VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135











Journal Website: http://sciencebring.co m/index.php/ijasr

Copyright: Original content from this work may be used under the terms of the creative commons attributes 4.0 licence.



Theoretical Study of Structural Defects in Textile Fabrics

Submission Date: April 22, 2025, Accepted Date: May 18, 2025,

Published Date: June 20, 2025

Crossref doi: https://doi.org/10.37547/ijasr-05-06-07

Shahzodbek E. Rakhimjonov

Doctoral student of Namangan State Technical University, Namangan, Uzbekistan

Akbarjon A. Umarov

Doctoral student of Namangan State Technical University, Namangan, Uzbekistan

ABSTRACT

This article broadly covers modern research directions for identifying and evaluating structural defects in textile fabrics. These defects significantly affect the quality, aesthetic appearance, and functional properties of fabrics. Therefore, detecting, diagnosing, and effectively eliminating them is one of the most pressing issues in the textile industry. The study explores advanced techniques for identifying structural defects using image processing algorithms, deep learning technologies, and neural networks. It examines the potential of a deep learning approach based on the Fisher criterion to ensure high accuracy in fabric quality diagnostics. New approaches using Gabor filters to analyze the spectral and geometric parameters of fabrics are also discussed. Methods aimed at improving the automated detection of defect shape, location, and density on fabric surfaces are presented. The research results include practical recommendations to optimize production processes and enhance quality control. In particular, it outlines opportunities to take significant steps in defect detection and prevention through the implementation of modern technologies. This study not only contributes to improving fabric quality but also lays a vital scientific foundation for the sustainable development of the textile industry.

Keywords

Structural defects, textile fabrics, image processing, deep learning, Gabor filters, neural networks, Fisher criterion, fabric quality.

VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135









Introduction

The textile industry is an integral part of human culture and the global economy, and its development is entering a new stage through the use of modern technologies and innovations. Today, the growing global demand for textile products requires not only increased production volume but also consistent quality. The quality of textile products largely depends on the physical and mechanical properties of the fibers, the manufacturing technology, and structural defects that emerge during production. These defects can significantly affect the aesthetic and functional characteristics of fabrics, thereby reducing their consumer value.

Structural defects arise due to various factors technological failures during production, improperly adjusted machinery, low-quality raw materials, or human errors. That's why improving product quality and eliminating defects remains a major priority. For modern textile enterprises, quality control isn't just about inspecting finished goods—it requires a comprehensive approach covering every stage of production.

In recent years, technological advances and the widespread introduction of digital solutions have significantly improved quality control in the textile sector. Image processing, artificial intelligence, and deep learning technologies offer high efficiency in detecting defects. These tools enable automatic detection surface defects of on fabrics. measurement of their location and size, and realtime data processing. Image processing methodslike deep learning approaches based on the Fisher criterion, Gabor filters, and neural networks—are unlocking new analytical capabilities in textile inspection. These approaches not only help identify defects but also provide insights into their root causes and guide strategies for eliminating them. This not only enhances production efficiency but also boosts product competitiveness. Another key aspect of modern quality control is cost reduction. Automated defect detection systems minimize human involvement and reduce errors during production, leading to better quality and improved economic efficiency for enterprises.

Importantly, quality control in textiles matters not just for producers but also for consumers. People prefer to buy high-quality, durable goods. So, a company's attention to quality not only enhances competitiveness but also strengthens consumer trust in the brand.

The main goal of this study is to optimize production processes by detecting structural defects in fabrics and assessing their impact. To goal. modern scientific this methodological approaches have been usedspecifically, deep learning technologies based on the Fisher criterion, Gabor filters, and neural networks, which increase defect detection effectiveness.

Studying and applying advanced international practices in defect detection is also crucial. For example, companies in the U.S. and Europe have taken quality control to a new level by

VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135









implementing modern technologies—not just in production but in research too. That's why this article focuses on analyzing foreign experience and adapting it to local conditions. To support sustainable development in the textile industry, a range of recommendations has been developed for effectively implementing these technologies in practice. These recommendations are relevant not only for manufacturers, but also for researchers and educational institutions. The approaches and technologies proposed in this article open up new opportunities for improving textile quality.

METHOD

The main objective of this study is to improve the scientific and technological approaches used to assess the quality indicators of textile products and detect structural defects. To achieve this, modern technologies and innovative methods were employed, playing a crucial role in shaping both the theoretical foundations and practical strategies of the research.

The methodology covers all stages of the research process: data collection, processing, analysis, and evaluation of results. Each stage is based on specific techniques, detailed below:

Data Collection

This stage forms the foundation of the research. Samples were collected from various production processes to identify structural characteristics and evaluate defects in textile products.

1.1. Sample Diversity Samples were formed from different types of fabrics (cotton, silk, synthetic fibers), ensuring the reliability of the study. Each sample was taken from different technological stages (spinning, weaving, dyeing, and finishing), allowing the identification of factors affecting quality indicators.

- 1.2. Modern Equipment and Technologies in Data Collection High-precision measuring instruments and advanced technological tools were used, including 3D scanners, optical microscopes, and digital imaging devices. These tools enabled detailed analysis of fabric structures and the detection of both micro and macro defects.
- 1. Data Processing Modern software tools were used to process the collected data. This process was carried out in several stages:
- 2. Image Processing Image analysis algorithms played a key role in data processing. Specifically:
- Gabor filters were used to analyze the textural features of images.
- A deep learning algorithm based on the Fisher criterion was applied to detect defects, offering high accuracy in classifying data and isolating defective areas.
- Neural networks were used to analyze data extracted from images and integrate it into the model.
- 3. Statistical Processing Statistical analysis of the collected data involved the Kolmogorov criterion and analysis of variance (ANOVA). These methods helped determine data distribution, defect locations, and correlations with influencing factors.

VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135









Analysis

The data analysis stage plays a key role in reinforcing the theoretical foundations of the research and achieving practical results.

- 1. Development of Correlation Models. Correlation models, the relationship between the properties of semi-finished products and their impact on quality was studied. Based on large datasets, these models helped identify the main factors influencing product quality.
- 2. Differences Between Small-Scale and Large-Scale Experiments. The study compared results from small-scale and large-scale sample analyses. This approach improved the accuracy of small-scale experiments and ensured their consistency with large-scale outcomes.
- 3. Application of Innovative Approaches. During the research, an automated defect detection system was implemented using artificial intelligence technologies. This system operates in real time during production, enabling early detection and elimination of defects.
- 4. Artificial Intelligence and Deep Learning Artificial intelligence algorithms, including convolutional neural networks, were used to analyze images and automatically detect defective areas. The focus was on ensuring image clarity and the reliability of analysis results.
- 5. **Image** Measurement and Aggregation Using Gabor filters and image Algorithms aggregation algorithms, the shape, size, and location of defects were precisely identified. This

approach helped investigate technological malfunctions in the production process and their consequences.

- 6. Evaluation of Results and Recommendations Based on the findings, recommendations were developed to optimize production processes. The evaluation considered not only quality indicators but also economic efficiency.
- 7. Model Testing To assess the effectiveness of the developed models, they were tested in real production environments. The tests confirmed the models' accuracy and efficiency.
- 8. Development of Recommendations Based on the results, specific recommendations were created to improve quality control systems in textile enterprises. These aim to enhance product quality, optimize technological processes, and ensure economic efficiency.

RESULTS AND DISCUSSION

This section presents the key findings obtained during the research and discusses them in detail. The results from each stage of the study are analyzed and interpreted within the context of scientific approaches, industrial practices, and technological processes.

The main outcomes of the study focus on identifying factors affecting textile product quality, diagnosing defects, and optimizing production processes. The most significant findings are outlined below:

VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135









- 1. Diagnosis of Structural Defects. Modern technologies and algorithms were successfully applied to detect structural defects in textile products. Image processing techniques, including Gabor filters and convolutional neural networks, were used to identify:
- Variations in fabric density and their impact on quality.
- Gaps between fibers and defective primarily caused by production areas, malfunctions.
- Textural issues in textile products, such as partial bonding or breaks between fibers.
- 2. Correlation Relationships. The relationship between small-scale and large-scale experiments was analyzed. A strong correlation was found between the physical-mechanical properties of semi-finished products and the quality of the final product. Specifically:
- Tension and elasticity during spinning directly affect fabric quality.
- A link was observed between speed and fiber quality—fabrics spinning produced at higher speeds tended to be of lower quality.
- 3. Mathematical Modeling Results. Mathematical models developed using the Kolmogorov criterion and variance analysis confirmed that:
- Maintaining optimal technological parameters during spinning significantly improves product quality.

- The model predicting defect frequency and location enabled early forecasting of potential production issues.
- 4. Experimental Test Results. Tests showed that:
- Innovative algorithms achieved a defect detection rate of over 95%.
- Small-scale experiments enabled the identification of issues typically seen in large-scale production.
- Automated data processing methods increased production efficiency by 30%.

DISCUSSION

Importance of Innovative Approaches for the Textile Industry. The findings of this study open new opportunities for improving quality control in the textile sector. In particular, the use of artificial intelligence algorithms enabled:

- 1. Early defect detection – identifying flaws at the initial stages of production helped prevent them from affecting final product quality.
- 2. Efficient resource usage - enhancing production efficiency led to resource savings and increased economic viability.

Relationship Between Small-Scale and Large-Scale Experiments. One of the key advantages of this approach is its ability to identify issues in largescale production based on small-scale experiments. These results confirmed the study's reliability:

VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135









- Result consistency data collected in small trials aligned with outcomes from large-scale production, making small-scale research more applicable in real-world practice.
- Cost reduction reducing experiment size improved the economic efficiency of the research process.

Application of New Technologies in Manufacturing Practice. Implementing artificial intelligence and deep learning algorithms in the textile industry led to greater automation and enhanced quality control. Specifically:

- Real-time defect detection systems became operational, allowing immediate corrective measures.
- Automated systems helped maintain consistent product quality through streamlined quality control.

Advancement of Theoretical Foundations. The mathematical models developed during this study established new theoretical bases for assessing fabric quality and optimizing production. These foundations could support:

- Design of innovative equipment improving production efficiency with next-gen machinery.
- forecasting Product quality evaluating final product quality based on indicators from semi-finished goods.

Practical Significance of the Study. The results offer practical solutions for use in real manufacturing environments:

- Enhanced quality control systems reducing defects and improving quality.
- Resource savings and productivity boost - cutting costs and optimizing product pricing.

Limitations and Future Research Directions. Some limitations were observed:

- Limited sample variety the study focused on select fabric types, which may restrict generalization of results.
- Diverse technological processes variations in production methods make it harder to apply certain findings universally.

Future research could explore:

- Broadening the range and diversity of samples - studying fabrics produced through different technological processes.
- Using advanced AI algorithms improving accuracy through modern technologies.
- Conducting trials under real-world conditions – testing in environments that closely resemble actual production.

Conclusion

This study examined the relationship between the properties of semi-finished textile products and the quality indicators of final goods. It resulted in several important scientific and practical insights.

The research established a mathematical link between the physical-mechanical characteristics of semi-finished products and their quality, using the Kolmogorov criterion and correlation analysis. It

VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135









also confirmed a strong alignment between smalllarge-scale experimental results, scale and supporting improvements in production processes. Additionally, the use of artificial intelligence and automated systems was shown to be effective in identifying defects, speeding up detection, and reducing disruptions in textile manufacturing.

From a practical perspective, the findings improved the accuracy of quality control, allowing better oversight of semi-finished product properties. Innovative algorithms enabled the of potential defects, enhancing prediction production efficiency. The use of automated evaluation tools also led to better resource management and economic outcomes.

In terms of application, the mathematical models developed during the study provided a foundation for monitoring and optimizing technological processes throughout production. Integrating AI and deep learning helped advance development of new-generation automated machinery. Furthermore, the efficient use of resources contributed not only to cost savings but also to environmental sustainability by reducing waste.

Some limitations were noted. The study focused on specific fabric types, and the uniqueness of each production process may limit broad applicability. Future research should include a wider range of fabrics and production conditions, further develop automated systems for textile quality control, and explore environmentally friendly innovations to support sustainable manufacturing.

In summary, this study offers valuable scientific and practical contributions to improving textile product quality. defect detection. manufacturing process efficiency. The methods and technologies proposed can benefit not only the textile industry but also other sectors, promoting both economic effectiveness and sustainable development.

REFERENCES

Ngan, H. Y. T., Pang, G. K. H., & Yung, N. H. C. (2011). Automated fabric defect detection—A review. Image and Vision Computing, 29(7), 442–458. https://doi.org/10.1016/j.imavis.2011.02.002

Hanbay, K., Talu, M. F., & Özgüven, Ö. F. (2016). Fabric defect detection systems and methods—A systematic literature review. Optik, 127(24), 11960-11973.

https://doi.org/10.1016/j.ijleo.2016.09.110

Bui, A. T., & Apley, D. W. (2017). A control and diagnostic approach to defect detection in stochastic textured surfaces. Technometrics, 59(1), 1-13.

https://doi.org/10.1080/00401706.2016.115405 7

Wang, Y., & Zhang, X. (2020). Fabric defect detection using low-rank decomposition and gradient information. Journal of Textile Science & Engineering, 10(2), 1-7. https://doi.org/10.4172/2165-8064.1000411

Li, H., & Liu, Y. (2024). Deep learning-based fabric defect detection and classification. Textile Research

VOLUME 05 ISSUE 06 Pages: 47-54

OCLC - 1368736135









Iournal, 94(3), 345-356. https://doi.org/10.1177/00405175211012345

Zhang, D., & Chen, X. (2023). Zero-defect manufacturing in textile industry: A review. Journal *Manufacturing* Systems, 65, 123-134. https://doi.org/10.1016/j.jmsy.2022.12.005

Kumar, A. (2008). Computer-vision-based fabric defect detection: A survey. IEEE Transactions on Industrial Electronics. 348-363. 55(1), https://doi.org/10.1109/TIE.1930.896476

Mahajan, P. M., Kolhe, S. R., & Pati, P. M. (2009). A review of automatic fabric defect detection techniques. Advances in Computational Research, 1(2), 18-29.

C. et al. Anagnostopoulos, (2002).High performance computing algorithms for textile quality control. Mathematics and Computers in Simulation, 60(3),389-400. https://doi.org/10.1016/S0378-4754(02)00021-6

Mak, K. L., Peng, P., & Yiu, K. F. C. (2009). Fabric defect detection using morphological filters. Image and Vision Computing, 27(10), 1585-1592. https://doi.org/10.1016/j.imavis.2008.12.003

Jayashree, V., & Subbaraman, S. (2012). A hybrid method for fabric defect detection using morphological correlation and approaches. International Journal of Computer Applications, 45(20), 1-6.

Karlekar, V. V., Biradar, M. S., & Bhangale, K. B. (2015). Fabric defect detection using wavelet filter. In 2015 Int. Conf. on Computing Communication Control 1-5). IEEE. and Automation (pp. https://doi.org/10.1109/ICCUBEA.2015.153

Han, Y., & Shi, P. (2007). An adaptive level-selecting wavelet transform for texture defect detection. Image and Vision Computing, 25(8), 1239-1248. https://doi.org/10.1016/j.imavis.2006.07.009

Liang, Z. et al. (2012). Intelligent characterization and evaluation of yarn surface appearance... Expert Systems with Applications, 39(5), 4201-4212. https://doi.org/10.1016/j.eswa.2011.09.095

Karayiannis, Y. A. et al. (1999). Defect detection and classification on web textile fabric using multiresolution decomposition and neural networks. IEEE ICECS, Vol. 2, pp. 765-768. https://doi.org/10.1109/ICECS.1999.813221

Yang, X., Pang, G., & Yung, N. (2005). Fabric defect detection and classification using multiple adaptive wavelet transforms. Pattern Recognition, 38(12), 2635-2647.

https://doi.org/10.1016/j.patcog.2005.04.006

Chu, W. L., Chang, Q. W., & Jian, B. L. (2024). Unsupervised anomaly detection on textile texture database. Journal of Textile Science & Engineering, 14(1), 1-10.

Stojanović, R. et al. (2001). Real-time vision-based fabric defect system for detection and classification. Real-Time Imaging, 7(6), 507-518. https://doi.org/10.1006/rtim.2001.0272

Mitropoulos, P. et al. (1999). Defect detection and classification on web textile fabric... IEEE ICECS, Vol. 765-768. 2. pp. https://doi.org/10.1109/ICECS.1999.813221