Survey Of Fabric Defect Detection

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Abstract—Due to the rapid growth of new computer technologies, fabric defect identification has become a prominent topic in recent years. Detection of defects in the fabric is a vital stage in the textiles industry's quality control. Traditional fabric inspections frequently use manual visual processes leading to inaccurate and imprecise results that are unsuitable for long-term industrial use. Many researchers have contributed their efforts for fabric flaw detection systems using different techniques such as computer vision, image processing, etc. All the previous work done in this area has some limitations. The accuracy rate in previously presented systems is around 88% to 90%. Datasets used by many systems had fewer images and were typical of one type. Also, pre- processing techniques were absent in the previously proposed system. This research presents u shaped network (U-Net), an enhanced convolutional neural network for detecting fabric defects. The attention mechanism is established based on network size compression. In this method, the U-Net network is improvised to discover the fabric defect more accurately and precisely.

Keywords—U-Net, fabric defect detection, attention mechanism, image processing, computer vision, convolutional neural network

I. Introduction

Quality assurance is an important factor in the industrial process. In the textile industry, fabric defect detection plays a vital role because it affects the standard of cloth products. The price of the fabric depends on the quality and number of defects in the fabric. In the increasing market competition, only high-quality products can survive. According to research, there's around 70% human accuracy to detect fabric defects and therefore the fabric defects result in high economic losses within the market. Thus, it is necessary to implement an automated fabric defect detection system. The basic purpose of fabric detection is to identify fabric flaws and hence limit the financial losses incurred by such items.

Using an automated visual detection system to detect potential fabric flaws is a more reliable and consistent quality control method. Deep networks (PTIP), which use local images in the training stage and whole fabric data in the testing phase, and full convolutional neural networks (U-Net), which employ pixel-to-pixel training and deliver satisfactory results in medical image segmentation, are two examples. Mobile-UNET, a fast convolutional neural network, was proposed in a paper. To combat the unbalanced sample problem, the model uses the median frequency balancing loss function, along with depth wise separable convolution, which greatly decreases the network's complexity and model size. A system for detecting fabric defects using the optimal gabor wavelet has been proposed [1]. Gabor wavelet features such as spatial localization, frequency selectivity, and direction selectivity allow it to successfully detect frequency and direction information aspects reflecting the texture's immediate region. K- means clustering algorithm also has a presence in fabric defect detection. To blur image segments and amplify defective regions of fabric samples, the K-means clustering technique was utilized [4]. A study has provided a saliency mapping fabric defect detection approach based on regional membership by assessing the saliency of the regional features of an image [8]. In comparison to the above-mentioned methods, this study provides an improved U-Net model for fabric defect identification, and the results exhibited are highly effective. The approach is an end-to-end architecture for accurate defect target localization that includes defect object segmentation and pre-processing, among other things. The background information is passed to the upper feature map through the skip connection between the contracting path and the expansive path in U-Net, and pixel-to-pixel mapping is obtained by discarding all full connection layers. After the processing, the binary segmented image is the output. Based on this segmented image, the defect area of the fabric is marked with a rectangular frame in the post-processing stage. The results inferred that the defect areas through post- process were more visible and more likely to be recognized by technicians.

The organization of this paper is as follows: Section II presents the related work for fabric defect detection, Section III gives the proposed methodology for detection of fabric defect and concludes the article with future work followed by references.

II. Related Work

Many researchers have experimented with various methods for detecting fabric defects. Wei Wei et al. presented a system to compare unsupervised learning algorithms based on CNN, such as auto encoder, variation automated encoder, and generative adversarial networks. image denoising, slicing, and encoding was used for pre-processing [1]. Guohua Liu et al. proposed fabric defect detection based on information entropy and frequency domain saliency. According to the relationship between information entropy and picture texture, the approach introduces two-dimensional entropy, which can express spatial distribution properties of images based on one-dimensional entropy [2]. BoshanShi et al. presents an approach to detect fabric defects based on a structured low rank decomposition of gradient information graph algorithm and graph algorithm. The low rank decomposition approach, which decomposes a matrix into a sparse matrix that represents the defect-free zone (background) and identifies the problem area, exhibits the potential of fabric defect detection (foreground) [3]. Deep learning based on convolutional neural networks is recommended for the classification and detection of filtered images using the VGG model various filtering methods were used to denoise for comparison, and an appropriate low pass filter is chosen for the filtering of modified grayscale images [4]. Li Y et al. presented an optimal gabor wavelet based on radon. Gabor wavelet is a useful approach for working with data redundancy and low multi-channel Gabor wavelet operation [5]. Based on a u-shaped de- noising convolutional auto-encoder, the research proposes an unsupervised yarn-dyed fabric flaw detection approach [6]. An unsupervised method combining principal component analysis and dictionary learning is described for detecting the global image to characterize the woven cloth texture image because the method uses a large dictionary, the results of fault identification are poor [7]. Tomás Almeida et al. presents fabric defect detection with deep learning and false negative reduction. The study proposes the method used in the K-means clustering approach for detecting a defect in fabrics [8]. K-means clustering algorithm was used to blur segments of images and amplify defects regions of the fabric samples. unsupervised characterization based global fabric defect detection was used by Ying Wu et al [9]. Liwen Song et al. proposed a fabric defect detection system based on the membership degree of regions. The proposed detection method is more effective at detecting fabric faults while suppressing noise and background textures [10].

Table 1 illustrates the complete view of different techniques used for fabric defect detection on different types of fabrics in detail.

Table 1. Summary of work on different fabric detection techniques

Work Cited	Fabric(type)	Pre-processing	Method Used	Dimension(In pixels)	Data Set	Issues not addressed
[1]	plain and twill fabrics	Slicing, denoising, encoding	Variational automatic encoder with structure similarity	Not defined	1.Fabric Sample library 2.TILDA public library	1.False defect detection, resulting in a textural deficiency near the defect. When reconstructing, the VAE is unable to fully reproduce the texture of the original fabric.
[2]	Dot patterned, box patterned and star patterned.	Otsu classification	Entropy and frequency domain saliency	256×256	336 images. Dot patterned, box patterned and star patterned.	1.Only five common fabric defects were tested.
[3]	Dot patterned, box patterned and star patterned.	Image denoising	Low-rank decomposition with gradient information and structured graph algorithm	256x256	81 defect images with 24-bit	1.When the threshold value is greater than 150, the performance of PG-NLR decreases.
[4]	plain woven fabric	Image adjustment and image filtering	Deep Learning	Not defined	12000 samples for the 6 typical types of plain woven fabrics	1.The RGB image was transformed to grayscale, however the image was not converted back to RGB image after processing.
[5]	None	None	Optimal Gabor Wavelet Based on Radon/DDPA	256×256	Real time images, 8-bit resolution	1.The detection accuracy of the proposed method DDPA is lower than Max MDAM and the average detection speed is lower than RMMM
[6]	Yarn-dyed	Data encoding, data denoising	U –shaped denoising convolutional auto encoder	512x512	4 different types of datasets (3 different colour channels)	1. The system is only used to detect defects on yarn dyed type fabric. 2.U-Net architecture capability is limited in extracting image-derived information.
[7]	plain, twill fabrics, and yarn-dyed fabric	Data denoising	Unsupervised characterization consisting of PCA and dictionary learning	256x256	33 real world with 256 grayscale levels	1.Similarity in flow and background texture leads to poor detection results.
[8]	None	Grayscale transformation and histogram equalization	Custom CNN with False Negative Reduction	150 x 150	TILDA, MVTec, Stains and Fabric-Net-Dataset	1.No pretrained networks or weights were used. Only 3 out of 4 datasets were used test phase. In contrast the CNN cannot clearly identify the defective features.
[9]	None	None	K-means clustering algorithm	10 x 10	Real time images	1.No standard datatypes used.
[10]	None	3x3 median filter, corrosion and expansion	Membership Degree of Regions, threshold iterative method	Not defined	Images obtained from product line	1.The rate of detecting defect decreases when the noise intensity is greater than 10.

III. Proposed Methodology

Our defect detection system consists of the following sub-modules: pre-processing and defect object segmentation.

A. Pre-processing

This step consists of an image filtering technique to enhance the image.

A.1 Image filtering

Histogram equalization is a computer image processing technique for increasing image contrast. It does so by effectively spreading out the most common intensity values or expanding out the image's intensity range. This enables areas with low local contrast to obtain a lift in contrast. Following are the steps involved in histogram equalization.

Step1: Obtain the image for the input

Step2: Create an image histogram.

Step3: Calculate the image's local minima.

Step4: The local minima are used to divide the histogram.

Step5: Each segment of the histogram should have its grey levels.

Step6: Equalize each partition's histogram.

B. Defect object segmentation

For defect segmentation, the U-Net method is introduced. The context information is passed to the higher feature map through the skip connection between the contracting path and the expansive path in U-Net, and pixel-to-pixel mapping is achieved by discarding all full connection layers.

C. U-Net Architecture

U-Net gets its name from the architecture, which resembles the letter U when viewed, as illustrated in the diagram above. A segmented output map is created from the input images. There is no fully connected layer in the network. The convolution layers are the only ones that are used.

The original U-net model is a supervised machine learning method that can efficiently segment biological cell images during the testing phase after being fed as many labeled examples as possible during the training phase. U-net takes the border pixel difference between every two concatenated convolutions. The cross-entropy loss function of the U-loss net is used in biomedical segmentation.

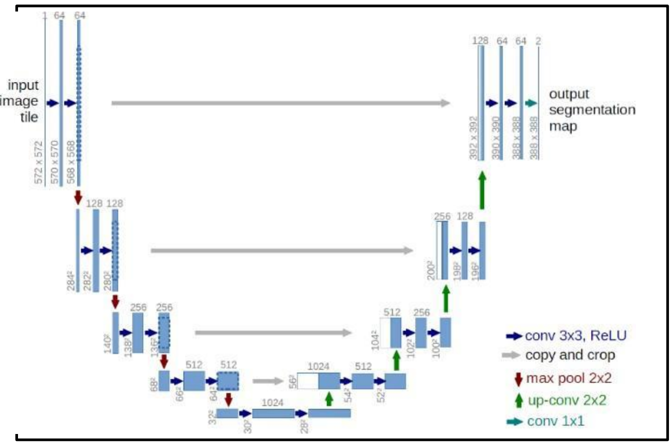

Fig1: Olaf Ronneberger (2015) U-Net Architecture

Using annotated samples, these improved applications demonstrate that the U-net model has high generalization capability. To allow faster testing and testing of the model, the number of feature channels and down-sampling are reduced from 64,128,256,512,1024 in basic U-Net to 32,64,128,256.

In CNN, the smaller feature map has more semantic information for classification, while the wider feature map contains more spatial information for localization. Fabric defect detection is a binary classification challenge, which necessitates a greater emphasis on localization. Due to the reduced quantity of down sampling, the smallest feature map of CU-Net is quadrupling the size of U-Net, resulting in better localization precision.

D. Attention Mechanism

The cognitive process of selectively focusing on one or a few things while dismissing others is known as attention. The attention mechanism enables the classification algorithm to pay closer attention to some of the image's more discriminative local regions, resulting in improved model classification accuracy in complicated scenarios.

The attention method is being used in skip-connection because some fabric images contain minor faults that are easy to overlook during the segmentation process. The attention technique is used to explicitly model the dependencies between feature channels. It's implemented in the CU-skip-connect Net's feature to reduce the number of redundant features by suppressing the typical response of disconnected regions.

IV. Conclusion

Many researchers have done remarkable research in the field of defect detection and have proposed a variety of different detection algorithms concentrating on improving different types of defects, as fabric detection has grown increasingly vital over time. If the fault is not discovered adequately, the textile industry may suffer a loss. We conclude that combining a U- Net architecture with a deep learning architecture can be an effective method for detecting fabric defections. This can match the demands of detection of defects in fabrics and delivers an effective engineering solution for detection of defects in fabrics.

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