Image Analysis Technique for Quality Evaluation of Textiles

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ABSTRACT
Image analysis is an extraction of meaningful information from images by using computer algorithms. Digital image analysis is when a computer or electrical device automatically studies an image to obtain useful information from it. The image processing technique has provided a useful tool to solve complex problems in textile technology. Many tests performed on textiles for identification, classification, measurement of geometrical dimensions, quality evaluation, etc. are very time and labour consuming as well as cause standard-sample destruction. This does not fulfill current expectations regarding the speed and precision of the non-destructive measurement of ready product quality. Use of computer-based image analysis, among other techniques, has enabled faster quality evaluation, identification of geometrical dimensions of very small textile objects, defect detection, fibre classification, etc. without damaging the specimen. Different steps involved in image analysis and processing and application of the same for quality evaluation textiles is discussed in this paper.
Keywords: Image analysis, segmentation, fabric testing, fibre testing, yarn testing

I. INTRODUCTION

Generally, quality of textile material is evaluated based on its aesthetical properties, physical properties and defects. Earlier, the task of quality evaluation of textiles was done using subjective methods, where groups of experts would visually examine the textile material and grade its quality. These subjective methods were time consuming, exhaustive, and resulted in inaccurate results. Using a reliable method for detection and measurement of these defects could lead to more accurate evaluation of the quality of products and confirmation of the machines functioning correctly. Assessing defects in textiles with human vision is an inaccurate method for quality control; this problem became the motivation for employing digital image processing techniques for detection of defects of fabric surface. Rapid development of digital image analysis technology over the recent past has led to a multitude of new applications in the field of textile quality evaluation. Digital image analysis permits a detailed analysis of basic structural parameters of linear textile products such as thickness, hairiness, number of twists, etc. Technique also enables the estimation of other characteristic features of the external structure of linear textile products. Due to its simplicity of operation, high processing speed and higher accuracy, precision of the non-destructive measurement of ready product quality, modern image processing technology can be effectively used in quality evaluation of textiles.

II. STEPS INVOLVED IN IMAGE ANALYSIS

Digital analysis of two-dimensional images of fabric is based on processing the image using a computer. The image is described by a two-dimensional matrix of real or imaginary numbers presented by a definite number of bytes. The following operations are involved in image analysis:

1. Image acquisition
2. Image pre-processing
3. Segmentation
    a. RGB to Grey Colour Conversion
    b. Image Enhancement (Thresholding)
4. Defect Identification and Texture Analysis i.e. Representation and Description

2.1. Image Acquisition

It is the method of obtaining image of Textile fabric by using hardware such as an optical scanner or digital camera. In order to obtain a satisfactory image, proper illumination and distance adjustment is required. Hardware must have proper resolution so that smaller details of the textile product can be clearly captured.

2.2. Image pre-processing

Image pre-processing operation is used for improvement of the image data by suppressing unwanted distortions or enhancement of some features of an image required for further processing. It mainly includes denoising and image enhancement algorithms; these pre-processing operations can help in identifying defects in textile products.

2.3. Segmentation

After pre-processing, segmentation is done in order to separate the object of interest from its background. Segmentation is the process of dividing the image into distinct regions; pixels having similar attributes are placed into one region. To obtain this, the image is first converted into grey-scale image; then, morphological filters are used to remove imperfections from the image, and after that, the image can be converted into a binary image having only two pixel values (0= black and 1= white) so that the object is clearly identified for further processing.

2.4. Representation and description

The final stage is the representation and description of the objects in the image. After segmentation, the image needs to be described and interpreted for which it has been analyzed. In representation, an object may be represented by its boundary. The object boundary may be described by its length, orientation, number of concavities, etc. An object can be represented by its external characteristics, such as its boundary or its internal characteristics, such as its texture. The features that represent the image are used as descriptors. Based on what we want to analyse, there are different representation schemes as well as descriptors. Chain codes, polygonal approximation, signatures, boundary segments, etc. are some of the representation schemes and boundary descriptors. Fourier descriptors, regional descriptors, topological descriptors, etc. are some of the examples of descriptors which are used to extract the information from the image.

III. APPLICATION OF IMAGE ANALYSIS TECHNIQUE FOR QUALITY EVALUATION OF TEXTILES

Image analysis techniques can be effectively used for quality evaluation of textiles. There is a wide scope for the same. Many researchers have successfully developed a number of different methods for evaluation of quality of textile materials, defect detection and measurement of textile parameters using image analysis. Image analysis in textiles is a highly investigated area. Following are some of the applications where image analysis techniques are used to evaluate textile parameters.

3.1 Fabric Testing:

Fabric Structure and defect analysis

To enable a detailed identification of the structure and geometry of linear textile fabrics, various image correction techniques are available, viz. histogram method, averaging the brightness function, median filtration, threshold procedure, autocorrelation, frequency method, Erosion & Dilation etc. [1]. The numerical characteristics of a textile product’s structure can be obtained by elaborating the digitization algorithms and combining them with numerical methods. Pourdeyhomi & Spivak [7] used frequency methods based on the Fourier transform for image analysis to identify structural faults of the carpet structure during usage.

Prof P. Y. Kumbhar et. al. [3] and Prof. Jingmiao Zhang et. al. [4] have proposed image processing method to detect fabric defects; the former [9] used support vector machine (SVM) approach for defects identification in textiles. The method detects and classifies 90% of defects in fabrics. The latter [4] used image recognition method to detect fabric defects, which is capable of detecting defects like Combine skip, Long bamboo knot, Red line, Blue line, Kinky filling, Oil-spotted defect, Oil-immerse, etc. The example of a fabric with combine skip defect is shown in Figure1a and the adjusted histogram image is shown in Figure1b. When "combine skip" defect image carries through histogram adjustment, it generally enhances the image brightness. This can greatly enhance the dynamic range diversification of the original image, which makes details more easily observable.

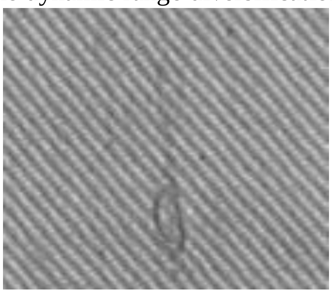

Figure 1a. De-noised "combine skip" Defect Image

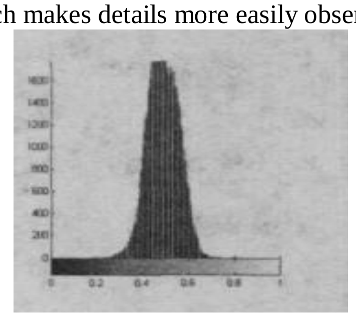

Figure 1b. The Adjusted Histogram image

Bending Characteristics

Digital image processing is used to determine one of the important parameters for simulation of textiles, which is the bending stiffness as seen in different directions of the garment as shown in Figure 2a. The bending behaviour is described by the deflection of the textile along one major direction i.e. warp or weft direction, in the cantilever test. The work proposed in the paper [2] uses a 3D measurement method to determine deflection of the textile, which is achieved by using the light section method in combination with a laser line projector as shown in Figure 2b. This method is capable of measuring the bending stiffness ranging from 0:5 μNm^2 to 200 μNm^2; this means that the bending stiffness of most fabrics used in modern textile industry can be measured with this method.

Figure 2a. Men suit Simulation

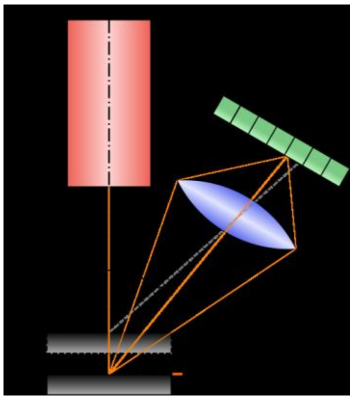

Figure 2b. Light Section scheme

3.2 Yarn Testing:

Yarn Diameter and Uniformity

The image processing approach can also be used to evaluate yarn quality [5]. The algorithm presented in the work involves different steps viz. Yarn Image Acquisition, Image Thresholding, Segmentation, Feature Extraction, Feature Vector Set Compilation, Standards/Reference, and Yarn Quality Determination. In this work, the mean diameter and standard deviation of radii of yarn images in different quadrants are computed. Standard deviation is the measure of uniformity of yarn diameter and which, in turn, is the measure of the yarn quality.

Yarn Hairiness

Hairiness is an important indicator of the quality of yarn. The length and extent of hairiness directly impact the quality of products, level, productivity and the subsequent process and therefore, yarn hairiness detection is an important task in textile production process. Guohong Zhang et al. [6] have given an overview of application of image processing techniques for evaluation of yarn hairiness, which generally include imaging unit, light source, industrial lens, image acquisition card and computer with software for processing of image as shown in Figure 3. The captured image is pre-processed to eliminate noise and then this high quality image is passed through a series of processes like thresholding, tilt correction, segmentation, thinning, etc. to evaluate hairiness of the yarn.

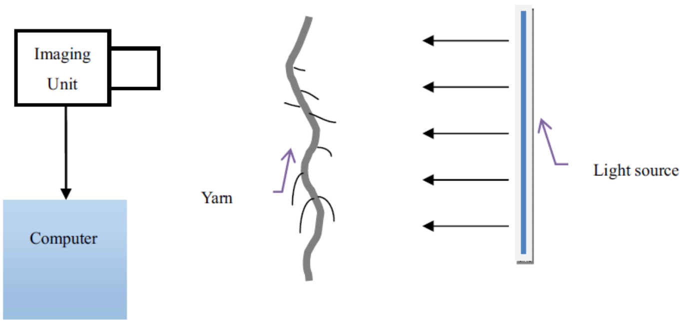

Figure 3. Image acquisition system

3.3 Fibre Testing:

Fibre Maturity and fineness

Fibre maturity is an important character of cotton and is an index of development of fibres. Maturity affects the quality and processing of the yarn. It becomes essential to have an accurate measurement system to measure maturity of fibre. The work [8] presents an image processing algorithm developed for longitudinal view analysis of cotton fibres. Cotton fibre image in longitudinal view before pre-processing and after pre-processing treatment are shown in Figure 4a and 4b respectively.

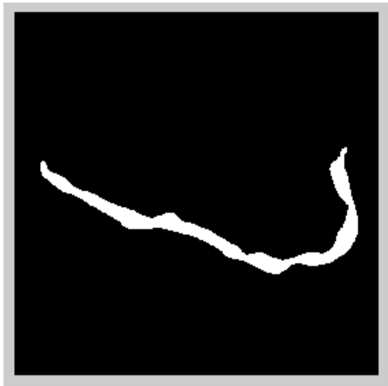

Figure 4a. Longitudinal view of fibre before pre-processing

Figure 4b. After pre-processing

The algorithm involves a sequence of pixel manipulations in order to resolve problems present in the image for better analysis. Then, a set of cotton geometric parameters like width and shape are measured; these two parameters are used to estimate the fineness and maturity of cotton fibres.

Fibre Length

Currently, fibre length is measured using instruments like HVI and AFIS. Newly developed image analysis method presented [9] overcomes errors in current methods such as holding length error in HVI, fibre breaks in opening in AFIS measurement and handling errors in hand measurement method.

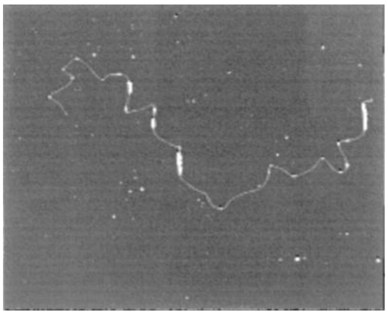

Figure 5a. Raw front-lighting image

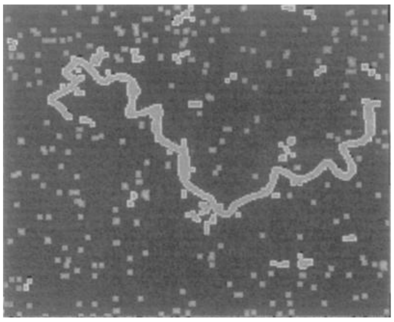

Figure 5b. Processed image of fibre

High resolution front lighting image is captured using CCD camera as shown in Figure 5a; then this image is pre-processed using thresholding procedure; next, this image is processed using different algorithms like outlining, thinning (erosion) and adding (dilation) to obtain the final image as shown in Figure 5b, from which fibre length is evaluated.

IV. CONCLUSION

Image processing is successfully used in various fields of textiles. It offers a very useful tool to solve many complex problems in the textile industry. The techniques are efficient, accurate, fast compared to traditional evaluation methods. All the tests carried out with fibre, fabric and other textile material give an accurate reading without any human error by image analysis method.

V. REFERENCES

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