OPTIMIZING WOVEN FABRIC INSPECTION USING IMAGE PROCESSING AND ARTIFICIAL NEURAL NETWORK AT CV. MAEMUNAH MAJALAYA

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Abstract

CV. Maemunah Majalaya is one of Textile Industry in Indonesia, they produce woven fabrics which will be exported to Japan. To maintain the quality it needs quality control such as inpection process. The inspection process of woven fabric still using traditional method that makes unbalance between inspection capacity and production volume. The production volume of fabric is more than 20.000 meters of fabric that should be produced every week but there is just four inspection station with two person in each station and the capacity of each station is 23 s prescreen. It caused the massive bottleneck in inspection station it is affect to the time for management to deciding strategy for fulfilling order just in time and shipment delays. In this research automation system with image processing technique and artificial neural network were used to optimize inspection process by decreasing inspection time and increasing the detection rate. Neural network models are preferred for image-understanding tasks because of their parallel-processing capabilities as well as learning and decision making abilities. The input for neural network model is come from the GLCM and edge feature extraction. The purposed method provide better result in classifying fabric defect. Using 90 data that divided into data test, data training and validation provide overall accuracy 83.9% and average processing time 3.4 second. Therefore, using automated fabric inspection can decrease process time 16 second.

Keywords : Textile Industry, Inspection Process, Automation, Image Processing, Genetic Artificial Neural Network, GLCM Feature Extraction.

1. Introduction

Nowadays, fabric inspection in Indoneisa still using the traditional technique or using human visualization, this traditional technique who use human visualization has low detection rate only up to 70% and traditional technique easily influenced by subjective factors of inspection worker. Traditional technique also need more time because sometimes inspection worker has to double checking because worker doesn't sure enough about the result of the previous inspection [1]. Development of computer hardware is rapidly increasing, today's computers are not only used to simply helping people work, However the start to be operated as a decision support system that petrified solve problems in the process of decision making by an individual or group[1].

The number of textile industry in Indonesia, from 708 textile industries, 355 located in West Java. West Java as the central textile industry has many industry area, one of them is Majalaya. CV. Maemunah one of textile industry that located in Majalaya. It produce many kind of fabric based on the order from the other company, usually the order comes from Japan.

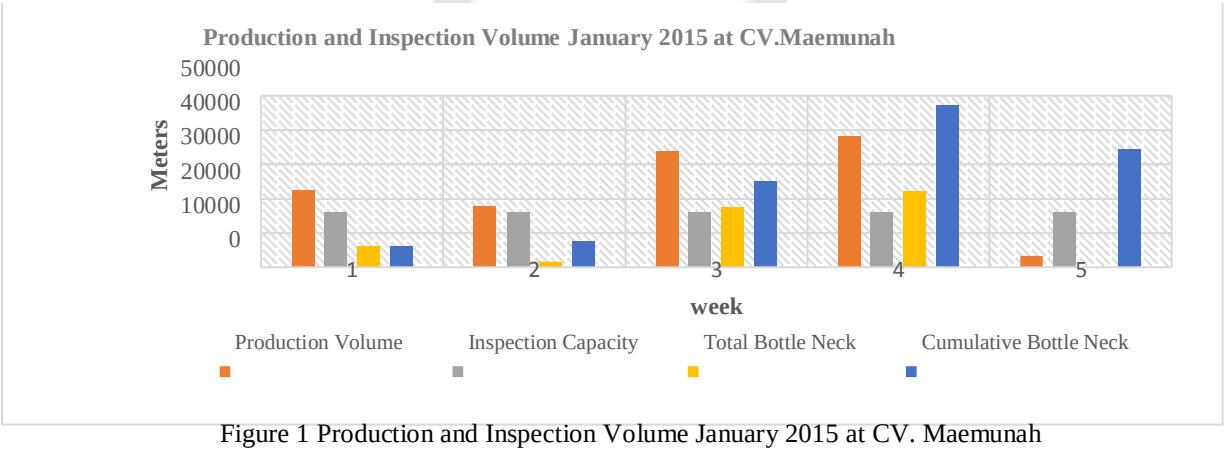

Figure 1 Production and Inspection Volume January 2015 at CV. Maemunah

Based on Figure 1 it can be seen that the production volume of fabric increase every week and more than 20000 meters of fabric should be produced every week. Moreover, the critical problem that can be seen from the Figure 1 is the inspection capacity is not balanced with the production volume, since the inspection process still use the manual or traditional inspection and there is just four inspection station with the capacity from each station is 30 meters per hour it caused the massive bottleneck in inspection station it is affect to the time for management deciding the strategy for fulfilling order just in time and shipment delays.

Many kind of defect that can appear in woven fabric, based on Table 1 *Amrol* is kind of defect that usually appear, the characteristic of *Amrol* same as broken yarn and *Rabuk* same as unwoven yarn in SNI.

Table 1 Total Fabric Defect Rank in January 2015 at CV. Maemunah Majalaya

NO	FABRIC DEFECT RANK	TOTAL FABRIC DEFECT (Point)	% FABRIC DEFECT
1	*AMROL*	1,445	16.98
2	*RABUK*	1,302	15.30
3	*KANJIAN Meter Kurang*	976	11.47
4	*KANJIAN Tanda ke Tanda*	684	8.04

The example of defect that usually appears on the fabric it shows on Figure 2 there are Defect *Amrol* (Broken yarn) and *Rabuk* (Unwoven yarn).

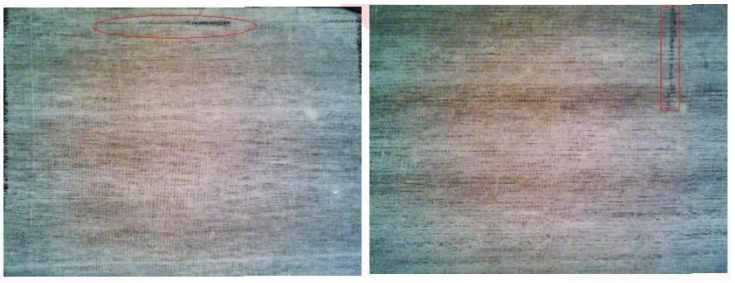

Figure 2 Defect *Rabuk* Unwoven Yarn (left), Defect *Amrol* Broken Yarn (right)

The development of inspection process is needed to minimize the waiting time and accuracy loss, so the management can make decision for production strategy faster than before. One of the development of inspection process it can be using the automation system that integrated with computer technology. So the human factor, and the waiting time will be decreased. Automated vision system can be conducted to solve this problem, and its also supported by many algorithm and techniques, one of them is Neural Network. Neural network models are preferred for image-understanding tasks because of their parallel-processing capabilities as well as learning and decision making abilities. Because of that the research about Optimizing Fabric Inspection using Image Processing and Artificial Neural Network at CV. Maemunah will be developed inspection system that can reduce inspection time and accuracy loss.

2. Literature Review and Research Methodology

2.1 Literature Review

2.1.1 Computer Vision

Computer vision is a process of recognizing objects of interest in an image, and it can be described as the automatic logical deduction of properties of three dimensional objects from either a single image or multiple image. There are some steps in computer vision, the system consists of six stages: image acquisition, processing, feature extraction, associative storage, knowledge base, and recognition.

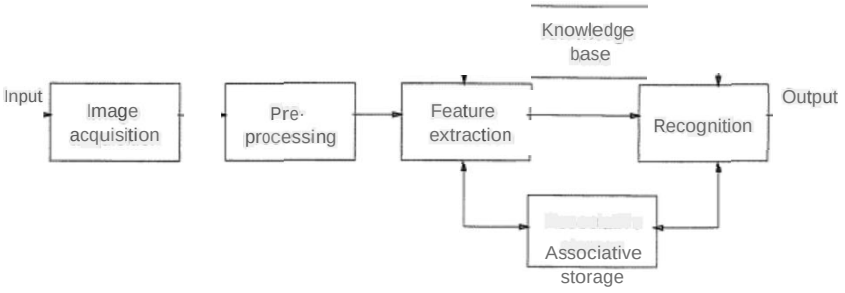

Figure 3 Computer Vision Process (Kulkarni, 2001)

1. Image acquisition, or acquiring a digital image, digitized image can be considered as a matrix in which each row and column identifies a point in the image and the corresponding matrix element value represent the gray level at that point, the element of a digitized array is called picture element or pixels
2. Pre-processing is related to low level processing, there are several techniques for this stage, like grayscale manipulation, noise filtering, isolation of regions, geometric correction, Brightness and contrast, restoration reconstruction, and segmentation. It usually called image enhancement, it is necessary to get the better quality of image. [5]
3. Feature extraction, many techniques that already developed for feature extraction. These include the fourier transform, moment invariants, the wigner distribution, the hough transform, orthogonal polynomials, gabor functions, Grey Level Co-Ocurance Matrix (GLCM), etc
   Grey Level Co-Occurrence Matrix or usually called GLCM, is one type of feature extraction. GLCM often used to extract feature from image that shows the texture like smooth, silky, rough, and etc. The feature of GLCM got from calculating the second order of statistics, first order calculating GLCM is measure image values like variance and the second order is defining the relationship between two pixels in the original image.[6]
4. ANN consist of some neuron. Neurons will transform input that accepted by other neuron. This input is sent to the neurons with a specific weight of arrival and processed by the propagation function that will sum all grades weights come. The sum of all the weights will be compared with the value threshold (threshold) given through the activation function of each neuron. If the input is not passes a certain threshold value, the neuron will not be activated. If the input passes a certain threshold value, the neuron will be activated so that the neuron will send output through weights output to all the neurons associated with it. ANN layers include input layer (input layer), hidden layer (hidden layer), and the output layer (output layer). Layer input is a place to enter data. Hidden layer located between the input layer and output functions to process the input. the output layer is where the output of the process over the network or operating results ANN. The output of the output layer is a value that is the result of the activation function.

2.2 Research Methodology

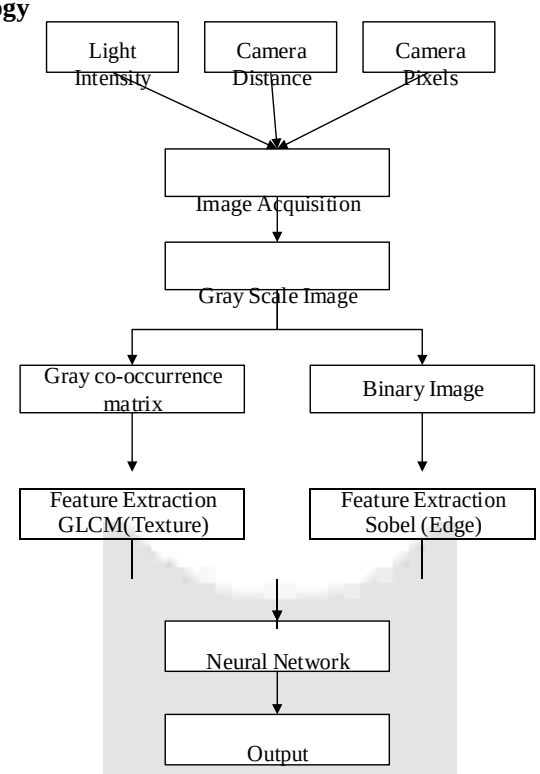

Figure 4 Conceptual Model of Research

Image Acquisition is the first stage of every vision system. There are many tools that can used in this stage such as, cam recorder, camera digital, etc. This stage affected by some factor like light intensity, camera distance and camera pixels, to get the best image that will be processed the factor must be adjusted. Setting to adjust the factor is based on the design of experiment result.

The acquired image must be converted into gray scale to eliminate the hue and saturation information while retaining the luminance.

Feature Extraction using GLCM Method [3]

1. Energy is sum square of GLCM elements, it can calculate by using Equation

$$E = \sum_{i=1}^{N} \sum_{j=1}^{N} \{p(i,j)\}^2$$

$p(i,j)$ is and input on GLCM row i and column j
N is the sum of Grayscale

2. Contrast shows the variance between grayscale on an image

$$Con = \sum_{i=1}^{N} \sum_{j=1}^{N} (i-j)^2 p(i,j)$$

$p(i,j)$ is and input on GLCM row i and column j
N is the sum of Grayscale

3. Correlation is a value from calculating grayscale based on the linearity between pixel

$$Corr = \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} (ij) p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y}$$

With

$$\mu_x = \sum_{i=1}^{N} \sum_{j=1}^{N} i \, p(i,j)$$

$$\mu_y = \sum_{i=1}^{N} \sum_{j=1}^{N} j \, p(i,j)$$

$$\sigma_x = \sqrt{\sum_{i=1}^{N} \sum_{j=1}^{N} (i-\mu_x)^2 . p(i,j)}$$

$$\sigma_y = \sqrt{\sum_{i=1}^{N} \sum_{j=1}^{N} (j-\mu_y)^2 . p(i,j)}$$

$p(i,j)$ is and input on GLCM row i and column j
N is the sum of Grayscale

4. Difference Variance

$$Dv = var(p_{x-y}(k))$$

With

$$p_{x-y}(k) = \sum_{i=1}^{N} \sum_{j=1}^{N} p(i,j); |i-j| = k = 0,1, \ldots N-1$$

$p(i,j)$ is and input on GLCM row i and column j
N is the sum of grayscale

Binary image is type of image that the value in each pixel just two possibilities there are one or zero, one determines the white color and zero determine the black color, this type of image usually used for feature extraction in edge detection, based on the result of Design of Experiment on the previous research to get the optimum binary image it needs to increase 47 point of contrast before converting into binary image.

This research using Sobel edge feature extraction, because this kind of technique can determine the difference between vertical and horizontal element on an image. It used to know dots that has value one or white, to make the dots or the white line stronger it needs imfill operation so the dots that represent the defect area easier to analyze or see. After that each defect will be identify and calculated based on the direction vertical or horizontal.

Neural Network Architecture

Artificial Neural networks have been developed as generalization of mathematical models of human cognition and showed promise for solving difficult problems in areas such as pattern recognition and classification. A neutral network consists of a group of simple elements called neurons which process the input information. These neutrons are connected to each other with links carrying the signals between them. There is a weight for each connection link (W) which acts as a multiplication factor the transmitted signal ($\Sigma\theta$). An activation function (F) is applied to each neuron's input to determine the output signal (O). Bias terms can be presented to solve specific problem with obvious result-tendencies. [2]

Using neural networks as a classifier requires two phases –a training phase and a testing phase. In the training phase, the neural network makes the proper adjustment for its weights (W) to produce the desired response. When the actual output response is the same as the desired one, the network has completed the training phase (i.e. it has acquired knowledge). In the testing phase the neural network is asked to classify a new set of images and its success is evaluated. In this work the neural networks were trained by the "backpropagation" algorithm to detect and classify the woven fabric defects. The feature vectors were used as the input vectors to the Neural Network. [2]

3. Result and Discussion

3.1 GLCM Feature Extraction Result

These are the result of 15 variable GLCM Feature Extraction that will be the input for the artificial neural network. But not all of the variable will be the input for artificial neural network.

Table 2 Result of GLCM Feature Extraction

No sample	Entropy (entro)	Homogeneity (homom)	Vairance (sosvh)	Sum Average (savgh)	Sum Variance (svarh)	Difference Entropy (denth)	Vertical n	Horizontal k
30	0.8662	0.9779	19.7802	8.8707	65.5022	0.181	6	10
31	0.7205	0.9802	18.0902	8.4939	61.558	0.1664	6	9
32	0.853	0.9787	19.5334	8.8156	64.7998	0.1761	10	3
33	0.8532	0.9788	19.5833	8.8268	64.9751	0.1752	4	6
34	0.8683	0.977	19.6725	8.8467	65.0963	0.1865	10	15

Table 3 Result of GLCM Feature Extraction (Continue)

No sample	Autocorrelation (autoc)	Contrast (contr)	Correlation (corrm)	Cluster Prominence (cprom)	Cluster Shade (cshad)	Dissimilarity (dissi)	Energy (energ)
30	19.8961	0.0442	0.9102	0.9884	0.2364	0.0442	0.4661
31	18.2029	0.0395	0.8939	1.2184	0.6923	0.0395	0.5899
32	19.6494	0.0426	0.9119	1.0408	0.3304	0.0426	0.4761
33	19.6995	0.0423	0.9128	1.01	0.3137	0.0423	0.4744
34	19.7873	0.046	0.9059	0.9989	0.2768	0.046	0.4678

3.2 Artificial Neural Network Architecture

The input layer on Neural Network Architecture consist of 6 neurons that represent the data from GLCM and sobel feature extraction there are autocorrelation, cluster shade, energy, variance, number of object on horizontal and, vertical.

Hidden layer is the black box on ANN method, there is no precision calculation for the number of hidden layer to get the optimum number of hidden layer it needs to do the trial and error.

Number of neuron in output layer is based on the number of output or classification that will used, in this research there is three output neuron there are normal, unwoven yarn and broken yarn.

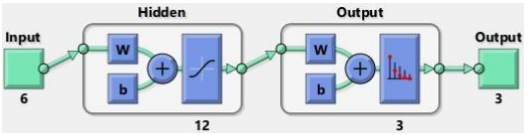

Figure 5 Neural Network Architecture

Table 4 Output from Artificial Neural Network

No sample	ANN Output			Biner Conversion			Target		
	O1	O2	O3	O1	O2	O3	O1	O2	O3
30	0.0001035	0.9997829	0.0002373	0	1	0	0	1	0
31	0.1509399	0.7571871	0.0929205	0	1	0	0	1	0
32	0.000304	0.9625679	0.0355862	0	1	0	0	1	0
33	0.0001111	0.9991959	0.0008581	0	1	0	0	1	0
34	0.0003713	0.9995183	2.26E-06	0	1	0	0	1	0

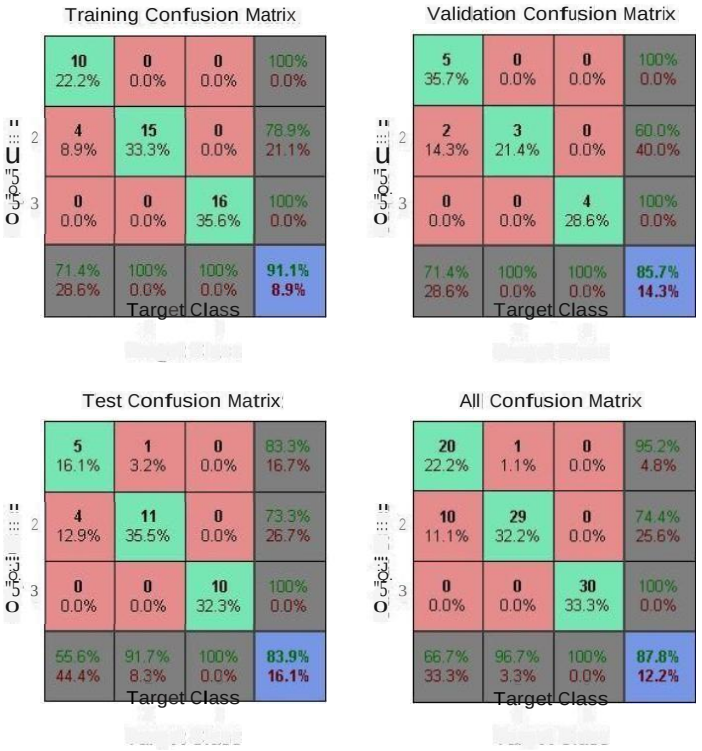

Figure 6 Confusion matrix for Training, Validation, Test, and Summary of ANN

4. Conclusion

In order to optimize the woven fabric inspection on inspection station in CV. Maemunah Majalaya, Image processing and artificial neural network is being applied in the proposed improvement to replace the human resource in the inspection process. The use of automation provides better result on identifying classification for each woven fabric. Proposed system produce an overall accuracy 83.9%% and reduce inspection time 16 second

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