INTEGRATED IMAGE SENSOR AND DEEP LEARNING NETWORK FOR FABRIC PILLING CLASSIFICATION

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Abstract- **In recent years, fabric defect detection has been used in machine vision technology to process fabric images. In the past, knitted fabric pilling evaluation was classified by manual observation which resulted in misjudgments and a decrease in efficiency. Pilled fabric image consists of different frequency components of sub-images. In this paper, to strengthen the pilling information from pilled fabric images fast Fourier transform (FFT) and Gaussian filter are used for image preprocessing. Fabric images are collected using an image optical sensor and classifications of fabric pilling are identified using a deep learning network. The proposed method for pilling level classification has high accuracy**

Keywords-Deep learning network, image sensor, fabric image, pilling level classification, Gaussian filter

I. INTRODUCTION

The traditional fabric inspection method is based on the defects in the fabric through manual visual inspection, which causes misjudgments and decrease in efficiency. This method has errors in the pilling classification and lack of experience needed subjective evaluation of human operators. This work tries to overcome this problem and classify the pilling resistance of knitted fabrics using artificial intelligence methods. The deep learning network of CNN has to perform the pilling classification of knitted fabrics. The proposed method is the fabric images found by an optical sensor are subjected to an FFT and a Gaussian filter and deep learning network is used for feature extraction and fabric pilling classification. Using the Fast Fourier Transform (FFT), the obtained fabric is converted into a frequency signal, and then noise is removed by the Gaussian filter. The deep learning network uses LeNet-5 model, and does not require a large amount of hardware resources, which has automatic feature extraction and classification capabilities. The convolution layer and pooling layer are used to automatically extract the features of the fabric pilling. The difference between the traditional neural network and the deep learning network is constantly adjusting the weights in the convolutional layers and the fully connected network layer. Also, calculate the error between the predicted output and the desired output of the network. The experimental results show that the deep learning network has high performance in fabric pilling classification.

II. LITERATURE REVIEW

Saharkhiz et al. [1] used to process the image of the fabric using two-dimensional fast Fourier transform and a low-pass filter to blur the texture of the fabric's surface. The extracted surface of the knitted fabric piling evaluation has three parameters such as the number, the volume, and the pilling area.

Deng et al. [2], the pilling information of knitted fabric is extracted using the multi-scale

two-dimensional dual tree complex wavelet transform. This DWT method extracted six such as the energy ratio of the pilling quality, the area of the pilling, the total number of the pilling, the standard deviation of the pilling area, the standard deviation of the height of the pilling and the deviation coefficient of the pilling position.

Furferi et al. [3] pre-process in the fabric's image done by binarization and B-splines and the extracted five parameter such as entropy curve, total kurtosis, total skewness coefficient of variation and brightness of the fabric. The ANN used as a classifier to evaluate knitted fabric.

Eldessouki et al. [4] to evaluate the pilling of a knitted fabric used four methods binarization, cutting, quantification, and classification. The extracted surface of the knitted fabric has the following four parameters such as the number of pilling, the average area of pilling, the area ratio of pilling and the density of pilling. The classifier used in this method as artificial neural network (ANN).

Yun et al. [5] used the American Society of Testing and Materials (ASTM) for knitted fabric and used to process the fabric's image as fast Fourier and fast wavelet filtering methods. Using this method the number of pilling, the total pixel area, and the total pilling image grayscale value were extracted.

Techniková et al. [6,7] proposed a system to evaluate the pilling of unicolor fabrics and fabrics with complex patterns. The use of image analysis tools for pilling detection and pilling evaluation system included a 3D fabric surface ted from shading based on a gradient field method. LeCun et al. [8] proposed the piling of a knitted fabric LeNet-5 model which used the back propagation (BP) algorithm to adjust the parameters of the neural network and CNN is used as a classifier

III. METHODOLOGY

This proposed CNN as a deep learning network to perform the pilling classification of knitted fabrics. In this method the fabric images are obtained using an optical sensor. It uses, the FFT and a Gaussian filter to fade the background texture of the fabric. a deep learning CNN is used for feature extraction and fabric pilling classification. Figure.1 shows the flow chart of the proposed method. For image preprocessing methods, first FFT converts the image to a frequency signal, and the Gaussian filter is used to remove the noise. The Gaussian filter uses the sigma value is set as large, and then the filtered image is clearer shown in Figure.2.

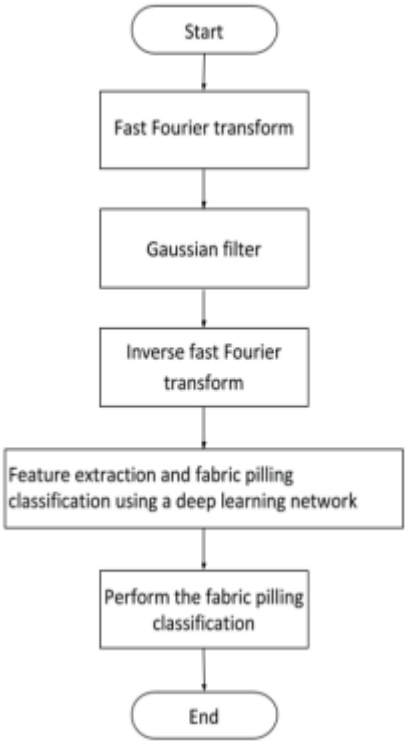


Fig.1 Flow chart of the proposed method

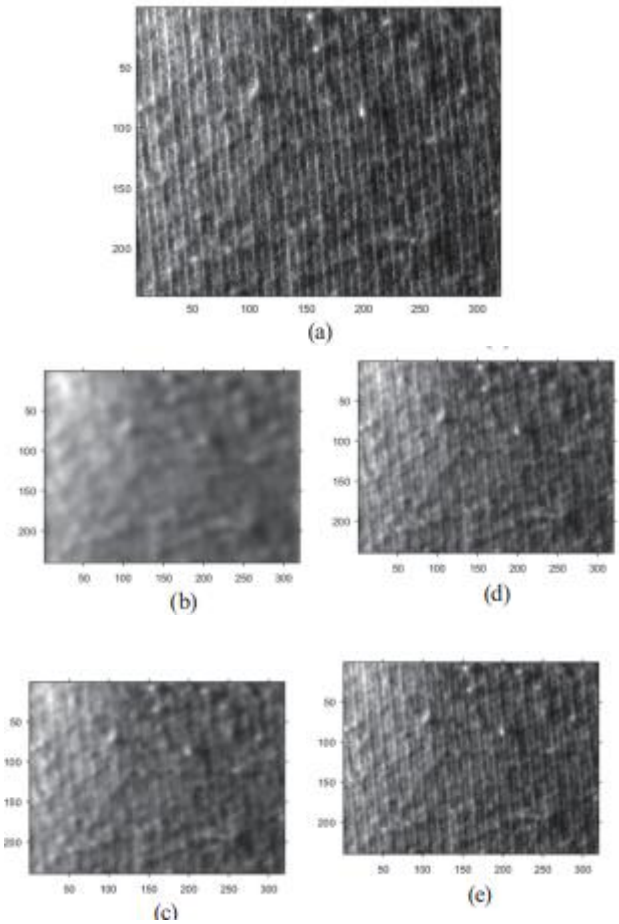
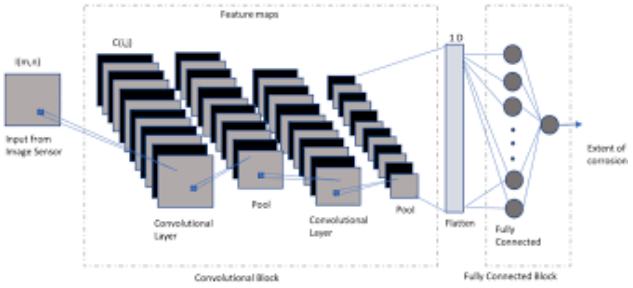


Fig. 2. (a) Original image, (b) image with σ = 10, (c) image with σ = 20, (d) image with σ = 30, and (e) image with σ = 40.

Pilling level classification using CNN

The process of extracting features using CNN is shown in figure.3 , and the features are obtained through the learning process. This method is to be effective and have multiple layers for feature extraction by constructing a multilayer network structure.

The CNN is composed of four types of network layers such as convolution, pooling, activation, and fully connected layers. The learning process is CNN also uses a BP learning algorithm to update the parameters in the convolutional layer and the fully connected network layer.



Pooling layer

The pooling layer in CNN is to reduce the feature map, after pooling can still retain the advantages of rotation, anti-alias information, translation invariance, and avoidance of overfitting.

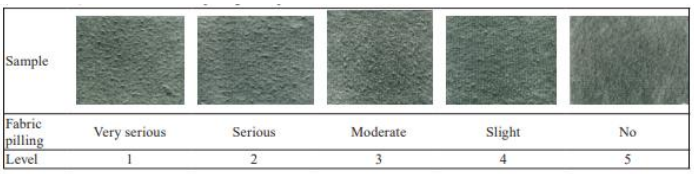
Activation layer

The activation layer is used to simulate the transfer operation of the neural network. Because the activation function used in this layer is nonlinear. The first two layers of a fully connected layer in CNN are a convolutional layer and a pooling layer. The last two layers of the CNN use a multilayer perceptron and Softmax to obtain prediction results. In the multilayer neural network, all feature maps must be converted into a 1D array as the input data of the fully connected network, and then the output is obtained through Softmax.

IV.EXPERIMENTS

Pilling level of knitted fabric we collected fabric samples and distinguished the levels of fabric pilling as preliminary work. First, the fabric was tested in a Martindale abrasion. Fabric was rolled in the tester, the condition of fabric pilling on the surface was detected. Four types of fabrics were evaluated using an image optical sensor and their pilling levels were identified in this experiment. In the dataset we collected images for each level of pilling, 80% of the data for each level was randomly selected and 20% was used as testing

samples. Then fabric pilling was identified by deep learning networks. The inspection results obtained using the proposed method is shown in Figue.3.



Five levels of fabric pilling in inspection

V.CONCLUSION

In this paper image preprocessing is used to strengthen the pilling information from pilled fabric images fast Fourier transform (FFT) and Gaussian filter. Fabric images are collected using an image optical sensor and classifications of fabric pilling are identified using a deep learning network.Using a deep CNN the pilling level classification of the knitted fabric was automatically captured and identified. The experiments are conducted to calculate the fabric piling in five different levels. The proposed method for pilling level classification has high accuracy.

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