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DIGITAL TECHNOLOGIES IN TEXTILE MATERIALS QUALITY MANAGEMENT

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Abstract: Explores the potential of artificial intelligence for digitalizing fabrics, predicting their physical properties, and replacing traditional laboratory testing with mathematical modeling. Particular attention is paid to the operating principles of neural network models that analyze textile materials using scanned images, as well as the advantages of digital measurements in clothing development and 3D modeling.

Keywords: digitalization , fabric testing, defect, color uniformity, sorting.

Currently, the whole world is experiencing “ digitalization ”, which creates new opportunities for technological development and management of the production of complex technical products [1-3].

The textile industry is currently only at the beginning of its digital transformation journey. To create a sustainable and circular textile industry, future professionals must understand and utilize all the opportunities that digitalization offers to save costs and resources. Only in this way can we fundamentally transform the world's oldest textile industry. As digitalization transforms the textile industry, we are witnessing the fourth industrial revolution – Industry 4.0. The concept of Quality 4.0 has emerged as an element of the system lifecycle.

For objects (raw materials, technologies, finished products) of the textile and light industry, digitalization systems management production, technological processes, and provision of quality products play a paramount role. This connected With those, What for the last few decades assortment textile materials (fibers, threads, fabrics) have changed significantly in the direction improvements consumer characteristics. New fibers have appeared or become widespread, both in composition (for example, polylactide) and in structure (hollow, bicomponent , profiled, with microcapsules, etc.) [4]. In addition, the structure of the fabrics has changed: for example, weaves have been developed,creating effect 3D (volume) [5]; Multilayer materials (duplexes, triplexes) have become more in demand; forincreases water resistance are used membrane canvases [6]. Eat new items And in the finishing of textile products: for example, processing enzymes, allowing significantly reduce rigidity flax fabrics; fixing the applied finishing drugs IR remission And etc. [7].

Textile testing is the most important process in the textile industry, enabling the production of clothing and other products without any problems. Textile manufacturers place great emphasis on fabric testing to strengthen their brand image and reputation. This involves assessing the chemical, mechanical, and physical properties of clothing. This requires new methods and means research,

includingWith application digital technologies that can ensure highly organized management of the management system in the production of textile products, including the following categories:

- Work With control specifications quality clients;
- Control sources, cost And exit raw materials;
- Application the best systems measurements And informational systems;
- Continuous control production For fast response;
- Understanding alternatives improvements for check automated know-how applications.

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The textile industry is currently only at the beginning of its digital transformation journey. To create a sustainable and circular textile industry, future professionals must understand and utilize all the opportunities that digitalization offers to save costs and resources. Only in this way can we fundamentally transform the world's oldest textile industry. As digitalization transforms the textile industry, we are witnessing the fourth industrial revolution – Industry 4.0. The concept of Quality 4.0 has emerged as an element of the system lifecycle.

For objects (raw materials, technologies, finished products) of the textile and light industry, digital systems for production management, technological processes, and the provision of quality products play a paramount role. This is due to the fact that over the last few decades, the assortment of textile materials (fibers, threads, fabrics) has changed significantly to improve consumer characteristics. New fibers have appeared or become widespread, both in composition (for example, polylactide) and in structure (hollow, bicomponent , profiled, with microcapsules, etc.). In addition, the structure of the fabrics has changed: for example, weaves have been developed, creating a 3D (volumetric) effect; Multilayer materials (duplexes, triplexes) have become more in demand; to increase water resistance, membrane fabrics are used. There are also innovations in the finishing of textile products: for example, enzyme processing, which allows to significantly reduce the rigidity of flax fabrics ; fixing the applied finishing agents using IR reflectance, etc.

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- Working with client quality control specifications;
- Controlling the sources, cost, and yield of raw materials;
- Application of the best measurement systems and informational systems;
- Continuous control of production for fast response;
- Understanding alternative improvements to verify automated know-how applications.

A major technological breakthrough in recent years has been the emergence of AI metrology platforms capable of replacing traditional physical fabric testing with digital modeling. One of the most striking examples is SEDDI Textura, a platform that uses artificial intelligence to analyze and predict textile properties.

According to the company's official information, the SEDDI neural network has been trained on thousands of fabric samples and is capable of determining the physical and visual characteristics of a material from a standard scanned image: drape, stretch, light reflection, texture, and fabric behavior in a 3D environment.

One of the key advantages of this technology is its accessibility. The product description emphasizes that the user "does not require expensive equipment or specialized training—a standard desktop scanner is sufficient". This means that digital metrology is becoming accessible not only to large laboratories but also to small manufacturing companies and design studios.

For example, a designer or manufacturer can simply scan a fabric sample, upload the image to the system, and within minutes receive a digital model of the material suitable for use in 3D programs like CLO 3D or Browzwear. Instead of the time-consuming process of sending physical samples between suppliers and brands, the workflow is transferred to a cloud-based digital environment.

Another example concerns fabric drape prediction. In one study, SEDDI compared the results of its AI model with the classic Cusick test. The Drape Test is an international standard method for assessing fabric drape and fold behavior. The results showed that the system can accurately reproduce the material's actual behavior without conducting full mechanical testing.

The technology can also handle complex materials. For example, the AI can recognize mesh fabrics, lace, and perforated materials even with a standard scanner, whereas traditionally this requires specialized optical equipment.

The high level of trust in digital measurements is confirmed by the company's cooperation with major global brands, including Levi Strauss & Co. and Under Armour. Using solutions like these allows companies to accelerate collection development, reduce the cost of physical samples, and increase production sustainability by reducing logistics and waste.



Fig. 1 Scanning and analysis of fabric sample

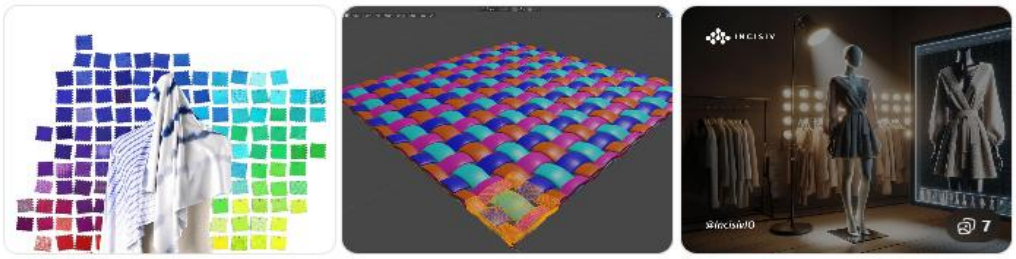


Fig. 2 Examples of digital 3D fabric models

In quantum metrology, the focus is exclusively on peer-reviewed science. A study by scientists at the Korea Advanced Institute of Science and Technology (KAIST) on the creation of quantum-dot light-emitting fibers (QDLEFs) was published in the journal ACS Nano (DOI: 10.1021/acsnano.4c04374).

- The device's official specifications include: Fiber diameter is 250 microns. Efficiency is 22.46 mW/sr/A.

- Operating mode: The fiber can withstand washing and operates autonomously for up to 18 hours.
- Verification Methodology: The researchers used modified photon diffusion analysis (MPDA). It has been theoretically proven that the use of quantum dots (narrow peak half-width of ~30 nm) improves the accuracy of pulse oximetry compared to OLED sensors, which have a wider peak width (which introduces error in multilayer tissue structures).

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