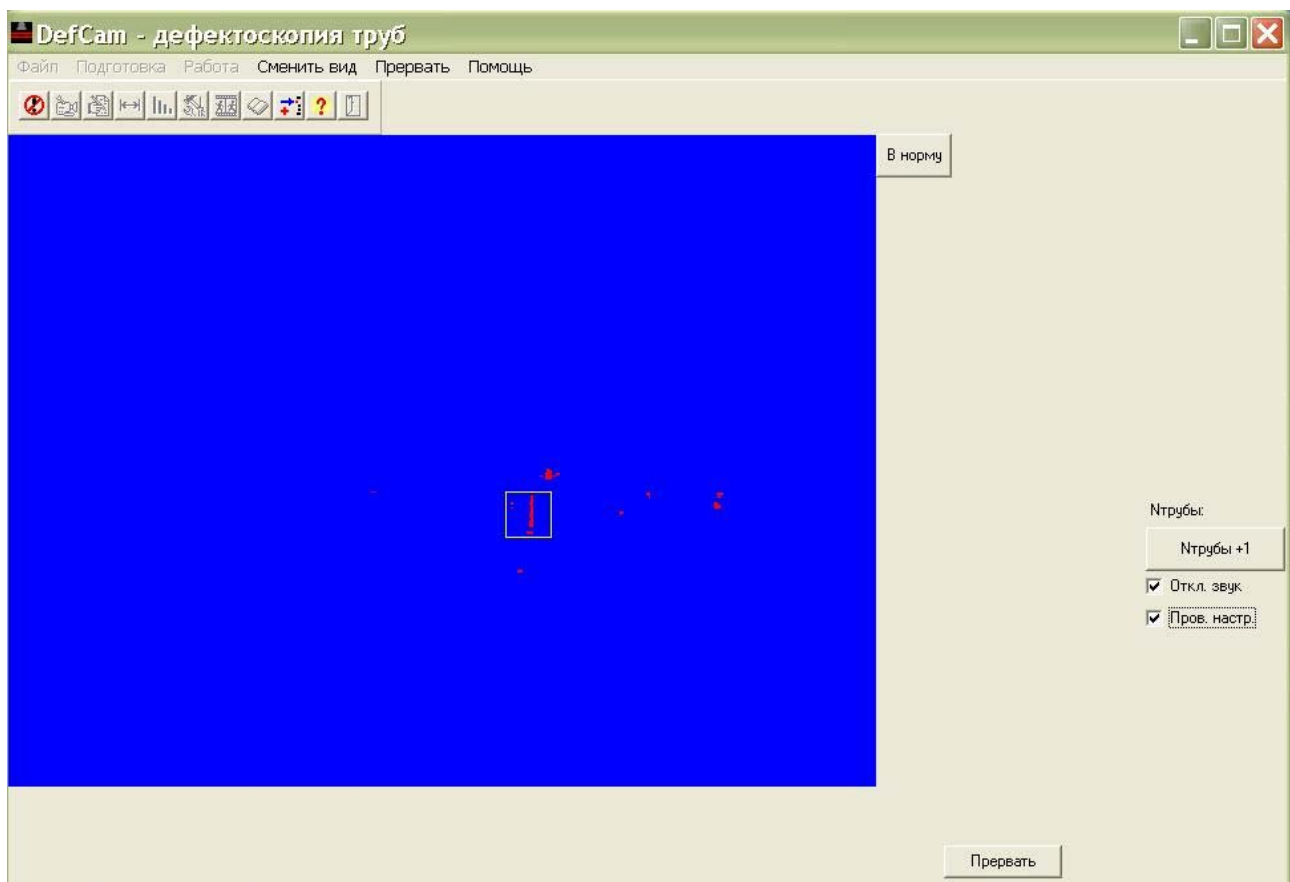
Fig.4. Window of adjustment by brightness, contrast and defect dimensions

Fig.5. Window of defect detectability verification