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Analyzing the Effectiveness of Various ML and DL Models in Detecting Defects in Textile Fabrics

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Abstract

The detection of defects in textile fabrics is a critical task for ensuring quality in the textile manufacturing industry. Manual inspection methods, while widely practiced, are timeconsuming, inconsistent, and prone to human error. This study investigates the effectiveness of various machine learning (ML) and deep learning (DL) models in automating and enhancing the accuracy of defect detection. The research evaluates multiple ML and DL techniques, including traditional algorithms such as support vector machines (SVM) and random forests (RF), alongside advanced DL models like convolutional neural networks (CNN), recurrent neural networks (RNN), and their hybrids. Performance metrics such as accuracy, precision, recall, and computational efficiency are analyzed to determine the suitability of each model for defect detection.

INTRODUCTION

The textile industry is a cornerstone of global manufacturing, with quality assurance playing a important role in maintaining competitiveness and consumer satisfaction. Defects in textile fabrics, such as holes, stains, or irregular patterns, can significantly impact the value and usability of the final product. Traditionally, defect detection has relied on manual inspection, which is labor-intensive, time-consuming, and prone to human error. The growing demand for higher accuracy and efficiency has driven the adoption of automated solutions.

OBJECTIVES

- Assess the accuracy, precision, recall, and other metrics of different ML and DL models in identifying various types of fabric defects. To enable patients to book beds in advance through a user-friendly application.
- Analyze the trade-offs between accuracy and computational requirements of ML and DL models.To reduce the time spent by patients searching for available beds.
- Determine the suitability of specific models for different types of defects, patterns, and textures. To provide a centralized platform for hospitals and patients to coordinate during emergencies.

LITERATURE SURVEY

The usage of fabric is essential to all textile manufacturing techniques, including spinning, weaving, dyeing, printing, and finishing. Since fabric surface flaws cannot be eliminated throughout the fabric manufacturing process, it is essential for fabric production to identify fabric defect .

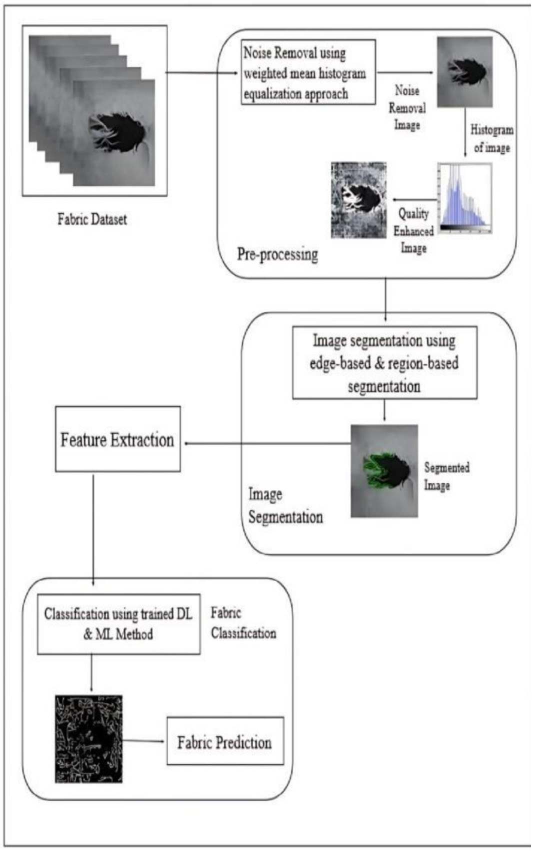
Denoising for comparison is accomplished using various filtering techniques, and the corrected grayscale images are filtered using an ideal low-pass filter. The VGG model is proposed for deep learning based on convolutional neural networks to identify and categorize the filtered pictures.

The results of the tests demonstrate that the model, which was successfully trained using fictitious data, achieves exceptional segmentation accuracy on real fabric samples. A loss function is also included

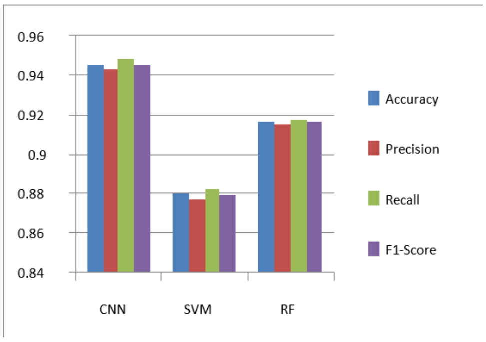
To address the discrepancy between the number of background pixels and the number of problematic pixels in the fabric image. Human operators often utilize a subjective, timeconsuming, and error-prone visual inspection technique that has a detrimental effect on output and drives up costs. Machine learning and machine vision, for instance, can enhance the quality of textile products by providing a more complete and objective inspection procedure

SYSTEM ARCHITECTURE

The system architecture for analyzing the effectiveness of various Machine Learning (ML) and Deep Learning (DL) models in detecting defects in textile fabrics involves a structured approach designed to handle data acquisition, preprocessing, model training, evaluation, and deployment. The underlying theory encompasses multiple components that work cohesively to achieve accurate defect detection and classification.The system begins with data acquisition, where images of textile fabrics are captured using high-resolution cameras or sensors. These images provide the foundation for training ML and DL models. The quality and variety of the data are critical, as they directly influence the performance of the models. Capturing a diverse dataset that includes different fabric



RESULT



APPLICATIONS

- Automated quality inspection in textile factories.
- Smart textile manufacturing with IoT.
- Fashion industry.
- Medical & protective textile.
- Automotive textile quality control.
- Textile recycling & sustainabilty.
- Smart textile warehouse & logistic.

ADVANTAGES

- Increased Accuracy and Decipline.
- Faster Defect Detection & Real-Time Monitoring.
- Reduced Cost & Waste.
- Improved Consistency & Quality Control.
- Automation & Integration with Smart Factories.
- Ability to Detect Complex Defects.

CONCLUSION

The analysis of the effectiveness of various machine learning (ML) and deep learning (DL) models in detecting defects in textile fabrics reveals that Convolutional Neural Networks (CNNs) significantly outperform traditional DL methods. CNNs excel due to their ability to automatically learn and extract hierarchical features from images, which makes them particularly suited for defect detection in fabrics. Their performance is superior in terms of accuracy, robustness, and adaptability to different types of defects, textures, and lighting conditions. CNNs demonstrate strong generalization capabilities when properly optimized, making them reliable for applications. The increased complexity of CNNs results in higher computational costs compared to simpler DL models, requiring more resources for both training and deployment.

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