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A novel method for identification of cotton contaminants based on machine vision

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ABSTRACT

Foreign matter is easily mixed into cotton during picking, storing, drying, transporting, purchasing, and processing. These contaminants are difficult to remove in the spinning process and can cause yarn breakage, thus reducing efficiency of working. This paper proposed the new method based on machine vision to measure the contaminants in raw cottons. The color images of cottons with contaminants are acquired and divided three channels images. Intensity of illumination of cottons often is unstable because of the driving voltage of light source unsteady. The intensity of illumination of images should be corrected for measuring correction and precision. The Gamma adjustment function was adopted to correct non-uniform illumination for images. Through the experimental contrast, Gamma correction parameter is set as 0.8. The Otsu method is used to segment the image. After images of three channels' information fusing, the contaminants of cotton samples can be correctly detected and cotton seeds also can be effectively inspected. The false detection ratio of the measuring system is less than 5%. The experimental results show the measuring system can meet with the requirement of the cotton's industry application.

1. Introduction

Foreign matter is easily mixed into cotton during picking, storing, drying, transporting, purchasing, and processing. These contaminants are difficult to remove in the spinning process and can cause yarn breakage, thus reducing efficiency of working. This in turn leads to great economic loss for cotton textile enterprises [1–3]. Although manual sorting of lint contaminants is widely used, it is time consuming, labor intensive, and unreliable. To reduce economic loss, the development of an automated contaminants detection system in the textile industry is urgently needed [4]. With the computer technology and photoelectric detection technology development [5], machine vision systems have been widely applied to textile industries for inspection foreign matters in cotton [6]. High quality image acquisition, fast image processing, effective feature extraction, accurate object classification and precise content measurement are key factors in the inspection.

In recent years, absorption and reflection spectral differences between lint and contaminants under X-ray [7], near-infrared spectroscopy [8], and mid-infrared spectroscopy [9] have been used to detect contaminants in seed cotton, lint, and yarn. However, the costs of these methods are always very high, time-costing, and expensive which limit the application in online detection.

Image segmentation is one of the key techniques in image processing and machine vision system, and is the precondition of image analysis and pattern recognition. The goal of image segmentation is to partition an image into meaningful connected parts to extract the features of the objects [10]. There are some methods used in automated visual inspection systems [11,12]. In recent years, more efficient approaches are developed for segmentation, however more complicated. Fast and precise segmentation is very important step to image processing for online inspection. Light source change often affects the image precise segmentation and processing. The suitable segmentation method to avoid light source influence can improve the image processing.

This paper proposed a novel method to inspect the cotton contaminants based on machine vision to avoid the light source influence. The remainder of this paper is organized as follows: in Section 2, the principle and method are presented. Section 3 describes the experimental results and discussion and conclusions are drawn in Section 4. The experimental results show the measuring system can meet with the requirement of the cotton's industry application.

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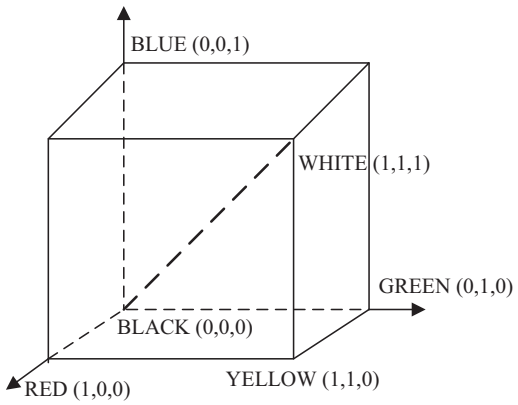

Fig. 1. RGB color model.

2. Principle and method

2.1. Principle

The appropriate color space chosen is the first step for cotton image processing. Proper color space can not only save calculation, but also improve the image processing.

RGB color space is the fundamental and commonly color space of image processing. RGB model can be denoted based on Cartesian coordinate shown in Fig. 1. In this space, any color calculated is all within the RGB colorized coordinate. Any color C can be expressed from Eq. (1):

$$C = r \cdot R + g \cdot G + b \cdot B \tag{1}$$

2.2. Image acquisition

The image acquisition system is the most important aspect of this experimental system, as shown in Fig. 2. The system includes one camera, two light sources, and a computer. In order to improve inspection precision, raw cotton samples with contaminants formed by technicians is 500 mm wide and 5 mm thick. Images are acquired using the CCD color camera (GCI – 070103 of DaHeng Technology Co., LTD) with USB images transmission.

Fig. 3 shows the acquired color image example by the experimental system. The typical image includes cotton stems, leave and seeds. The original images are often noised because of CMOS sensitivity difference. The original image should be pre-processing with the gray scale correction, noise filtering and so on.

The three channels information of color images of cottons can be used to inspect contaminants because of different contaminants with different thresholds. Three channels color images were

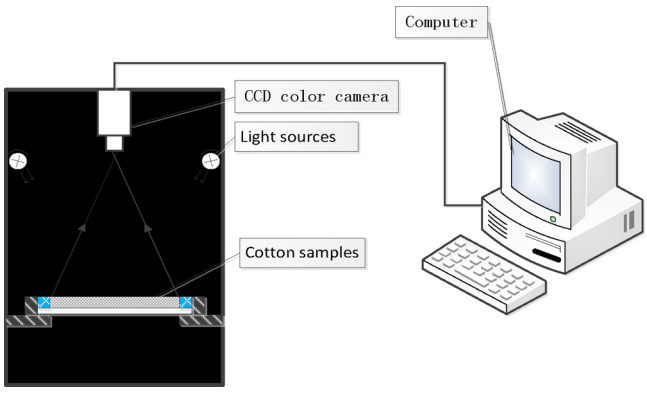

Fig. 2. Image acquisition system diagram.

Fig. 3. Original RGB image of raw cotton with contaminants.

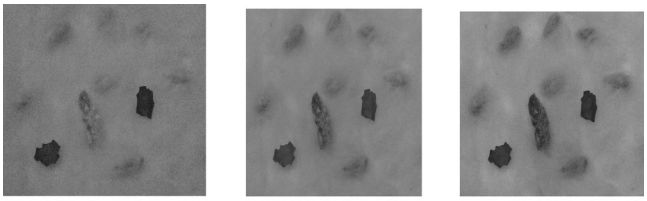

Fig. 4. R, G, and B channel gray images. (a) R channel, (b) G channel, (c) B channel.

obtained and then transferred to gray images. As shown in Fig. 4, R channel image shows the leaf obviously, G and B channel image shows the cotton stalk and seeds. These contaminants can be inspected by setting different thresholds in the channels image. In this paper, the pre-processing of three channel gray images is the same. The B channel gray image is introduced as the sample.

Fig. 5 shows the histogram of B channel image. There are two peaks in the histogram. The threshold is set as 50 to the image segmentation threshold. The light source of image acquisition system usually uses the filament lamp or fluorescent lamp. Intensity of illumination of cottons often is unstable because of the driving voltage of light source unsteady. The intensity of illumination of images should be corrected for measurement correction and precision. The Gamma adjustment function was adopted to correct non-uniform illumination for images. Through the experimental

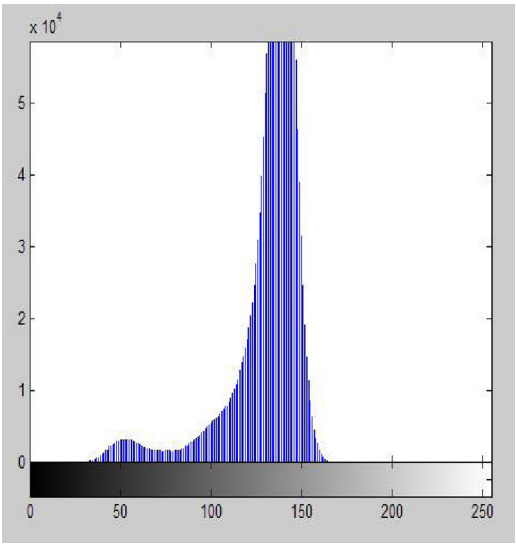

Fig. 5. B channel histogram.