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A review of automatic cotton contaminant detection techniques

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***Abstract*— The inspection of cotton quality is an important aspect of modern industrial manufacturing. In textile industry, automatic cotton contamination detection is required for maintaining the cotton fiber quality. The inspection of cotton contaminants is particularly challenging due to the large number of contaminant classes which are characterized by their vagueness and ambiguity based on their characteristics. In the manual process of cotton contamination detection, it is difficult to detect the contaminants due to their unpredictable size, shape, material and position as some of the contaminants get inside the cotton fiber layer and become invisible and some are of same color as cotton fiber. So, automated systems are required that can detect different types of contaminants. This paper presents a review of various image processing techniques that can be used for detecting contaminants in cotton fiber.**

***Keywords*- Cotton contaminants, Machine Vision, Contaminants detection.**

I. INTRODUCTION

Cotton Contamination refers to the presence of foreign material in cotton that affects the quality of cotton fiber. Contamination, even if it is a single foreign fiber, can lead to the downgrading of quality of yarn, fabric or garments or even the total rejection of an entire consignment and is thus a very **critical** fiber parameter. Contamination makes serious visible effects in the fabric. The quality of cotton, as determined on the basis of its color, length, strength, fitness and most of all the degree of contamination, greatly affects its price so better the quality of cotton, higher will be the price and better the position of cotton industry in the market.

Contamination of raw cotton can take place at every step i.e. from the farm picking to the ginning stage. Since cotton is picked manually by rural women so human hair, contamination caused by cloth pieces and fabric sheet are the biggest cause of cotton contamination. In addition foreign fibers including cloth strips, plastic film, jute, hair, polypropylene twine and rubber are serious threat to the textile and cotton industry. Such contaminants have effect on cotton grade and can cause color spots in fabric, thus reduce the textile value as well.

The improved blow room machinery [1] plays a key role in reducing the quantity of undesirable particles in cotton. However this required detailed information on the type, size and number of such particles. Some of the contaminants remain undetected even after processing..So, an automated cotton contamination detection system [2] is used which is economical and efficient to guarantee higher textile quality and lower production cost. The digital image processing made it possible to detect and distinguish between fiber Neps, trash and other foreign fibers. In recent years, machine vision systems have been widely applied to cotton industries for inspection of foreign matter in cotton [3].

As machine vision technology has been improved, Automatic Visual Inspection systems have become more widely used in many fields. In recent years, AVI systems are also used in textile industries. Zhenwei Su [4], Liwei Zhang [5], built real-time automated visual inspection systems for contaminant removal from wool. Boshra D. Farah [6], built AVI systems for inspection or removal of contaminants in cotton. Bidan Li [7] designed a machine vision system for detecting foreign fibers in lint.

The purpose of this paper is to present a review on various automated inspection systems that are build on robust and efficient cotton contamination detection algorithms.

II. COTTON CONTAMINANTS

The major types of contaminants that affect the quality of cotton fiber are cloth strips, plastic film, jute or hair, polypropylene twine and rubber. Such contaminants have impact on cotton grade and can cause color spots in fabric, thus reduce the textile value of cotton fiber as well. The different categories of cotton contaminants are shown in fig.1.

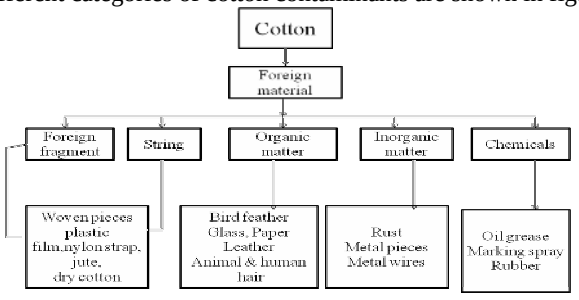

Fig.1. types of contaminants.

A. Effects of contaminants:

During inspection process, the quality of cotton fiber is assessed on the basis of some factors such as fiber strength,

color, length of fibers, the ginning process and purity (the absence of foreign matter. i.e. contaminants). Among these factors, the presence of contaminants greatly affects the quality of cotton. The reasons for this are:

1. Contamination of cotton causes it to become sticky that creates obstruction in rollers.
2. It causes wastage of dying material and requires extra efforts at cleaning process that unnecessarily increases cost.
3. Even the cleaning process can not remove all the contaminants and the leftover embedded pieces of contaminants affect the quality of yarn and its value.
4. Contaminants such as stones, metal pieces, etc. causes disturbance to material flow that especially affect production as well as quality of the machinery.
5. Fabric appearance produced with contaminated yarn will be poor and prone to rejection during the quality inspection process.

B. Traditional detection systems.

Contaminants can be easily detected and removed by visual inspection because the contaminants usually have different color than the white cotton lint. Traditionally, these contaminants were removed during the ginning procedure by human visual inspection and hand picking. The main drawbacks of such methods were high cost involved in training of labor, time involved and their poor cotton quality assessment and other human related issues.

III. RELATED WORK

The detection of cotton contaminants can be based on visual, photoelectric and ultrasonic techniques .A review of these cotton inspection methods can be found in J.X. Guo, Y.B. Ying, "Progress on Detecting Technique and Sorter of Raw Cotton Foreign Matters," Transactions of the Chinese Society for Agricultural Machinery, vol. 7, 2008, pp.107-113.]. Pai [8] used an X-ray microtomography system to acquire tomographic slices of contaminated cotton, and classified the cotton contaminants based on the physical density of patterns.. Gao [9] adopted color camera, and detected cotton contaminants based on the discrimination of hue and saturation in HSI color space. Jia [10] used an imaging system including near infrared and ultraviolet wavelength light sources to acquire and inspected the contaminated cotton. The results of these vision inspection systems were acceptable results, but other factors, such as time consumption, consistent performance, production and maintenance cost, should be taken into consideration. The installation of X-ray scanner in [8] is difficult and too expensive for the applications in textile production line. Therefore, the vision systems proposed in [9] and [10] are more appropriate to assess cotton quality, but the detection algorithm is based on color space feature that creates problem because of different color range of cotton.

IV. IMAGE PROCESSING TECHNIQUES FOR DETECTING COTTON CONTAMIANTS

A. Contamination detection using x-ray microtomographic image analysis:

X-ray microtomographic systems uses computer vision algorithms to detect and to classify the cotton contaminants with high resolution and accuracy. This technique generates multiple view of the object of interest which is then reconstructed by computer to obtain cross-sectional slices. These slices are then stacked up to produce 3D view of internal and external structural details. Pai[8] proposed an algorithm that could detect and classify different types of contaminants via x-ray microtomographic image analysis. This technique could be used with fuzzy-logic-based classification scheme to create a highly accurate contaminant analysis tool. Despite its advantages, x-ray imaging does have some drawbacks. The main drawback of this technique is the installation cost of X-ray scanner and time taken to perform the procedure **.**X-ray source and the detector might become a source of inaccurate computations and that too might happen at the cost of speed of the processor leading to more constraints on image quality.

B. Contamination detection using co-occurrence matrix features:

Texture is a neighborhood property therefore spatial interactions among neighboring pixels have been used for the characterization of textures. Mingxiao Ding et al. [11] used the texture features to construct gray level co-occurrence matrix algorithm to detect the sharp contrast objects. The researchers designed a rotating filter based on contextual information to remove the unwanted edges and locate the coordinates of impurities. Haralick and his colleagues proposed 14 different statistical features from GLCM values. The 14 different functional differences have been described in [12] and [13]. These features can be categorized into three groups: Correlation, Homogeneity Statistics and Smoothness Statistics. Among these, the contrast feature is less sensitive to noise, so GLCM contrast feature is the most effective parameter to discriminate the impurities. The main two issues with co-occurrence matrix being used in cotton contamination detection might be its application in local and global space may be inefficient which needs special attention.

C. Contamination detection using wavelets:

Wavelet is introduced to detect foreign fibers in cotton as it has great potential and excellent features in signal and image processing. The multiscale wavelet representation posses the property of shift invariance and can be used for examining cotton fiber images at different scales to detect contaminants. Wavelet analysis can detect many signal characteristics, such as signal trends, signal's high-order discontinuous points and self-similar properties, ignored by other analysis methods. Cheng liang Zhang et al. [14] proposed an approach for detecting contaminants using wavelets. This paper decomposed 2-D image signal into multi-layer wavelet by using wavelet packet 2-D. Experimental results show that the

two-dimensional wavelet packet tools have very strong function in detecting foreign cotton fibers image.

D. contamination detection based on color space model:

Tingting Xie et al.[15] proposed a method for detection of foreign body in cotton based on RGB space model . A space model of cotton was created by extracting the features of the standard cotton and channel background. The researchers used sampling algorithm and detection algorithm. Sampling algorithm created the cotton space model in RGB space by using the radius of cross-section that extracted the features of the channel background and the standard cotton. Detection algorithm used this model to detect whether the pixel is in the range. The main drawback of this method is that the images were acquired in RGB space which required high bandwidth for each component R,G and B. Dongyun Wang et al.[16] proposed a method of detecting foreign bodies but converted the RGB images to gray scale images as the data of gray image is only one-third of RGB image so the algorithm design is simplified. Cheng liang Zhang et al.[17] proposed an approach for detecting contaminants based on YCbCr color space. The advantage is that it can conduct various advanced algorithms to gray image from luminance, meanwhile, also can perform color detection to most colored foreign fibers and extract the chrominance information directly. Pooja Mehta & Naresh Mehta [18] presented a paper describing comparison between HIS model and YCbCr model and found that HSI model is better than the YcbCr model as YCbCr model was unable to distinguish the white colored contaminant from that of standard cotton whereas it was possible to detect the white fiber from the cotton in HSI model.

E. Contamination detection using optimal wavelength imaging:

The optimal wavelength imaging is based on finding different wavelengths of cotton and foreign fibers and based on these values the foreign fibers are distinguished from that of cotton fiber. Jia DongYao[19] used this method for detecting the foreign fibers in cotton .they used near infrared(NIR) imaging for detecting a wide range of foreign fibers in cotton and also developed an optimal wavelength imaging system with an image-processing algorithm.

V. GENERAL FLOW DIAGRAM FOR DETECTING CONTAMINANTS.

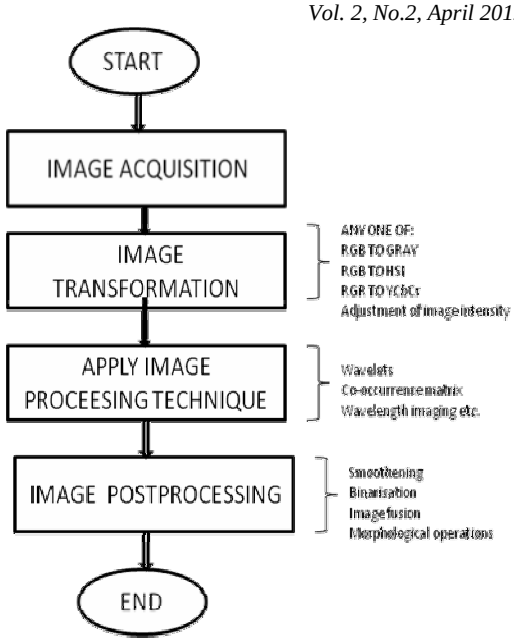

Fig. 2 General flow chart for detecting contaminants

VI. CONCLUSION

This paper has provided a review of various cotton contaminant detection techniques. The last few years have shown some encouraging trends in contaminant detection using image processing. However, the researchers till need to design a methodology that help them to classify the contaminants(silk, nylon etc) so that numeric quantitative analysis is also possible on the contaminants and classification of these contaminants is also possible**.**

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