OPTIMIZING WOVEN FABRIC DEFECT DETECTION FOR INSPECTION USING IMAGE PROCESSING AND FUZZY LOGIC AT CV. MAEMUNAH MAJALAYA

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Abstract

West Java has the largest number of textile industry in Indonesia. One of the companies that engaged in textiles is CV. Maemunah which located in the district of Ibun, Majalaya Bandung. The product of CV. Maemunah has been exported to Japan. To require fabric export best quality is needed to compete with other country. For to get the best quality of product needs to consider their quality control. In The inspection process still manually used four inspection stations with two workers in each station and average 23 second processing time needed inspection per screen. Therefore, unbalance of production volume with inspection process. The effect is bottle neck in inspection process. Inspection Process in CV. In this research proposed designing automated fabric inspection using image processing and Fuzzy Logic Model. Undertake extraction using GLCM to get value of autocorrelation, cluster shade and number of object. The proposed fabric inspection using Fuzzy Logic implemented with MATLAB provides better result in identifying fabric defect and optimizing process time. Using 35 data test produces an overall accuracy 82.86% and average process time 2.528 second. Therefore, using automated fabric inspection can decrease process time 17 second.

Keywords: Automated Fabric Inspection, Fabric Defect Detection, Image Processing, Fuzzy Logic Model

1. Introduction

Industri Tekstil dan Produk Tekstil (TPT) in Indoensia has an important role in improving the economy of Indonesia, as a foreign exchange earner in the export of non-oil sector [1]. In 2014 Indonesia contributed $ 12.72 billion of the GDP from non-oil industry. Currently Indonesia dominates for 2% of the textile trade world. By expand for export destination to the United States and the European Union, an estimated 2015 value of textile export reached 5%.

In order to fulfil export demand in the field of textile industry and clothing required product quality that can compete with other countries. To get the best quality of product needs to consider their quality control process. In the quality control process, it needs an inspection process that aims to fulfil the test method and assessment of defect and woven fabric that fits on SNI 08-0277-1989 standard.

Currently in Indonesia fabric inspection process is traditionally using human vision. This technique can only detect fabrics to 70% [2]. The inspection process is traditionally being certainly very difficult and requires a relatively long time, because of the limitations on human vision and the differences perception between person [3]. Increasingly development of technology and image processing are now widely used in helping to resolve problems in the inspection process.

To fulfill export standard CV. Maemunah divided the fabric into three grades. The first is grade A product quality that is less than 70 points defect, the second is a non-standard grade same with grade A but the length less than qualification request, the both grade are able to fulfill export standard. And the third is grade C with defect more than 70 points.

In the inspection process still manually using four inspection stations with two workers in each station. In the inspection process of each station is only capable of performing inspection by an average 30 m fabric per hour. Based on Fig. 1 the production volume is more than 20,000 m every week and can not all be inspected. So the effect is the accumulation on the inspection process and delays in the delivery process.

This research designing a system that focus on the automation of the inspection process to identify fabric defect. The purpose is to support the automation system to identify fabric defect using fuzzy logic model by replacing the function of the human vision into a digital image processing. This automation system design becomes important, because it is attractive to reduction in personnel cost and associated benefits are considered [4]

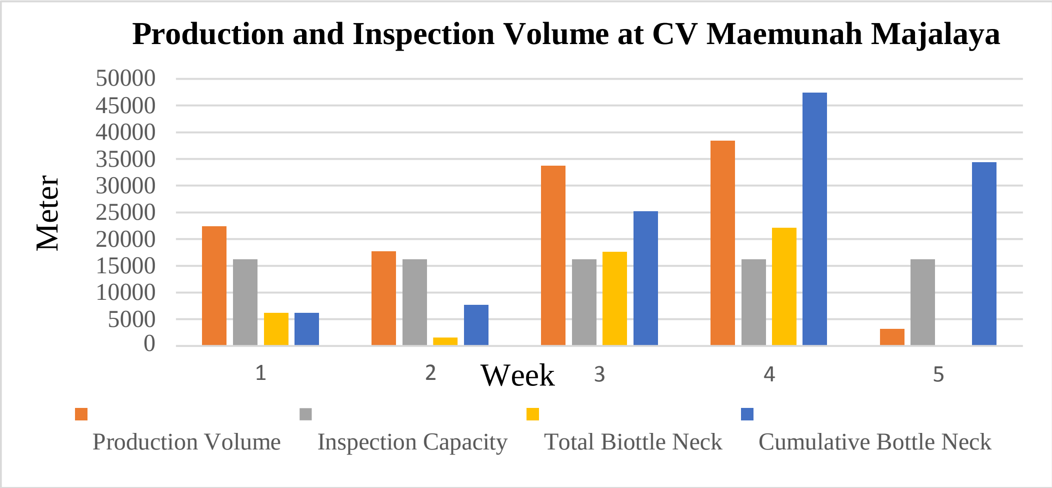

Fig 1 Production and inspection volume on January 2015

2. Literature Review

2.1 Textile Industry

The Indonesian TPT sector divided by three sectors, there are upstream, midstream, and downstream. Upstream industry involves producers of input (cotton, acrylic, rayon fiber, polyester) for non-woven manufacturing, spinning and weaving industry. Output of midstream TPT industry are processed by garment and polyester manufactures. Illustrated shown in Table 1

Table 1 Industrial Structure of TPT in Indonesia

Industry Structure	Sector	Industrial Characteristics
Upstream	Natural Fiber, Fiber Making (Man-made fiber)	Capital-intensive, full automatic technology, Very high energy, Product natural fiber, synthetic fiber, rayon fiber.
Midstream	Spinning, weaving, knitting, dyeing/ printing/ finishing	Semi-capital, modern technology, workforce is larger, high energy absorption, product thread, yarded fabric (woven & knitted), and finishing fabric
Downstream	Garment, other textiles product/ household	Labor-intensive, growing technology, high flexibility with various end-product consumers, product clothing, pillow sheet, curtains, blankets, car seats, tents, carpets, etc.

2.2 Quality of textile

Defects in the fabric is a disorder that appears on the surface of the fabric visually. According to ISO 08-0277-1989 defects in the fabric are grouped into seventeen types of fabric disability groups. This is nep, slub, *benang tidak rata*, broken yarn, tense or loose yarns, crease, line-shaped *lusi*, line-shaped *pakan*, pattern false, bare, *belang*, broke, unwoven yarn, stain, width defect, *pakan bias*, edge defect.

2.3 Gray Level Co-occurrence Matrix

Gray Level Co-occurrence Matrix (GLCM) method is a way extracting second order statistical texture features. The concept of Gray Level Co0occurence Matrix is introduced with one simple example. The GLCM measures the frequency of different combinations of pixel brightness values (gray levels) occurring in an image.

2.4 Fuzzy Logic System

Fuzzy Logic system has been used problem solving such as control, pattern identification, and image processing. Applying a Fuzzy Logic approach to an image processing system brings Fuzzy Logic properties such as [5]: The block diagram of the fuzzy logic process is shown in the Fig. 2

- Great flexibility, due to the ease of modifying or adding more functionality to the system
- Great tolerance of imprecise data
- Experience of human expert can be used as scaffolding
- Fuzzy Logic is based on natural language, natural language has evolved over the centuries to be convenient, easy and efficient, therefore it is safe to assume that Fuzzy Logic is also easy to use when compare to other methods.

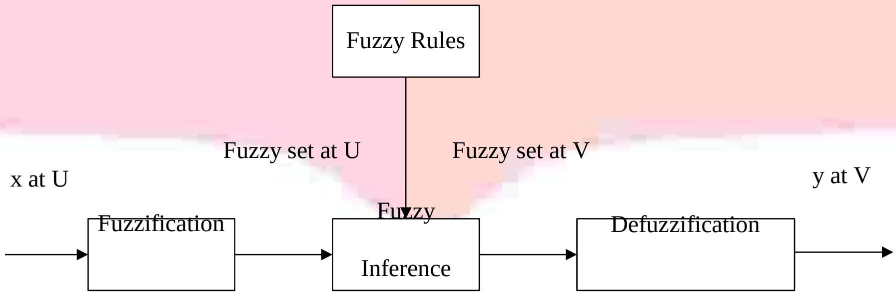

Fig 2 Fuzzy Logic Process

2.5 Automation System

Automation is the technology which can perform a series of process or procedure automatically without human assistance. It implemented with execute a list program of instruction which combined by a control system in perform the instruction [6]. Automated system builds from three basic elements such as power, program, and control system illustrated in Fig. 3

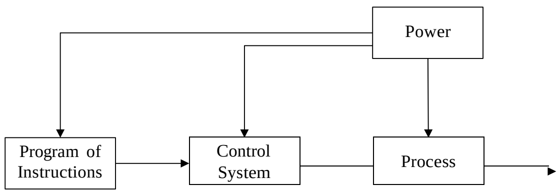

Fig 3 Elements of automated system

1. Power
   Power is basic element which is required and used to operate some process and drive all of the component in the automation system.
2. Program of Instruction
   Program of instruction is element required to operate control of the process from list of program and used to direct the operational of automated system.
3. Control System
   Control system is an element to execute program of instruction and to accomplish the process from each automation elements.

3. Research Methodology

This section describes the methodology of the system. In this research, the identification process is done by Fuzzy Logic. The steps of identification process are shown in Fig. 4 below:

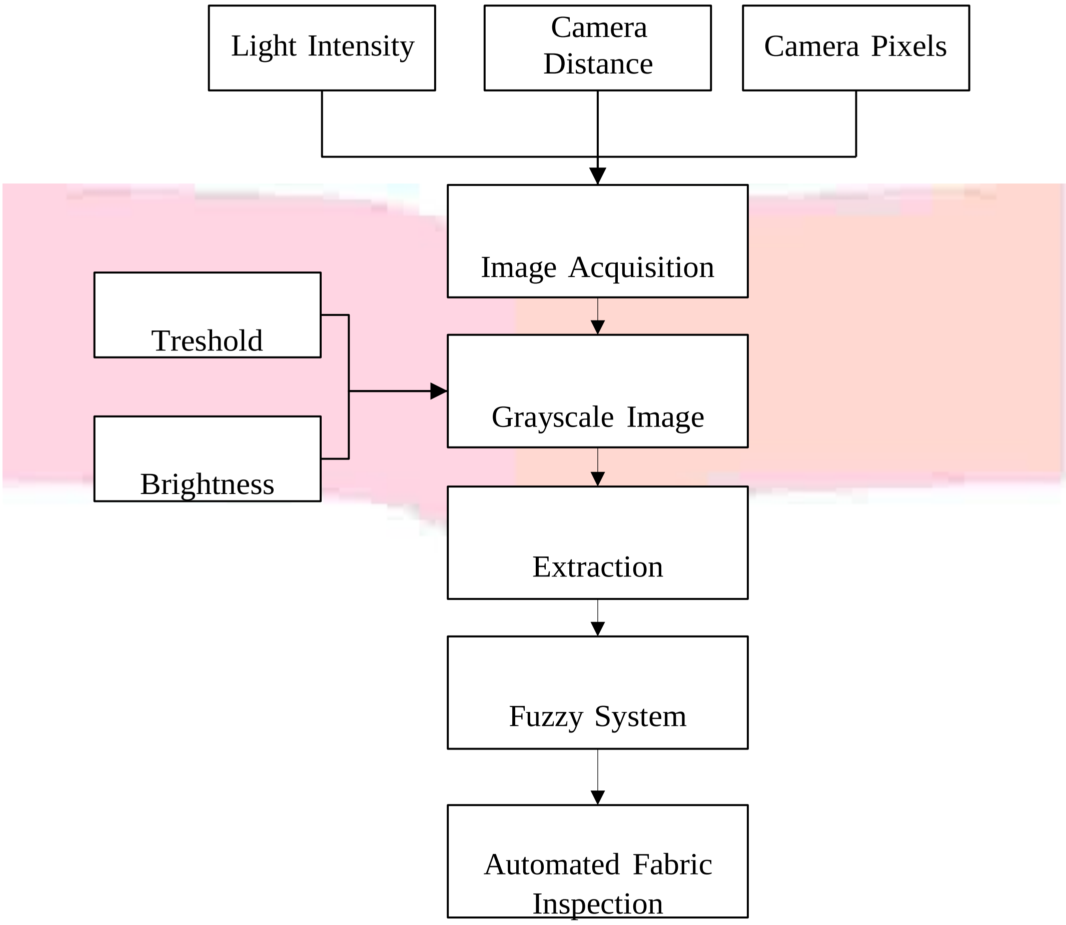

Fig 4 Conceptual Model of Research

Image acquisition process is the first step in vision system. This step can be affected by many factors, such as as light intensity, camera distance, and camera pixels. To setup these factors according to previous research is using focus in Design of Experiment (DoE).

The next step is converted into grayscale from RGB (Red, Green, Blue). This step uses two factors from Design of Experiment, there are threshold and contrast. Contrast in this research uses +47.

After converting in grayscale image, the next step is extraction image using GLCM (Gray Level Co-Occurrence Matrix). Feature extraction is a feature-taking process which describes the characteristic of the image. From GLCM we calculate the following attributes:

i. ***Autocorrelation:*** uses to known correlation between two different variables.
ii. ***Cluster Shade:*** to gauge of the skewness of the matrix and uniformity

Use edge detection to mark defect and account the number:

iii. ***Number of Object:*** uses image segmentation to calculate the number of labels in an image.

The next step is make fuzzy system [7]

1. **Fuzzification**, is the crisp values that are transformed into grade of membership for fuzzy sets, the crisp input values are tabulated shown in Table 2.

Table 2 Crisp Input Variables

Data	Range
Autocorrelation	18.9804 – 24.1985
Cluster Shade	-0.6706 – 1.2484
Number of Object	0 - 24

2. **Inference**, the truth value for the premise of each rule is computed, and applied to the conclusion part of each rule. This result in one fuzzy subset to be assigned to each output variable for each rule.
3. **Defuzzification,** is used to convert the fuzzy output set to a crisp number.

The last step to design automated fabric inspection is integrated image processing using fuzzy logic model, automation, human machine interface and database.

4. Result and Discussion

4.1 Fuzzy Logic Model

In this research, the textile defect identification captures digital fabric images, as shown in Fig. 5, by image acquisition (light intensity 463 lux, 8 megapixels, and 20 cm camera distances).

Fig 5 Original Defect (broken yarn) Fabric

Next step, to removes noise and then applies convert RGB (Red Green Blue) to grayscale image, illustrated in Fig.6

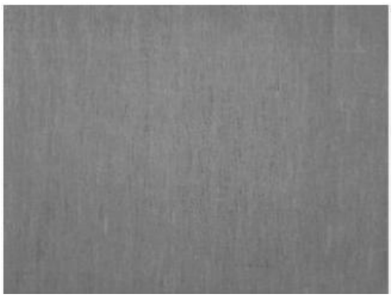

Fig 6 Grayscale image

After that convert grayscale image into binary image, illustrated in Fig. 7 Where blue is defect (broken yarn).

Fig 7 Binary Image

After successful, then calculates autocorrelation, cluster shade, and number of object using interface, illustrated in Fig. 8

Fig 8 Result extraction features

This result as an input set of the fuzzy logic. In this research, applied fuzzy uses Mamdani model. Using membership function to definition group fuzzy set shown in Table 3

Table 3 Result form extraction feature

Data	Result	Membership function	Fuzzy set
Autocorrelation	19.8961	0.6576	�
Cluster Shade	0.236435	0.7541	�
Number of Object	4	0.524	�
Fabric Identification	Defect		V�����

Based on Table 1 then the rules are from the extraction is:

"If autocorrelation is �$_7$ AND cluster shade is �$_3$ AND number of object is �$_3$ THEN fabric identification is V�����"

Variable input as antecedent and variable output as consequent. If they have same antecedent but difference consequent optimizing rules is needed with choose the biggest multiply membership function. In this research have 729 rules.

4.2 Defect Detection

For validating the result for the fuzzy model, 5 fabric sample are considered, in which 3 fabric defect sample. The proposed Fuzzy rule based method produces better result. Testing the model shown in Table 4 and interface illustrated in Fig.9

Table 4 Defect Detection Result

Detection Method	No fabric image samples	Number of True	Time
Based on Real Time Process	35	29	2.528
Based Fuzzy Logic	35	33	2.089

Fig 9 Result fabric defect identification

5. Conclusion

Fabric inspection is an important aspect to get best quality. For a long time, the fabric inspection process is still carried out with human vision, and thus make relatively perception. Therefore, automatic fabric inspection using image processing is required to reduce time and increase accuracy. Automated fabric inspection method and image processing using fuzzy logic with GLCM extraction to get autocorrelation, cluster shade, and number of object is proposed. Thus the proposed fabric inspection using Fuzzy logic implemented with MATLAB provides better result in identifying fabric defect. Textural features play a major role in determining the accuracy of identification. The above proposed system obtained an overall accuracy 82.86% and average process time 2.528 second of by considering 3 variable feature extraction. This is decrease 17 second from existing process.

6. References

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