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Textile Fabric Defect Detection

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Abstract

Technology and digital imaging have a variety of uses in automated production processes and other applicable disciplines. A novel subject of inquiry in the present era is the detection of flaws in the textile industry utilizing digital image processing methods and other learning methods. The identification of flaws in the fabric must be ensured through a quality control method. The product quality is enhanced via a mechanism for detecting fabric defects. Detection of fabric flaw becoming more and more popular in the production of high-quality textile products. This system works by using image processing, video processing and classic learning methods to recognize defects in the fabric surface.

Keywords: Fabric defects, automated production, digital image processing, learning based

1. Introduction

There are several applicable domains, including industry-based problems, where computer vision and image categorisation models are used. One of the fundamental needs for human existence is clothing, and the origin of the textile industry predates the development of human civilization. Fabric is employed in numerous industrial items in addition to serving as a primary component of human clothing. For textile business, quality monitoring is of the utmost significance. Companies run the risk of losing trust, reputation and money with a damaged product by failing to recognize the fabric faults. The majority of flaws either occur parallel to or in the movement direction. According to quality standards, there are two types of flaws on the fabric surface: Surface colour alterations and regional textural asymmetry[1].

The issues brought on by manual inspection can be resolved by automated, computer vision-based fabric flaw inspection systems. Researchers from several nations have been paying close attention to the automated approach for evaluating fabric flaws for years. The invention of automated defect inspection systems, which are capable of carrying out

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inspection tasks automatically, has been prompted by the high expense of human visual examination as well as other drawbacks.

This paper's fundamental flaw was its emphasis on uniform fabric textures, despite the fact that some types of fabric have non-uniform textures [2]. Another issue with was that no information regarding the picture capture technology was provided, which was a problem with the prior review technique[3-4]. The most recent techniques for detecting fabric defects are presented in this study and include hybrid, structural, spectral, model-based, learning, and comparison approaches.

1.1 Types of Fabrics

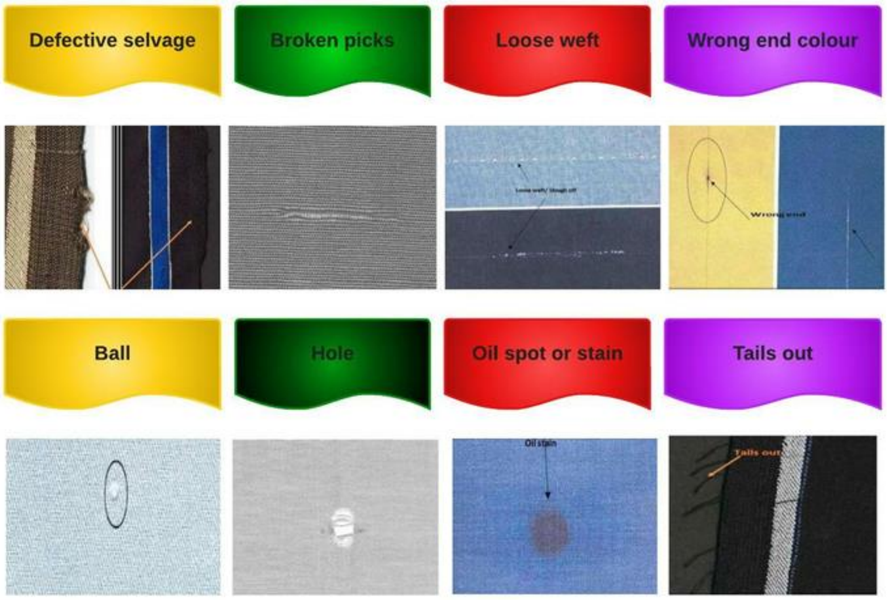

Figure 1. Types of Fabrics

Defective selvage: Due to poor weaving, woven fabrics have a bad selvage. Here, the warping ends are spaced apart too widely for the density of the yarns or the fabric's final product.

Loose weft: As a result of the filling yarn's looseness, it is manufactured in woven fabrics.

Broken picks: A filler yarn that breaks during fabric weaving.

Wrong end color: It is created in woven fabrics as a result of incorrect colored yarn drawing.

Ball: A ball of warp yarn will form between both the reed and the head shaft if the warping is very hairy. These will shape the ball in fabrics if it is sufficiently small to fit through the reed's depression.

Hole: A flaw in the fabric where one or more strands are sufficiently harmed to make a hole.

Oil spot or stain: Localized substrate discoloration that could be difficult to remove with laundry or dry cleaning. When spinning, weaving, or finishing, it happens. It can frequently be observed in woven cloth as well. If the loom's components have been too oiled, it can also be seen in woven fabric.

Tails out: If the cutter doesn't function properly, this kind of flaw will appear in woven fabric.

1.2 Fabric defect detection methods

In this survey, there are essentially two types of fabric defect detection algorithms: standard algorithms and learning-based algorithms. Standard algorithms, including analytical, structure, statistical, and model-based approaches, are founded on feature extraction with previous information. Deep learning algorithms and traditional machine learning algorithms are two additional categories for the learning-based algorithms [20].

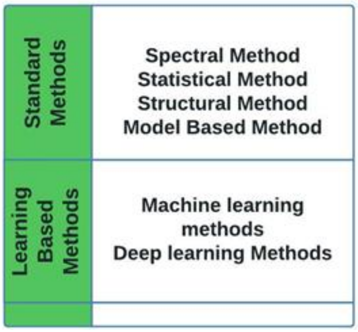

Figure 2. Types of fabric defect methods

2. Related Work

The quality of fabrics is significantly impacted by textile fabric flaws. The production demands of the current textile industry cannot be addressed by the slow and ineffective traditional manual techniques of textile problem detection. This study compares and contrasts various deep learning-based defect detection algorithms before designing and implementing its own defect detection system based on enhanced Cascade R-CNN. The experimental results demonstrate that the accuracy of the enhanced Cascade R-CNN model detecting defects is increased by 4.09 percent to 95.43 percent when compared to the detecting defects based on Cascade R-CNN, and the upgraded model has superior recognition of multi-scale faults effect[5]. This article, using integral pictures, solves the problem of detecting fabric defects. To expedite the computation procedure, the massive operations in Normalized cross correlation NCC are replaced using the integral image technique. Defect identification can therefore be carried out in real time. The robustness against various forms of sounds is enhanced by the integration procedure. Utilizing three separate datasets of fabric photos with various fabric faults, the effectiveness of the suggested technique is assessed. Integral image transform effectively provided the requisite 97.5%fault detection rate while reducing computation costs by 98.78 % [6].

A cloud-edge collaboration fabric defect systems is suggested as an alternative to the automated fabric fault detection system utilised in production facilities. First, real-time defect detection takes place out on edge devices, and upgraded MobileNetV2-SSDLite ensures the precision of minor defect detection. The channels attention mechanism is added to the network to draw attention to defect features and to reduce features that contribute to background noise. The accuracy of proposed Camouflage dataset with minor flaws has grown by 10.03 %, and the NVIDIA Jeston Nano's detection speed reaches 14.19FPS [7]. In this article, fabric defect detection method built on the enhanced YOLOv3 model is suggested in order to increase the detection rate of defects and the quality of the fabric product. Two essential steps are: Prior frames' size and number are first calculated using the fabric defect area and k-means algorithm in order to perform dimension clustering of the target frames based on YOLOv3. Second, the high-level information is integrated with the low-level properties. The enhanced network model's error detection rate is less than 5% [8].

This study introduces an unsupervised approach for detecting fabric defects that does not require user adaption and simultaneously achieves high detection rates. This approach can be applied to plain cloth and is primarily used with patterned materials. First, standard deviation filtration with an appropriate window size is utilised then image is then divided into blocks whose sizes correspond to the segmented of the texture features. Third, a calculation is made to determine the squares difference between every block mean and the median of all block medians. Finally, K-means clustering is used to categorize the blocks into defective and non-defective ones based on all these distinctions. With a 95 present overall detection success rate, the suggested algorithm performed admirably [9].

Table 1. A Survey on fabric defect methods and its inferences

Ref no/Year	Method	Strength
[10] 2016	Multiple gabor filters and kernel principal component analysis	High true detection rate, Low cost for online fabric inspection
[11] 2018	Unsupervised learning-based automated approach	High precision and acceptable recall rates
[12] 2015	Wavelet filter	Faster and cost effective, noise eliminating.
[13] 2020	Generative adversarial network (gan), faster r-cnn	Increasing the probability of defect recognition
[14] 2019	Deep convolutional neural network (cnn)	Accuracy of 97.31%
[15] 2022	Mobile-unet	Segmentation accuracy and detection speed
[16] 2011	Image processing techniques and neural networks	UV lighting for detecting oil defects
[17] 2019	Image pre-processing, fabric motif determination, candidate defect map generation, and convolutional neural networks	Average precision-90% Recall -80% Accuracy-98%
[18] 2019	Multi-scale analysis, filter factorization, multiple locations pooling, and parameters reduction	High detection accuracy with smaller model size
[19] 2020	Generative adversarial network (gan)	Fine-tuning of the semantic segmentation

3. Open issues and challenges

From the above discussions, traditional algorithms and computer vision based techniques results in bad production and significantly more costly. The recent image processing techniques and machine learning algorithms overcomes the mentioned disadvantages. Few challenges to be focused by the learning methods are

- Reduction in computational cost
- To recognize random fabric texture

- The selection of best filtering settings (filter parameters).
- Identification of errors on uncommon fabrics
- Detection of smaller defects
- Large set of features

The contrast between the appearance of the defects and the texture, the consistency of the texture background, the resolution of the images, the alignment and distortion of the images, the size and shape of the defect, the speed of an algorithm, the luminance, and the image acquisition techniques are some of the other factors that may affect fault detection. As a result of addressing the preceding difficulties, the rate of defect detection could be increased, which would also boost the production and quality of the weaving industry. Machine learning combined with computer vision will produce quick and accurate results.

4. Conclusion

Since the fabric contains flaws, the traditional process results in decreased output and greater market losses. This study looked at emerging technologies for working fabric inspection techniques. A computer vision technique that may be used to detect different types of fabric problems on various types of materials. However, it needs to be remembered that the investigations are carried out using various imaging systems, databases, and parameters, which makes it difficult to determine the reliability and accuracy of the methodologies. It is believed that thorough studies like this one will considerably benefit the textile industry. This review paper contains the most recent research on techniques for detecting textile fabric defects.

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