AUTOMATIC DEFECT DETECTION IN KNITTED FABRIC USING MLP and CNN

Madhan Kumar S[1], Subrata Das[2], Sundaramurthy S[3] and Suresh Jayaram[4]

[1]*UG scholart, Department of Fashion Technology, Bannari Amman Institute of Technology, Sathyamangalam, Erode.*

[2]*Professor, Department of Fashion Technology, Bannari Amman Institute of Technology, Sathyamangalam, Erode.*

[3]*Assistant Professor, Department of Information Technology, Bannari Amman Institute of Technology, Sathyamangalam, Erode.*

[4]*Sky Cotex India Private Limited, Tirupur, Tamil Nadu 641605, India*

Abstract: In textile and apparel exports 39 percent of production is contributes in Tamil Nadu, but the speed of the knitted fabric inspection process is slow due to manual inspection by worker. In manual inspection, the trained inspector can able to find 60-75 percent of defect due to fatigue, lack of concentration and triteness in continues work. To increase the speed and accuracy of the inspection process, automatic defect detection in knitted fabric by using artificial neural network can be use. Convolution Neural Network (CNN) and Multi-Layer Perceptron (MLP) in deep learning use to train the neural network by image processing. There is three layer in neural network are input layer, hidden layer and output layer. The defective and defect free knitted fabric images are collects from the Sky Cotex India Private Limited, Tirupur, India and it is use as input to train the neural network and in hidden layer there is n no of neurons to train the neural network and the trained neural network is generated in the output layer. Once the two neural network are train and it is use to test the accuracy of the neural network. With the accuracy percentage, the suitable neural network is identifies for the knitted fabric inspection process.

Keywords: *CNN, MLP, Image processing, Defect detection.*

1. Introduction

Knitted garment is one of the major exports in the India. To achieve the good qualities garment, ensure the quality of the knitted fabric is essential. In India the knitted fabric inspection [15] is inspect by the trained person. Even the highly skilled person can able to identify only 60-75 percent of defect due to lack of concentration, fatigue and triteness. Moreover, the fabric inspection time is high. The defect in textile can reduce its 40- 60 percent price of the product. In order to reduce the inspection time and increase the accuracy of the inspection process computerize inspection [16] using artificial neural network can be use. Using computerize inspection process can achieve the good quality of knitted fabric in the short interval time [6], this help to increase the productivity of the manufacturing process. For the computerized inspection process [7], two types of neural networks are undertake in the project. They are Convolution Neural Network (CNN) [9] and Multi-Layer Perceptron (MLP) [1] in deep learning. The MLP is the feed forward neural network, it use supervised learning technique that collect the errors while training, and with the collected data, the backpropagation is use for training. The knitted fabric defective and defect free images are collect from the Sky Cotex India Private Limited, Tirupur, India. The images are classify to defective and defect free images are use it as input for the neural network. There is n no of neurons in the hidden layer, which help to train the neural network. The performance of the neural network is calculate from the output layer. With the trained neural network, can able to calculate the efficiency of the neural network, which help to find the suitable neural network for the knitted fabric inspection process [5]. The high effective neural network is use for the knitted fabric inspection process that increase the accuracy of the process and reduce the processing time that increase the productivity of the knitted fabric manufacturing.

2. Methodology

To train the convolution neural network and multi-layer neural network [8] in deep learning. With the trained neural network to identify the efficiency of the neural network to identify the suitable neural network for the knitted fabric inspection process. The convolution neural network is train, test using the Teachable machine a web base tool and for multi-layer perceptron train and test using the python spyder in anaconda software. The data flow of the process is show in the Figure 1.

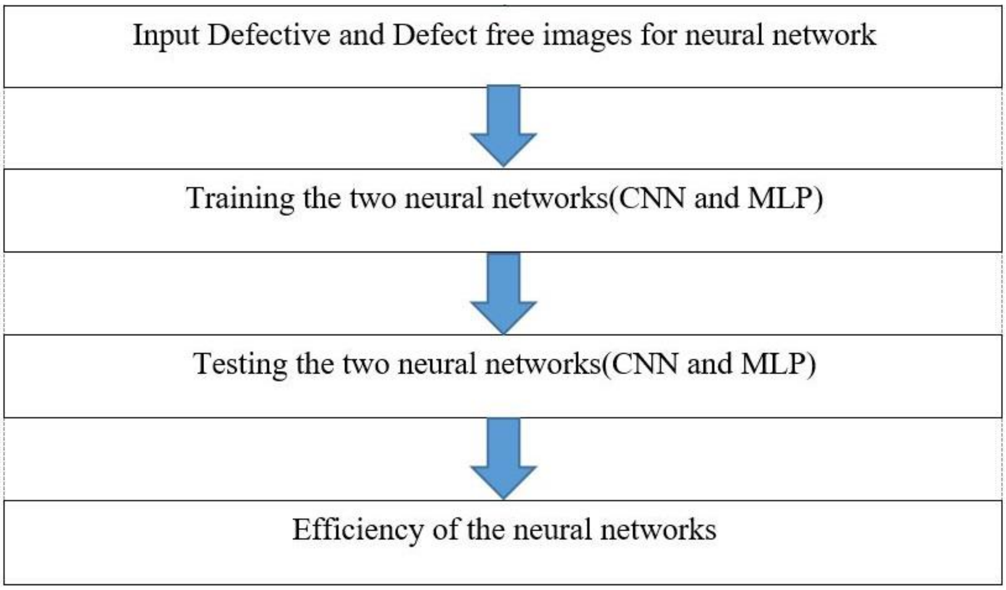
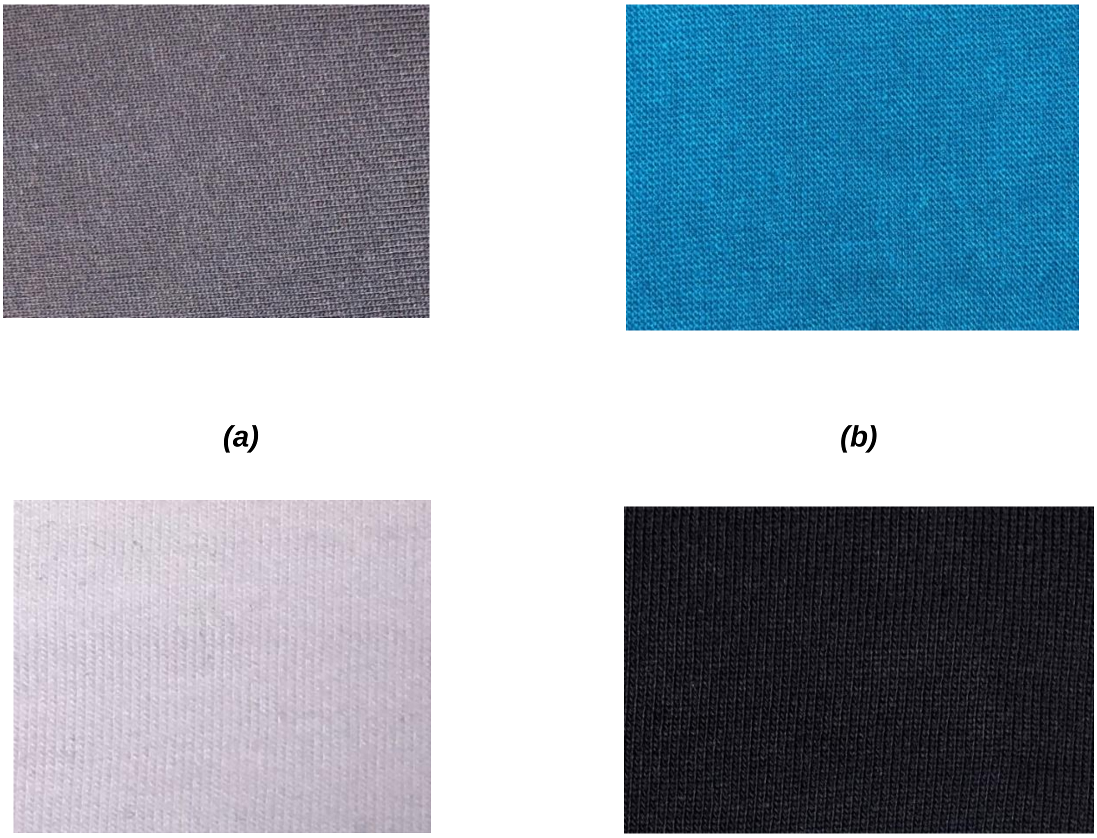


Figure 1. Data flow diagram of the process

2.1. Input images

The input defective and defect free images are collects from Sky Cotex India Private Limited, Tirupur. The input images are captures from the high quality images sensing device. The images are transfer to the computer system for training the two type of neural networks. The collected images are classifies to defective and defect free images for training the neural networks. There is 29 defect free images and 112 defective images are use as input for training the two type of the neural network (CNN and MLP). For testing 40 images are used. The defect free knitted fabric images are show in the Figure 2(a), (b), (c), (d). The defective images like holes, patches, stain, folding mark and seam joint are show in the Figure 3(a), (b), (c), (d), (e).



(a) *(b)*

(c) *(d)*

Figure.2 (a), (b), (c), (d). Defect free knitted fabric

(a)

(b)

(c)

(d)

(e)

Figure.2 (a), (b), (c), (d). Defects Holes, Patches, Stain, Folding mark and Seam joint

2.2. Training of neural network

The two neural networks (CNN and MLP) is train using 29 defect free fabric images and 112 defective images. For training the two neural network, the epochs value and learning rate change for getting good results. One epoch means that each and every input images in the training dataset has been fed through the training model at least once. The epochs value for convolution neural network and multi-layer perceptron are set as 100. It means that the model is train with the dataset 100 times. The large no of epoch better the model is learn to predict the defective and defect free images. The learing rate for the convolution neutal network is set as 0.001 and for multi-layer perceptron is set as 0.0001. The images used for training and testing is show in the Table 1.

Table 1. Images used

S.no	List	No of Image
1	Defect free images	29
2	Defective Images for Training	112
3	No of Images for Testing	40
4	Total No of Images	181

2.2.1. CNN parameter for training neural network

Epochs- 100

Learning Rate- 0.001

Time taken to train the Conventional Neural Network is 16 sec.

Mathematical calculation of CNN is express below:

V[0,0,0] = np.sum(X[:5,:5,:] * W0) + B0

V[1,0,0] = np.sum(X[2:7,:5,:] * W0) + B0

V[2,0,0] = np.sum(X[4:9,:5,:] * W0) + B0

V[3,0,0] = np.sum(X[6:11,:5,:] * W0) + B0

W0 represent weight vector and neuron size assume, the operator * represent the multiplication of each array with each element. V represent the output volume and B0 is represent the bias.

V[0,0,1] = np.sum(X[:5,:5,:] * W1) + B1

V[1,0,1] = np.sum(X[2:7,:5,:] * W1) + B1

V[2,0,1] = np.sum(X[4:9,:5,:] * W1) + B1

V[3,0,1] = np.sum(X[6:11,:5,:] * W1) + B1

V[0,1,1] = np.sum(X[:5,2:7,:] * W1) + B1

V[2,3,1] = np.sum(X[4:9,6:11,:] * W1) + B1

The second deep index of the output volume is denoted as V. For calculating the second deep index, different set of parameters are use. B1 represents the bias and W1 represents weight vector.

2.2.2. MLP parameter for training neural network

Epochs- 100

Learning Rate- 0.0001

Time taken to train the Multi-Layer Perceptron is 135 sec.

Mathematical calculation of MLP is expressed below:

$$a = \varphi \sum_{j} w_j x_j + b$$

Where x_j the input to the unit, the weight of the neurons is w_j, b is the bias, the non-linear activities of function is φ and a is the unit activation.

2.3. Testing neural network

After the training of two neural network is complete, 40 images are used for testing the efficiency of the convolution neural network and multi-layer perceptron. The efficiency percentage is used to identify the suitable neural network for the knitted fabric inspection process.

3. Experiments result

3.1. Accuracy per epochs

The accuracy per epochs describe the how effectively the model get right during the training process. For the perfect model prediction, the accuracy is 1, otherwise it show the value lesser then 1. The accuracy per epochs of convolution neural network and multi-layer perceptron is show in the Figure 4 and Figure 5 respectively.

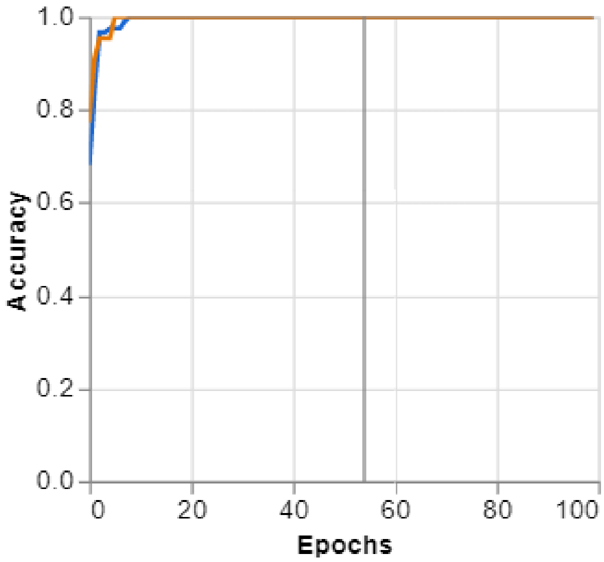


Figure 4. Accuracy per epochs in CNN

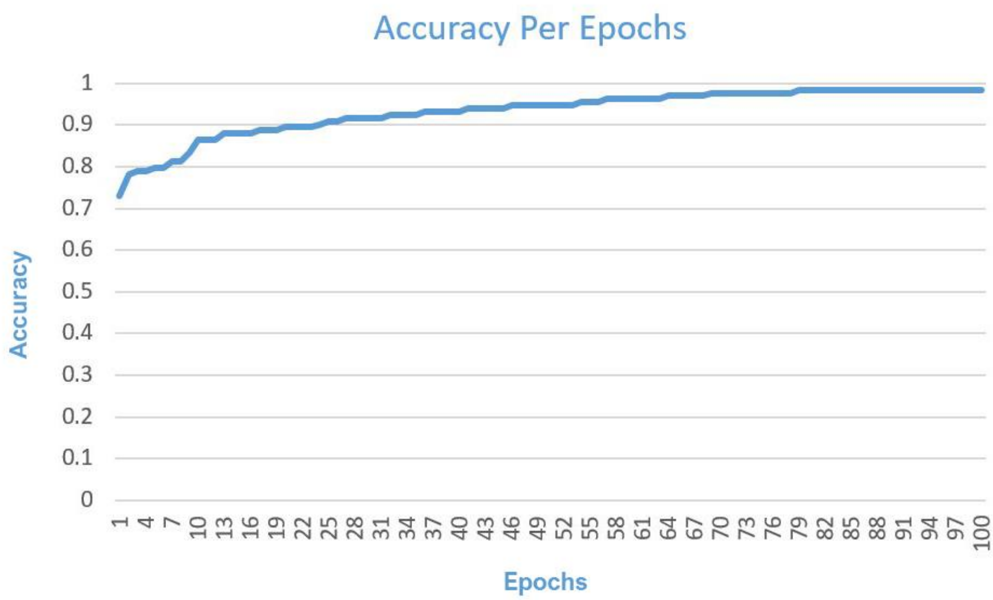


Figure 5. Accuracy per epochs in MLP

3.2. Loss per epochs

The loss per epochs is measure to calculating how the learned model has to predict the right classification for the defective and defect free data set in training. If the model predictions are perfect, the loss per epochs is zero, otherwise the loss per epochs is higher than 0. The loss per epochs of convolution neural network and multi-layer perceptron is show in the Figure 6 and Figure 7 respectively.

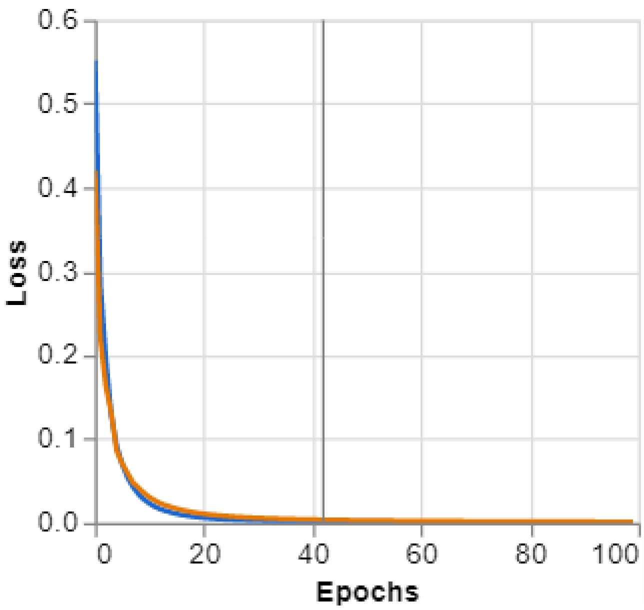


Figure 6. Loss per epochs in CNN

Figure 7. Loss per epochs in MLP

4. Result and Discussion

The 40 images are test in the trained convolution neural network and multi-layer perceptron neural networks. In conventional neural network, among 40 images, 37 images are spot accurately and 3 images are spot with low accuracy. And in multi-layer perceptron, among 40 images 33 images spot accurately and 7 images are spot with low accuracy. Experiment detail is show in the Table 2.

Table 2. Experimental result

Types of ANN	Training Time in Sec	Total Test Images	Accurately Spotted	Percent Classification
CNN	16	40	37	92.5%
MLP	135	40	33	82.5%

The efficiency of the knitted fabric defect detection in convolution neural network show higher efficiency 92.5 percent and training time 16 sec and in multi-layer perceptron efficiency 82.5 percent and training time 135 sec. The convolution neural network is get high accuracy with low training time then multi-layer perceptron.

5. Conclusion

In this paper, automatic defect detection in the knitted fabric is using Convolution Neural Network (CNN), Multi-Layer Perceptron (MLP) has trained by carried out several experiments to get accurate result, and the efficiency of the neural networks has calculated. The efficiency of the CNN is 92.5%, the training time is 16 sec and the efficiency for MLP is 82.5%, the training time is 135 sec. The Convolution Neural Network has the high accuracy, low processing time then Multi-Layer Perceptron. This artificial neural network is use to identify the defects in the knitted fabric inspection process in order to reduce the labour wages and processing time. This automatic defect detection in knitted fabric can be use to identify defect with high accuracy.

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