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Evaluation of yarn defects by image processing technique

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ABSTRACT

Yarn defect evaluation, since they can drastically deteriorate the quality of the product, is one of the most important problems in textile industry. In this work, the yarn defects are evaluated by image processing technique. Initially, images were taken by scanner, later the obtained images were modified by using several filters. Then, the yarn defects were identified base on their geometric shape and surface area. As the results show, image processing methods is excellently reliable in evaluating number and type of yarn defects.

1. Introduction

Yarn quality is influenced by various types of yarn faults which also affects the quality of fabric produced. During the yarn manufacturing process various types of irregularities are generated, like nep, snarl, thick and thin places, soft yarn, oil stained yarn, crackers, bad piecing, oily slub, kitty yarn, hairiness, foreign matters, slub and etc. Neps which can be formed by accumulation of fly and fluff on the machine parts or poor carding, damage fabric appearance and cause shade variation in the dyed fabrics. Snarls that can be caused by higher than normal twist in the yarn or presence of too many long thin places in the yarn, also damage fabric appearance and cause shade variation in the dyed fabrics and cause a break by entanglement with adjacent ends. Thick and thin places are the result of worn and old aprons and improper apron spacing, eccentric top and bottom rollers, insufficient pressure on top rollers. They damage fabric appearance and cause a break. Foreign matter is another important yarn defect which causes breaks during winding, damage fabric appearance and form holes and stains in cloth. Slubs are also known as a defect which are the result of defective ring frame drafting and bad piecing, accumulation of fly and fluff on the machine parts, improperly clothed top roller clearers or poor carding. Slubs can cause more end breaks in the next process and variation of shade in dyed fabrics, it also damage fabric appearance. As it was briefly mentioned, yarn faults can easily deteriorate the quality of the fabric and drastically decrease the revenue [1].

Defect inspection is a vital step for quality assurance in fabric production [2]. In automation, fabric defect detection (also called inspection) is a quality control process aimed at identifying and locating defects. Fabric defect detection has been a popular research topic for many years [1]. Fabric defect detection has been an active area of research since a long time and still a robust system is needed which can fulfill industrial requirements. A robust automatic fabric defect detection system (FDDS) would results in quality products and more revenues [3,4]. In the textile industry, defect detection is of crucial importance in the quality control of manufacturing. The traditional inspection process still depends mainly on human intervention. This nature of work is dull and repetitive, and the relatively hostile working environment near the weaving machines is not suitable for human inspection. The accuracy of human visual inspection declines with monotonous jobs and endless routines [5] (Table 1).

Quality control plays a crucial role in the garment manufacturing industry in order to maintain its competitive edge in the global market. Although it is reported that defects in fabrics may reduce the price of a product by 45–65%, quality inspection in such an industry is, at present, still manually intensive. The detection of defects in textile fabrics prior to any manufacturing process is usually performed by human inspectors with an accuracy of about60–70%. Indeed, human inspection of fabrics though the best possible means currently available, has the following deficiencies: (1) Human fatigue and boredom: in particular, visual inspection of fabrics of similar and repetitive patterns can readily become a boring task. (2) Inconsistency in the performance of human inspectors: for example, alertness at the beginning of a shift can quickly deteriorate which leads to failure in detecting existing defects. (3) High inspection cost: human inspector is a major resource and

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Table 1
Defects that will be studied.

No.	Defects
1	Oily slubs
2	Slub
3	Snarl
4	Thin places
5	Foreign matters
6	Bad piecing
7	Crackers

constitutes a significant cost factor in the garment manufacturing process. In general, it would be difficult for a human inspector to detect more than 70% of the defects presented, and to handle fabrics wider than 2 m, which are moving at a speed faster than 30 m per minute. One way to reduce the total manufacturing cost and to provide a more reliable, objective, and consistent quality control process is to use an automated visual inspection system to detect possible defects in textile fabrics. Being one of the most intriguing problems in visual inspection, automated inspection of plain fabrics has attracted a lot of attention in recent years. It is reported that 90% of the defects in a plain fabric could be detected simply by thresholding. Researchers had also started to study the automated inspection of more complicated fabrics, including twill and denim fabrics. It is important to understand the characteristics of the fabric defect detection problem and the basic requirements of an automated inspection system for textile fabrics. Indeed, the basic requirements of a good inspection system for textile fabrics can be briefly summarized as follows: (1) the performance of the inspection system should at least match that of human inspectors, e.g., the detection rate requires to be larger than 70%, if not better. (2) The system should support real-time inspection of textile fabrics, i.e., the system can inspect a roll of fabric moving in an acceptable speed. (3) The system must be robust. (4) The system should be able to identify not only the defects, but also the locations of the defects. (5) The system should have the ability to record the information related to the defects appeared, in order to facilitate statistical analyses conducted off-line. (6) The operation of the system should be easy and reliable. (7) The development cost and the operating cost should be low [6].

In order to lower the costs of this process and to increase the competitive advantage of the products, it is necessary to automate the inspection step [5].

That's where machine vision finds its way through the quality control in textile industry. The inspection of real fabric defects is particularly challenging due to delicate features of defects complicated by variations in weave textures and changes in environmental factors (e.g., illumination, noise, etc.) [4] and quality of acquired images [1].

Dynamic development of machine vision techniques broadens the range of their applications. Computer vision systems are commonly used in many branches of science, medicine and industry [7]. Machine vision provides innovative solutions in the direction of industrial automation aplethora of industrial activities have benefited from the application of machine vision technology on manufacturing processes. These activities include, among others, delicate electronics component manufacturing, quality textile production, metal product finishing, glass manufacturing, machine parts, printing products and granite quality inspection, integrated circuits (IC) manufacturing and many others. Machine vision technology improves productivity and quality management and provides a competitive advantage to industries that employ this technology [8].

In textile, visual assessment is one of the fundamental methods of yarn and final products quality evaluation and also of yarn and fabric structure analysis. For more than 30 years computer

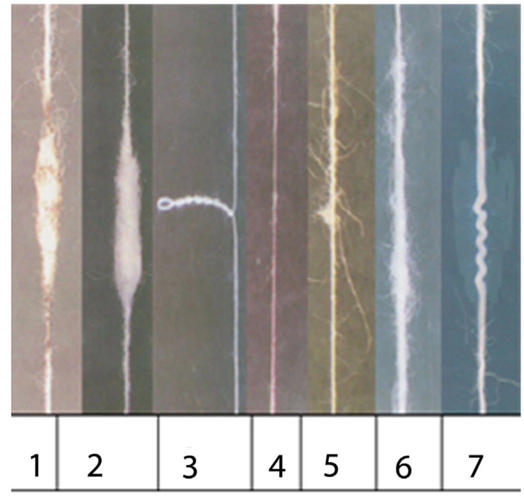

Fig. 1. Yarn defects [23].

vision techniques have been used in textile science for yarn quality inspection. In modern computer vision systems image processing and analysis algorithms are used for an automatic measurement of important yarn quality parameters, such as hairiness, diameter, twist, thickness, faults, density and bulkiness, surface defects, etc [7].

Machine vision and image processing technique are commonly used in weaving, spinning and also in dyeing and finishing [9] fabrics. Determination of the weave type [10], defect inspection of weaved fabrics [11–17], evaluation of textured yarn [18], grading of yarn appearance [19], inspection of lace [20], On Line Weight and Shrinkage Control [21], Measuring thickness of translucent plastic [22] are all examples of machine vision in textile industry.

Image analysis techniques are used not only for an automatic thread and warp quality analysis, but also for estimating the dimensions of spliced connections of yarn-ends and repetition of yarn structure, which influence fabric quality [7].

In this study, the yarn defects are evaluated by image processing. Initially yarns were imaged by scanner and the obtained images were modified by using several filters. As the results show, image processing technique is a reliable tool in yarn defect evaluation.

2. Material and method

In the present study, yarn faults were identified by image processing technique. Identified faults were nep, yarn undesirable hairiness, thick and thin places Fig. 1 shows variety of defects that can be seen in yarn.

In order to be able to study the images, they need to be modified. It means that by using the Otsu's method, pixel values were changed. Otsu's method which work through the fallowing function, divide the background and the main objects (yarn) [24].

$$\sigma(t) = q_1(t)\sigma_1(t) + q_2(t)\sigma_2(t) \quad (1)$$

by Otsu's method all pixels value will be in [0,1]. In fact, for an image to change into binary format, all pixel values with lightness less than a certain value will be reduced to 0,which will be the "off pixels" and all pixel values with lightness more than a certain value, will be increase to 1,which will be "on pixels". Fig. 2 is Fig. 1 in binary format.

In order to identify defects, first the image of faults is taken. Then image processing procedure is carried out on images. As the first step of processing, images are changed to binary format. Fig. 3 is the defects image after this step.