# Program for Visual Representation of Defects in the Appearance of Textile Materials with Different Types of Surface Design

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**Abstract.** The article is devoted to the problem of performing quality control of textile materials using technical vision systems. The authors developed a methodology and model for multitasking neural network training, and also developed software. The software is designed to recognize moving roll materials of large width with different types of surface design. The authors also formed a database of visual representation of defects in the appearance of textile materials and their classification in accordance with the various technological stages of textile and finishing production, where these defects are formed.

## INTRODUCTION

All textile materials at the exit from the weaving or finishing industries, as well as those entering the sewing shops, are subject to quality control. The standards allow for a small defect even on first-class fabrics. But there should be no areas with defects on the finished product. During the disassembly process, the appearance of the fabric is evaluated and possible defects are searched for. This procedure helps to identify the defects of the fabric, to determine the grade of the fabric. In addition, this procedure helps to determine the further cutting of parts by patterns. Quality control can be carried out at various stages of textile and finishing production:

1-quality control of the rough web at the exit from the machine allows you to identify defects in the yarn and the weaving process;

2-quality control of the bleached (painted) canvas before the printing process allows you to determine the defects of bleaching/dyeing;

3-print quality control directly at the output of the printing machine;

4-quality control of the finished material after the final finishing processes.

The inspection of fabrics is carried out by an employee with good eyesight directly at the exit from the final stage of weaving and finishing production at special rejection stations. The specialist involved in the disassembly of the fabric must have the necessary knowledge about the grades of materials and the classification of defects. The controller scans the material that moves at sufficiently high speeds and assigns points to each defect. The inspector summarizes the defects to determine the fabric grade. This often leads to an unjustified overestimation or underestimation of the quality of the rejected material. In addition, many defects go unnoticed. Losses of finishing industries from the production of defective products range from 3 to 5 %. For small and medium-sized enterprises, it is possible to control the quality of products produced by operators of rejection stations. But for large enterprises, it is advisable to replace manual labor with machine labor. For this purpose, technical vision systems and appropriate software have recently been used at control points, which greatly simplifies the evaluation process and makes the results of material quality control more accurate.

Improving the quality of products with minimal human labor costs is one of the main tasks in the development of any industry, including textile. An urgent task in this case is to create means of operational quality control of the manufactured fabric produced on weaving equipment, using electronic technology, the beginning of the development of which dates back to the last decade of the last century [1-4]. There are a number of systems for recognizing tissue defects developed by foreign companies. But due to the variety of structures of textile fabrics and ways of their design, there is no universal model for their recognition today. The use of such systems in Russia is constrained by their high cost in the absence of similar domestic developments [5].

## MATERIALS AND METHODS

An analysis of foreign studies in this area shows that the computerization of the control of tissue defects directly on the equipment is more promising. The authors solve the problem of developing a methodology and model for multitasking neural network training. In addition, its further software implementation is also performed. Moreover, the recognition of moving roll materials of large width with different types of surface design is performed. To solve the problem, a system of technical vision is proposed. This system provides detection, automatic control and analysis of objects based on their images. The system allows for real-time product quality control. Typically, such systems include a linear video camera, which differs from the usual one in that the images in it are formed by scanning the subject. It provides specialized lighting (mainly LED), a computer, meter sensors and interface cards with the drive of the machine engine. If there is a defect, then the system is signaled to slow down or stop. In addition, a message is issued to the operator.

An automated system for detecting defects in woven materials will analyze the image in three stages:

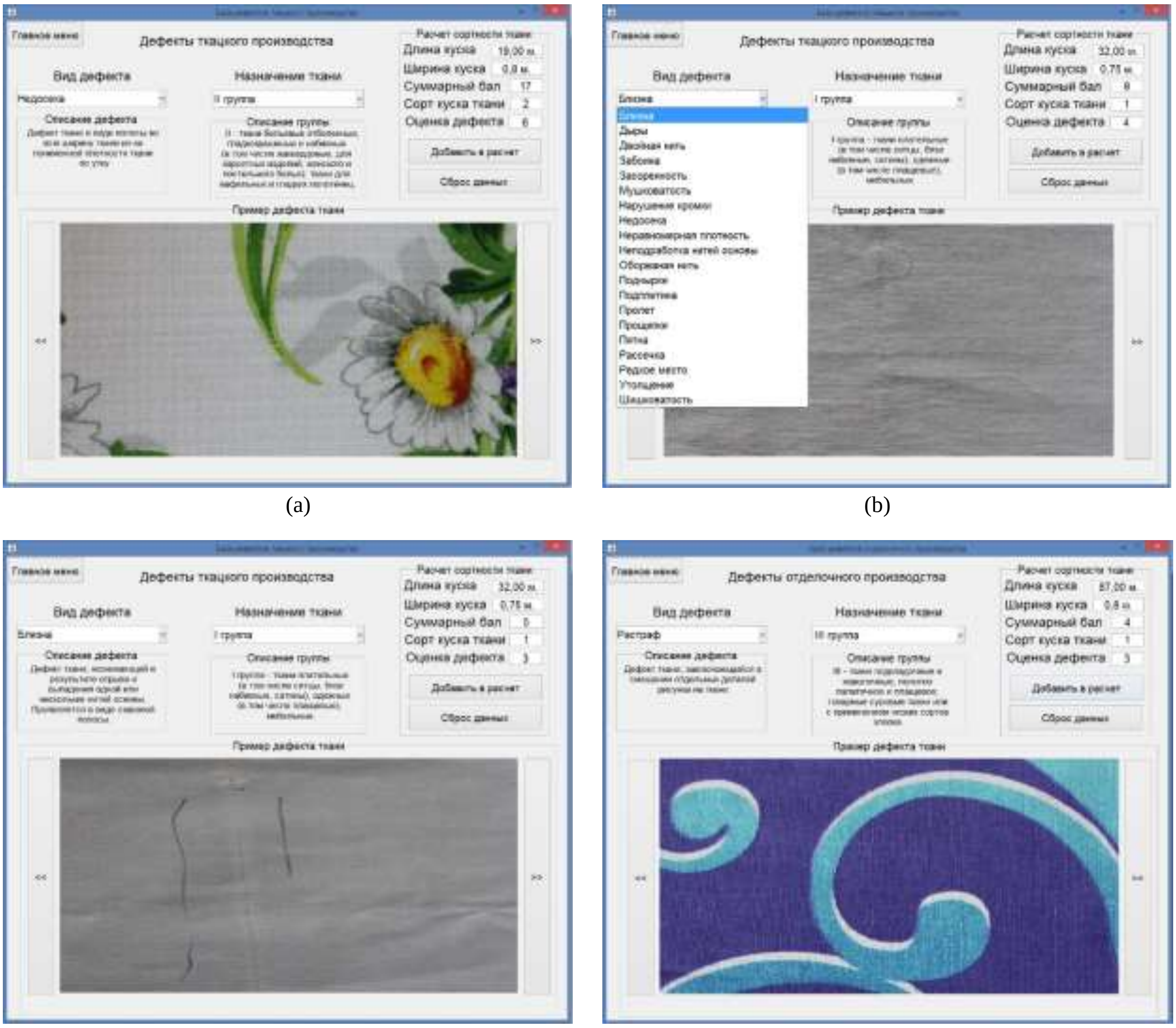
- at the first stage, image processing technologies such as noise reduction, contrast enhancement, threshold binarization and image markup are used. This is done in order to facilitate the task of detecting and locating tissue defects;
- at the second stage, the detection and classification of defects is performed based on the support vector (SVM) method. After extracting potential defects, two groups of features are distinguished: textural features and morphological features. Feature vector classification using a multi-layer neural network with a single hidden layer (MLP);
- in the third stage, an approach based on the use of Max-Pooling Convolutional Neural Networks (MPCNN) is applied, in which training is carried out directly on a marked-up sample of images with a teacher.

## RESULTS

At the first stage, a software product is developed for the visual representation of defects in the appearance of both harsh and finished fabrics and their assessment, in accordance with the state standard. Figure 1 shows the program interface.  The authors suggest using the MATLAB programming language based on working with matrices. This allows you to represent woven materials in binary code, where 1 and 0 correspond to the main and weft overlaps. A detailed description of the representation of tissue structures and the technology for their production using this programming language is described in [6-8].

The classification of material defects into groups according to the production stages at which they can occur: spinning, weaving or finishing is proposed. The database provides a description of both the defects themselves and the groups of tissue assignments. It is possible to calculate the grade of the woven fabric depending on the size of the piece and the presence of various types of defects on it. For each of the defects, a score is assigned in accordance with the state standard. The developed database also contains information about the concentration of local defects and the degree of prevalence of defects. The proposed database will be integrated into a complex for automated detection of defects using neural network technology. This is necessary for the classification of defects and the calculation of the web grade. A digital image of a tissue defect is stored in a database for further use, for example, when training a defect recognition system.

The developed complex for automated detection of defects using a non-contact method for controlling the quality of fabrics and commodity surovya on the basis of neural network image processing technology should provide a resolution that allows you to reliably detect fabric defects (weft flaps, sub-weft, nedosek, holes, thickened threads, seam, different weft number, reject, punctures, oil and dirt spots, poor whiteness, blizna, serifs, undershoots.) of various articles, including such difficult-to-identify defects as defects with a small signal-to-noise ratio.



(a) (b) (c) (d)

**Figure 1.** Interface windows of the database of defects in the appearance of textile materials:
(a) the defect of the nedosek is demonstrated; (b) the possibility of choosing different defects of textile materials is demonstrated; (c) the defect of the blizna is demonstrated; (d) the defect of the rastraf is demonstrated.

To train a neural network, you need to collect a large number of samples of photos with defects taken from different viewing angles. For this purpose, a stand has been constructed in a specially equipped laboratory to carry out such photography. The image of the laboratory stand is shown in Figure 2.

Composition of the stand for photographing samples of textile materials:

- video capture device;
- lighting device;
- block for fixing and tensioning the material sample;
- housing;
- laptop;
- cloud storage.

The main element of the stand is a video capture device, which uses a Basler acA2440-35uc camera with an IMX264 CMOS matrix from Sony, a frequency of 35 frames per second at a resolution of 5.0 megapixels and a Basler Lens C23-1224-5M-P f12mm. Shooting is performed at standard settings with the automatic exposure correction mode activated.

To illuminate the shooting area, a block of circular-shaped LED lamps is used. The circular shape and position of the camera at the level of the lamps ensures that there are no shadows on the sample material during shooting.

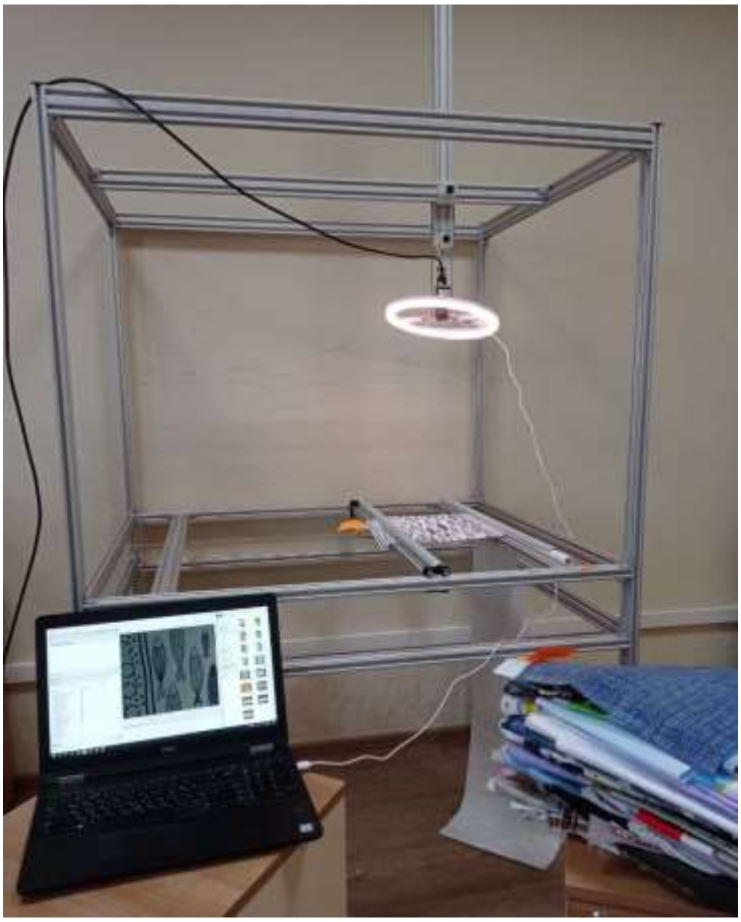


**Figure 2.** Laboratory stand for photographing samples of textile materials.

The unit for fixing and tensioning a material sample is designed to simulate the tension of a textile material on production equipment. The structure for fixing the sample is designed in such a way that a uniform longitudinal tension of the fabric sample is provided. The transverse tension of the sample is provided by a system of ropes and weights attached to a movable console. It is worth noting that on the production equipment, the textile fabric is in motion, and on the stand, the fabric is fixed in one place. However, this difference can be ignored by using a camera with a high-speed shooting mode on the product under development.

The body of the stand provides the possibility of placing the camera and lighting in the same conditions relative to the fabric sample, in which the developed device will be used in the future on production equipment. For the production of the stand body, a high-quality structural aluminum profile is used.

To capture images from the camera on the laptop, standard software from the camera manufacturer Basler is used.

For the convenience of sharing the created database of images of textile manufacturing defects, a cloud storage and a developed system for generating unique name codes are used.

Examples of images at different scales obtained on the stand are shown in Figure 3.

**Figure 3.** Examples of registered images with defects.

The developed stand allows you to sufficiently simulate the real operating conditions of the developed complex and perform photo-fixation of tissue samples with defects. Using the stand, the database of images of samples with defects is filled in to perform machine learning in the following stages.

## CONCLUSIONS

A database of defects in the appearance of textile materials with different surface design has been created. This database allows you to classify fabric defects in accordance with the state standard and determine the grade of rough or finished fabric. The developed database can also be used for training personnel involved in the disassembly of both harsh materials in the production of fabric, and finished products in finishing production and sewing workshops with a small volume of products.

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