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QUALITY CONTROL SYSTEM FOR GARMENT FACTORY

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Abstract: The apparel and textile industry relies on high-quality products, but traditional quality control methods, like manual inspection, are labor-intensive and error-prone. This study introduces an AI-based Quality Control System for Garment Factories, leveraging machine learning for automated garment quality assessment. Using a Random Forest Classifier, the system evaluates factors like fabric type, texture, thickness, and weave quality to classify garments as high-grade or low-quality. Built with Python and Flask for scalable backend processing, the system ensures real-time predictions. Its frontend, designed in HTML, CSS, and JavaScript, offers a user- friendly interface. The workflow includes a homepage overview, secure user registration, and login for factory users. Once data is submitted, the trained Random Forest model provides results, classifying garment quality effectively. This system enhances efficiency and consistency in quality control processes.

Keywords: Quality Control, Garment Factories, Machine Learning, Random Forest Classifier, User Interface, Weave Quality, Prediction

I. INTRODUCTION

In the garment and textile sector, high- quality standards need to be guaranteed in order to continue ensuring customer satisfaction. Defects are minimized, and efficiency in production is maximized. Manual inspection is traditionally used to monitor quality, but this is subjective in nature, time-consuming, and easily inconsistent. With the rise in demand for high-quality garments, demand grows for automated and data-driven solutions that will improve accuracy and reduce the process of assessing quality.

This project, "Quality Control System for Garment Factories," proposes a machine learning-based system to assess garment quality based on major fabric properties like cloth type, thickness, texture, and weave quality. The system implements the Random Forest Classifier algorithm, which takes these properties and classifies garments as high-quality or low-quality, eliminating human error and improving decision-making.

The system is designed with Python utilizing Flask for backend processing to allow real-time prediction, while HTML, CSS, and JavaScript are utilized for the frontend to develop an easy-to-use and interactive interface. The system workflow involves a home page, followed by user registration and login, culminating in a prediction page where garment information is input. After submitting the data, the system will process it based on the trained machine learning model and present the output on a specific output page, whether the garment passes or fails the required quality standards.

By incorporating machine learning into quality control, this project hopes to minimize human interaction, enhance accuracy, and maximize production efficiency in garment factories. Future development may involve real-time sensor-based fabric inspection, deep learning- based defect inspection, and integration with IoT technology to further enhance garment quality inspection. This system is a giant leap toward intelligent automation within the textile industry, offering an efficient and scalable solution for current garment manufacturers.

II. PROBLEM STATEMENT

The existing quality control system in garment manufacturing primarily relies on manual inspection by human experts, where inspectors visually examine fabrics and garments to detect defects such as weaving faults, thickness variations, stitching errors, and color inconsistencies. This process is highly subjective, time-consuming, and prone to human error, leading to inconsistencies in quality assessment. Since different inspectors may have varying levels of expertise, the evaluation of garment quality lacks standardization and reliability. Additionally, manual inspection is labor-intensive and expensive, requiring skilled workers who need continuous training to maintain accuracy.

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Another major drawback of the current system is delayed defect detection, as issues are often identified only after production, leading to increased waste, rework, and financial losses. Moreover, real-time quality monitoring is absent, meaning defects cannot be flagged early in the production process, causing inefficiencies in large- scale manufacturing. The lack of data- driven analysis further limits the system, as it does not utilize historical quality records to predict and prevent defects. These challenges highlight the need for an automated, machine learning-based quality control system that enhances accuracy, efficiency, and cost-effectiveness by leveraging data-driven insights and predictive modeling.

III. ALGORITHM RANDOM FOREST

Random Forest is a robust and popular machine-learning algorithm with high accuracy, robustness, and simplicity. It is an ensemble method that aggregates multiple decision trees to enhance predictive power and prevent overfitting. Leo Breiman developed Random Forest, which excels in dealing with high-dimensional data and intricate variable relationships. The algorithm is widely applied in both classification and regression problems in many fields, such as finance, healthcare, marketing, and others.

Key Features of Random Forest

1. Ensemble Learning Framework:

Random Forest follows the bagging (Bootstrap Aggregating) technique, where several decision trees are trained separately on random subsets of the data. The prediction is done by averaging the outputs (in regression) or majority vote (in classification).

2. Feature Randomness:

Random Forest differs from classical decision trees in that it adds randomness to feature selection. At every split in a tree, only a random subset of features is used, which makes the trees diverse and enhances generalization.

3. Dealing with Overfitting:

Overfitting is a typical problem in decision trees, but Random Forest avoids this by combining predictions from many trees, which decreases variance and enhances model stability.

4. Dealing with Missing Values:

Missing data can be easily handled by the algorithm using mean imputation (for regression) or mode imputation (for classification). The algorithm can also predict missing values based on patterns observed in the data.

5. Parallel Processing:

Because each tree in the forest can be built independently, Random Forest can be parallelized and hence is computationally efficient and can be used with large datasets.

6. Feature Importance Measurement:

Random Forest also offers feature importance scores, which assist in the identification of the most important variables in the data, contributing to feature selection and enhancing model interpretability.

7. Cross-Validation Capabilities:

Inbuilt cross-validation ensures strong model performance estimation, avoiding data leakage and optimal hyperparameter tuning.

IV. OBJECTIVES

Effective implementation of the quality control system is important for garment factories to achieve their products within acceptable levels of quality, safety, and reliability. A well-designed quality control system can detect and correct errors, minimize waste, and enhance overall efficiency. In addition, it can also serve to improve customer satisfaction, establish a brand image, and eventually contribute to the growth of business.

Yet the creation and installation of such a system involve a methodical process, including setting precise quality targets, selecting performance indicators, and offering regular training and support to manufacturing personnel. Through prioritizing quality control, clothing factories can achieve many advantages and remain competitive in a more exacting global marketplace

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V. PROPOSED SYSTEM

The proposed AI-driven Quality Control System for Garment Factories leverages machine learning techniques to automate the fabric and garment quality assessment process, addressing the limitations of traditional manual inspections. This system utilizes the Random Forest Classifier algorithm to analyze key garment attributes such as cloth type, thickness, texture, and weave quality, determining whether a garment is of high quality or defective. Developed using Python with Flask for backend processing and HTML, CSS, and JavaScript for a user-friendly interface, the system ensures seamless interaction for factory personnel. The workflow includes a home page, followed by user registration and login, leading to the prediction page, where garment details are entered. Upon submission, the machine learning model processes the input data and redirects the user to the result page, where the classification outcome is displayed. This system offers automated quality assessment, real-time defect identification, and high prediction accuracy, reducing reliance on human inspectors and minimizing errors. Additionally, it enables data-driven decision-making by utilizing historical defect patterns to enhance production standards. By integrating AI into garment quality control, the system improves efficiency, reduces material wastage, and enhances consistency in textile manufacturing.

Future enhancements may include IoT-based real- time monitoring, deep learning for image- based defect detection, and predictive maintenance features, making it a scalable and innovative solution for the textile industry.

VI. SYSTEM DESIGN AND IMPLEMENTATION APPROACH

The system is structured into **different modules** to ensure effective implementation. The approach includes:

System Architecture
The system follows a layered architecture:
1. Data Collection Layer: Captures and stores garment quality data, including fabric type, thickness, weave pattern, and defect occurrences.
2. Preprocessing Layer: Cleans, normalizes, and processes data for machine learning analysis.
3. Machine Learning Layer: Implements the Random Forest Classifier to predict garment quality levels.
4. Prediction and Classification Layer: Uses the trained ML model to classify garments as high-quality or low-quality and provides detailed quality insights.

VII. IMPLEMENTATION PHASES

The system's implementation is divided into structured phases:

Phase 1: Data Collection and Preprocessing
- Collect historical garment quality data, including fabric type, weave density, stitch quality, and defect rates.
- Clean, normalize, and extract relevant features to enhance model accuracy and efficiency.
- Integrate external data sources such as factory defect records and supplier material reports.

Phase 2: Model Training and Testing
- Train the Random Forest model using the preprocessed data.
- Tune hyperparameters and evaluate model performance using classification metrics such as accuracy, precision, recall, and F1- score.
- Select the best-performing model for deployment based on its ability to classify garments accurately.

Phase 3: Real-Time Implementation
- Enable real-time garment quality predictions based on ongoing factory production data.
- Deploy the trained model to continuously classify garment quality.

Phase 4: System Evaluation and Optimization
- Test system performance under different conditions, including various fabric types, production methods, and factory settings.
- Optimize the machine learning model and fine-tune parameters to enhance prediction accuracy and system efficiency.

Phase 5: Deployment and Maintenance
- Integrate the system with a web- based platform for user accessibility.
- Ensure periodic model updates and retraining to maintain high prediction accuracy.
- Monitor system performance, user feedback, and operational issues to ensure continuous improvement.

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VIII. CONCLUSION

The Quality Control System for Garment Factories leverages machine learning and automation to address the limitations of traditional manual garment inspection methods. By utilizing the Random Forest Classifier algorithm, the system provides accurate and consistent quality assessment, reducing human error and optimizing the garment production process. The integration of data preprocessing, feature engineering, model training, and real-time prediction modules ensures that garments are classified efficiently based on key attributes such as fabric type, thickness, weave pattern, and defect occurrences.

This system not only enhances quality control accuracy but also minimizes production defects, reduces costs, and improves manufacturing efficiency. The user-friendly web-based interface enables factory personnel to input garment attributes, receive instant quality assessments, and make data-driven decisions to maintain high standards in textile production.

Additionally, the system is scalable and adaptable, allowing future enhancements such as IoT-based real-time monitoring, deep learning-based image processing for defect detection, and predictive maintenance solutions. By integrating AI- powered automation, this system represents a significant step toward intelligent textile manufacturing, ensuring higher product quality, optimized resource utilization, and greater customer satisfaction.

IX. FUTURE SCOPE

The Quality Control System for Garment Factories has the potential for significant advancements and enhancements in the future. As technology evolves, integrating more advanced techniques can further improve accuracy, efficiency, and scalability in garment quality assessment. Some key future developments include:

1. Integration with IoT and Real-Time Monitoring
Implementing IoT-enabled sensors to continuously monitor fabric quality parameters such as thickness, texture, and stitching precision in real time.
Automating defect detection by analyzing sensor data and triggering alerts when quality thresholds are not met.

2. Automated Quality Control Using Robotic Inspection
Integrating AI-driven robotic arms for automated defect detection and quality assessment during garment production.

Using computer vision algorithms to detect minute fabric inconsistencies at a high speed.

REFERENCES

[1]. Agarwal, V., & Patel, R. (2021). Machine Learning-Based Fabric Defect Detection in Textile Industry. IEEE Transactions on Industrial Informatics, 17(3), 2156-2167.
[2]. Banerjee, S., & Chatterjee, A. (2022). AI- Driven Predictive Quality Control in Garment Manufacturing. Expert Systems with Applications, 204, 117839.
[3]. Chen, Y., & Wang, X. (2020). Automated Fabric Inspection Using Deep Learning Models. International Journal of Computer Vision, 128(5), 1348-1362.
[4]. Das, T., & Mukherjee, P. (2021). Machine Learning for Quality Prediction in Textile Manufacturing. Knowledge-Based Systems, 229, 107355.
[5]. Elango, S., & Raj, S. (2019). Smart Textile Quality Control System Using IoT and AI. Sensors and Actuators A: Physical, 298, 111539.
[6]. Feng, L., & Zhang, H. (2021). AI-Based Predictive Maintenance in Textile Machinery. Journal of Manufacturing Processes, 64, 567-578.