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Automated Fabric Defect Detection

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Abstract: Fabric defect detection is a significant phase of quality control in textile industry. Manual defect inspection lacks the accuracy and the labour cost is high. Automating this process is challenging due to large number of fabric types and defect types. Large number of Fabrics defects have the characteristics of low contrast and unclear, manual detection is very tedious and is inefficient. In order to resolve the key technology problem of automated fabric defect detection, is to develop a system to detect defects in uniform texture fabrics with image processing techniques and Neural Networks. The results indicated that the use of light beams based on the color of the material is more efficient than the white light beam.
Keywords: Fabric Defect Detection, Image Processing, Neural Networks, Open CV, Light beam.

I. INTRODUCTION

Visual quality inspection of raw- materials is an important task in many industries. The importance is even higher in cases like the textile industry where the quality materials. Typically, these inspections are carried out by trained individuals making visual assessments. However, this method often suffers from a number of deficiencies arising from an individual's skill level, work fatigue and inconsistencies in their judgements. Automated visual inspection, on the other hand, solves these problems by providing a consistent and objective judgement on the visual properties of the material as well as improving the overall efficiency and throughput of the process. Method based on the neighbourhood association describes the relation of the current point and the neighbourhood point by a trained Neural Network. Image analysis techniques are being increasingly used to automate the detection of fabric defects in recent years. The traditional fabric inspection is done by manual visual inspection, with high labour cost and low efficiency. At present, the research of defect detection technology mainly occurs unmanned intelligent detection, its purpose is to develop a rapid and effective defect detection and positioning of the machine vision system. In this dissertation, it is mainly pointed out the defect segmentation.

The purpose of this paper is to use the Visual quality inspection of Raw- Materials. Raw materials used in many of the finishes consumer products are available in the form of web materials [1]. Even though these may take many forms, requirements for their visual inspection are common in many cases. The web materials are often divided into two broad categories as 'uniform' materials and 'textured' materials [2]. The first category, in general, includes materials with uniform surface properties such as paper and metals while the second includes materials with relatively rough surfaces including textile, plastic etc. In this paper, we focus on automated inspection of uniform textured materials.

II. FABRIC DEFECTS AND INSPECTION

The fabric is produced by weaving yarns in a knitting machine to form a textured material in a weaving mill. Even though the quality of this product is significantly affected by input yarn quality, inspections are usually carried only on the output at weaving mills [3] due to mechanical difficulties in interrupting the weaving process [4]. Defects can be located according to the location of abnormal position. Quality inspection can also be carried 'on-line' at the end of the weaving process or 'off-line' in terms of inspection the products like uniform weaving process completed. It must be noted that the size of the product is very important. Owning to the characteristics of the fabric during the weaving course and the flexibility of the fabric in itself, this paper focuses on the "online" inspection of the finished fabric.

Cotton Incorporated [5] has categorized fabric defects [6] to six main categories as vertical lines, horizontal lines, isolated defects, pattern defects, finishing defects and printing defects. Among these this paper prioritized Vertical Lines, horizontal Lines, and Isolated Defect categories. Most of the products contain the basic, defect-free pattern, while the surround operation is implemented in the model. Its essence is to first determine a feature extracted, such as slub, burl, holes, oil spots, and knots that are common in the weaving process.

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III. RELATED WORKS

Some of the early work on automation of fabric inspection process dates back to 1990s. Over the years many kinds of research have published their works related to vision-based automated fabric inspection using different techniques. Further, these works indicate the automated fabric inspection had been a topic that working on for many years. A lot of information shows that traditional threshold segmentation method cannot be used to real application. Then, use the content of it is extracted from feature integrate theory, that maps in multi scales, using the central difference operation was compared around the map.

These works differ if the techniques used as well as types if defects that researched. They have also recorded varying levels of the accuracies in detecting fabric defects. However, many number of samples used for the testing.

IV. PRE-PROCESSING AND FEATURE EXTRACTION

The main purpose of the pre- processing step is to correct the non- uniform illumination and image de- noising. The goal of illumination correction is to remove uneven illumination of the image caused by sensor defaults, non-uniform illumination of the scene, or orientation of the surface. Textile image pre-processing consists of correction of non-uniform luminously and contrast enhancement. In this work, we applied morphological operations and scale conversion method with help of the Open CV Library which is based on the main advantages of this method is the superior performance.

A. *Morphological Transformations And Images*

Morphology was defined in this paper as a set of images processing operations that process images based on shapes. The spatial threshold method defines a normal gray scale range, the number of pixels in the statistical sub window that exceeds that range, and checks to see if the child material contains the defect. Morphological method for defect fabric defects using corrosion and extended edge detectors, method based on the neighbourhood association describes the relation of the current point and the neighbourhood point by a trained neural network. Dilation and erosion are basic morphological operations. It also adds pixels to the boundaries objects in an image whilst erosion removes pixels on object boundaries.

1) *Characteristics of Erosion*

a) Erosion generally decreases the size of objects and removes small anomalies by subtracting objects with a radius smaller than structuring element. Also it must be noted that the size of the objects is very important.

b) With gray scale images, erosion reduces the brightness (and therefore the size) of bright objects on dark background by taking the neighbourhood minimum when passing the structuring elements over the image.

c) With binary images, erosion completely removes objects smaller than the structuring elements and removes perimeter pixels from later image objects.

2) *Characteristics of Dilation*

a) Dilation generally increases the sizes of objects, filling in holes and broken areas, and connecting areas separated by spaces smaller than the size of the structuring elements.

b) With binary images, deletion connects areas that are separated by spaces smaller than the structuring elements and adds pixels to the perimeter of each image object.

c) An opening is obtained by the erosion of an image followed by dilation whereas closing is obtained by the dilation of an image followed by an erosion.

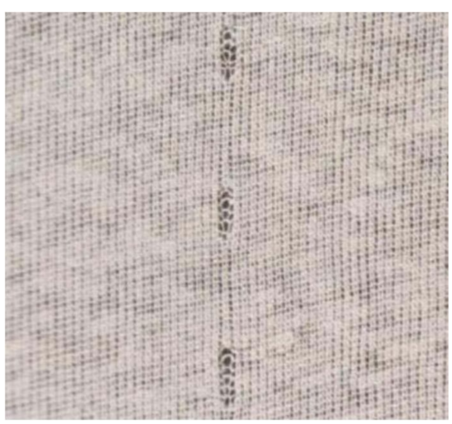

Fig 1: Original Image

Fig 2: Apply Morphology Operation

3) *Image Scale Conversion:* After application of morphological transformations, the scale of the image was converted into gray scale to reduce the noise. As the fabric samples used in this paper are raw-materials. For many applications of image processing, color information doesn't help identity important edges or other features. Gray scale is simply reducing complexity from a 3D pixel value to ID value. Threshold was used to create a binary image from a gray scale image.

Fig 3: Binary Image

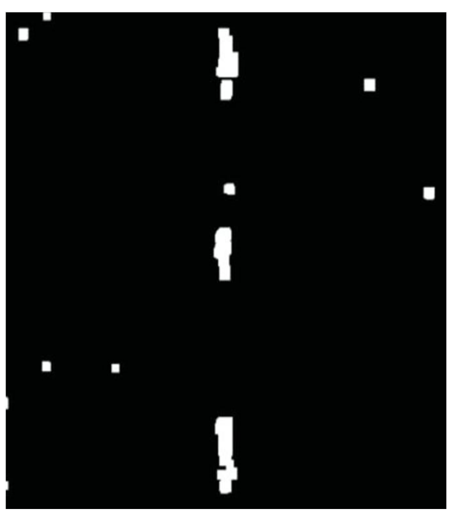

Fig 4: Apply Morphology Operations

B. Proposed Methdology

Proposed methodology consists of two sub-phases or two sub-systems.

1) *Embedded System:* A camera is used to continuously capture the images of the moving fabric with the resolution of 544x548. Role of the frame grabber was synchronized camera capture frequency with the velocity of the production line in order to capture the entire fabric. Fig. 6 illustrates the proposed prototype of the embedded system.

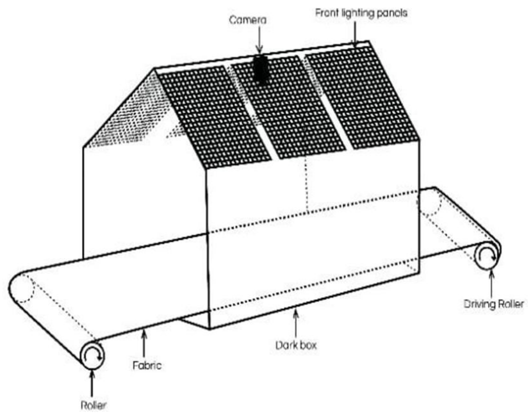

Fig 5: Proposed Prototype

This prototype represents the complete procedure of the fabric defect detection. There was one driving roller, which continues the rotating process of the fabric. The system can detect the certain number if defects. A sample fabric containing those defects was used for the prototype to demonstrate the system. Lighting is one of the key aspects of this prototype. Right now this Fig. 7 shows how a panel of lights that inclined to the production line have been used. This light panel includes red, green, blue, and UV lights. Specific lightning systems were used (rear lightning, black lightning, and UV lightning) to detect different defects. Fabric with the oil defects required UV lightning for detection and accurate classification. Lightning was required to capture the high quality image for applying image processing methods and defect classification process.

Fig 6: Light positioning in the prototype

2) *Defect ExtrAction And*

a) *Classification System (Server):* The present system performed Threshold and morphological operations on binary images of the captured images so that the noise of the images was reduced and defects were highlighted from the background. The algorithm has been implemented by Visual Studio 2015 using C++ with the help of Open CV Library. Since most of the methods in Open CV are highly optimized, the image acquisition processes required less time to execute. This program has been tested for the three defect types and will undergo further testing for other types. Next, the output of this process will be classified into a few selected categories, and a report with the defect categories and the location of the defect will be generated.

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V. RESULTS

Fig 7, 9 and 11 show the original image samples that were used from the fabric defect glossary created by Cotton Incorporated. The above described operations were applied to those images. Fig. 8, 10 and 12 illustrate the resultant images, which highlight the defects of the fabrics. Then these images were used as the inputs to the Convolution Neural Network.


Fig 7: Knot   Fig 8: Feature Extracted knot


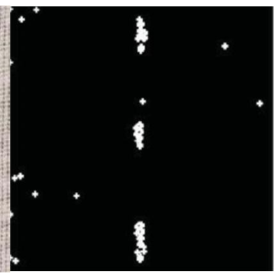

Fig 9: Dropped Stitches   Fig 10: Feature Extracted stitches

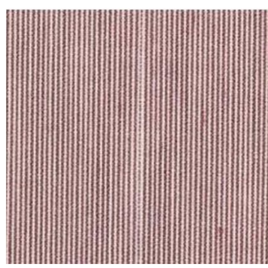
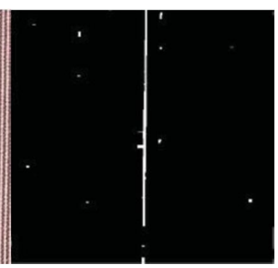

Fig 11: End Out   Fig 12: Feature Extracted stitches

It is observed that using a lighting condition similar to the color of the fabric is much more effective in image feature extracting process, rather than using a traditional white light beam.

Hole defect on a dodger blue colored fabric was captured separately under a white light beam and a dodger blue color light beam as shown in Fig. 13 and 15. Next, the captured image was processed using the prior mentioned pre- processing techniques as shown in Fig. 14 and 16. Feature extraction using Fig. 15 produced more accurate results than using Fig. 13 because defects were highlighted when the lightning condition was similar to the color of the fabric.


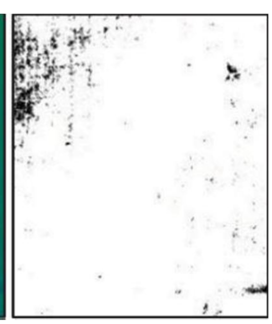

Fig 13: Hole defect beam   Fig 14: Feature under the white light Extracted from hole defect under White light beam


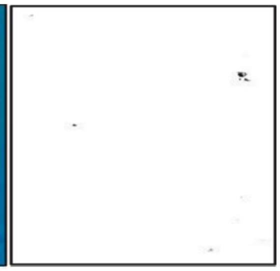

Fig 15: Hole defect color light beam Fig 16: Feature under “Dodger blue” extracted fromhole defect under “Dodger-blue” color light beam

A UV beam of light was used to capture the image of oil defects as shown below Fig. 17below. Fig. 18 illustrate that an oil defect was highlighted more under a UV light and enabled easier identification of the oil defect.


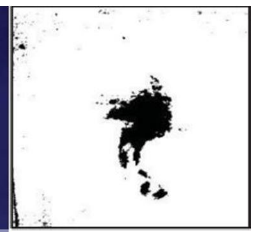

Fig 17: Oil defect Fig 18: Feature Under UV beam extracted from oil Defect under UV light beam

VI. CONCLUSION

In order to make sure that the method that has been used for detecting is feasible, a lot of tests have been done on fabric with different colors and textures, and a lot of tests have been done on fabrics with different defects. In this research, varying light conditions were tested for defect identification. Results showed that using a light beam of similar color intensity to defect identification compared to using a white light. The performance of the proposed woven fabric defect detection scheme has evaluated by using a set of plain woven fabric images. The experimental results obtained have indicated that the scheme performs very well in detecting woven fabric defects. The future work is to apply the woven fabric defect detection scheme into real-time industrial environment. Results clearly indicated that the algorithms successfully extracted the defects in the fabric. Lastly results highlighted use of the UV lightning as more effective when detecting oil defects than other lightning.

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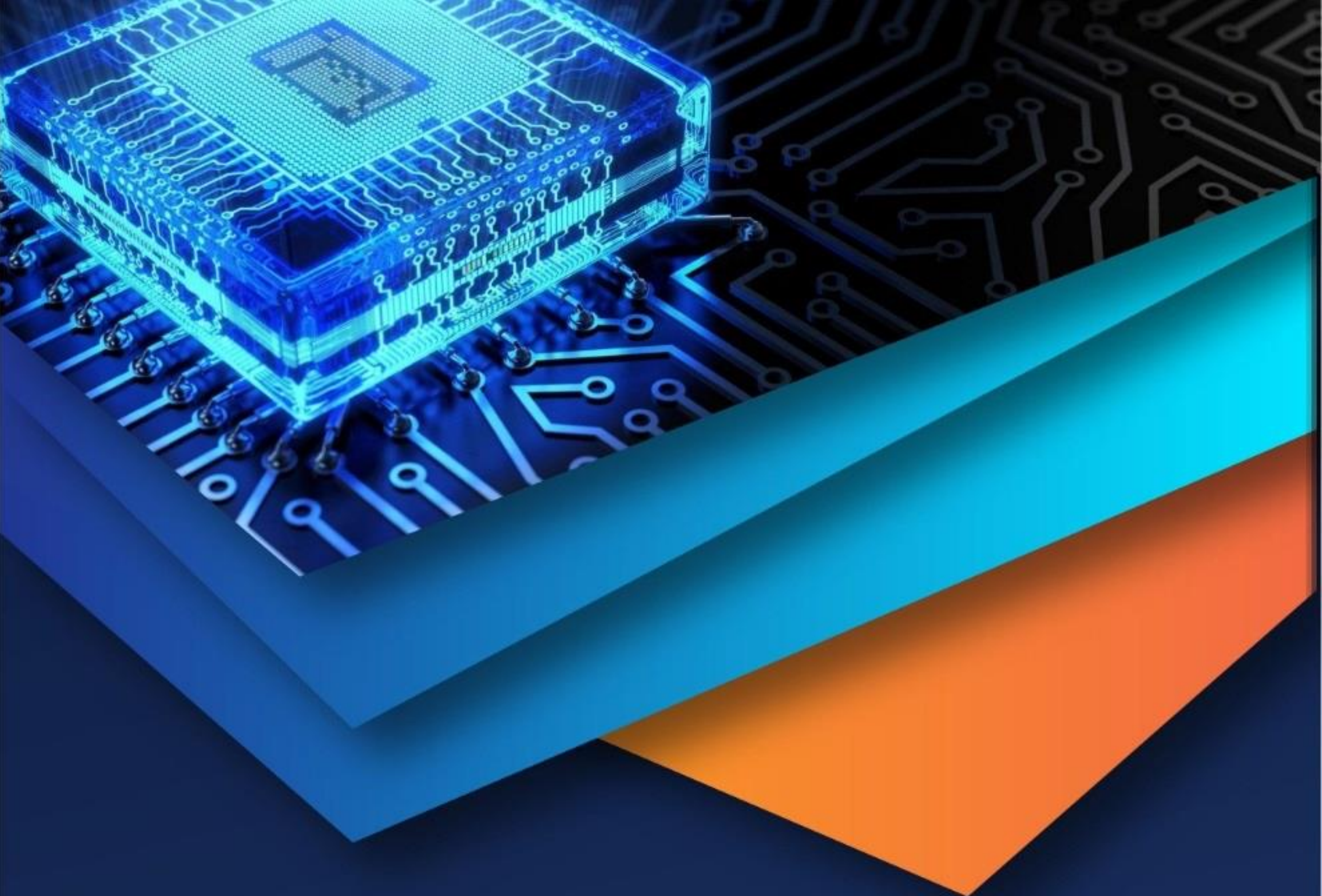

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