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A fast image segmentation algorithm for detection of pseudo-foreign fibers in lint cotton ☆

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ABSTRACT

Detection of pseudo-foreign fibers based on Automatic Vision Inspection system is crucial to improve the classification accuracy of foreign fibers in cotton, and justify the quality and grade of lint. Pseudo-foreign fibers are dried cotton leaves, seed-coats, barks, grass and dust which mixed into cotton during production, they usually have relative small sizes and large quantities compared to the foreign fibers, so it is hard to detect and segment them from images. In this paper a novel algorithm is proposed to solve the problem. 110 images with pseudo-foreign fibers are tested, and the result showed that both spots and slender shaped pseudo-foreign fibers can be segmented clearly with average speed of 0.67 s, which can meet the requirement of online cotton trash detection.

1. Introduction

Pseudo-foreign fibers in lint cotton are referred to trashes such as dried cotton leaves, seed-coats, barks, grass and dust which are mixed into cotton during planting, picking, and processing. Cotton trash and color are the determinants in judging the spinning quality and hence the market value of cotton in the current cotton grading system [1]. Compared to foreign fibers which must be detected and removed from lint because it may seriously affect the quality of the final cotton textile products, the pseudo-foreign fibers in lint are smaller in size, larger in quantity and harder to detect. The interferences of Pseudo-Foreign Fibers would lead to high false positive rate in the detection and classification of foreign fibers based on AVI (Automatic Vision Inspection) [2–4]. In order to improve the detection accuracy of foreign fibers, segmentation algorithm of pseudo-foreign fibers images is studied in this paper.

In recent years many researches have been done on the detection and classification of cotton trashes. For instance an AVI system for the detection of foreign fibers in lint is presented in [5–11]. Qu Xin presented a fast feature extraction algorithm for detection of foreign fibers in lint cotton within a complex background [12]. Xu Bugao introduced a new trash and spot identification method by multi-dimension threshold [1,13,14], and the method could be used to characterize size, spatial density, shape, and color of trashes and spots present in cotton samples. So far articles about segmentation of pseudo-foreign fiber images have not been found in the literature.

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Many efforts have been done to both 2D and 3D image segmentation tasks in fields from face recognition to agricultural product quality inspection. Dana E. Ilea reviewed image segmentation based on the integration of color–texture descriptors [15]. Zhang Liwei used image processing algorithms in RGB and HSV color spaces which can segment 96% of contaminant types in wool [16]. Wang Chunhao implemented Graph Cut for video object segmentation with shape information [17]. However there's no single segment method that can handle all kinds of images, because images in different scenes have different meanings, and the method chosen is highly target oriented, subjective and hard to compare with. Among image segmentation algorithms based on different theories, threshold is the most prevalent one for its simplicity and fast speed. Yang Wenzhu analyzed the distribution of gray levels of the foreign-fiber images, applied a piecewise transform model to enhance the image, and then proposed an improved Otsu's method to segment foreign fibers from background of opened lint [10]. Akira Mizushima proposed an image segmentation method for apple sorting and grading using support vector machine and Otsu's method [18]. Inspired by the articles mentioned above, a local Otsu's algorithm is implemented in our method.

In this research, sub-images of pseudo-foreign fibers in R, G and B channels are compared at the first step, then the chosen sub-image is separated into 36 blocks with size of 200×250, histograms of these blocks are studied and blocks without trashes are labeled as background, other blocks with foreign fibers and pseudo-foreign fibers are segmented by the algorithm proposed, at last all the 36 blocks are merged into one image.

The rest of the paper is organized as follows: experiment materials for this paper are introduced and the proposed method is described in details in Section 2, experiment results are showed, analyzed and compared with other algorithms in Section 3, while conclusion is drawn in Section 4.

2. Materials and methods

2.1. Image acquisition

2.1.1. System setup

Images used to segment in this research are acquired by the AVI system provided by China Cotton Machinery & Equipment Co., Ltd., whose system setup is showed as Fig. 1. There are two 3CCD line-scan cameras, one color camera for colorful trashes detection, and one black–white camera to catch foreign fibers that have fluorescence when illuminated by ultraviolet lights. When lint cotton is opened into thin layers foreign fibers are brought out to the surface of cotton layer, which made them easier to detect, but pseudo-foreign fibers most of which are botanical, usually mixed into the layer, small and light, and hard to discern.

2.1.2. Pseudo-foreign fiber images

The images acquired by the AVI system are 4000×500 pixels in size. Typical pseudo-foreign fibers are picked out, which are showed in Fig. 2. There are large quantities of them in lint cotton, that usually have 3 kinds of shapes (flake for cotton leaf crumbs, slender for grasses and straws, and spots for seed-coat crumbs some of which have cotton around them). Most of the pseudo-foreign fibers have a color between yellow green and brown, and that is one reason why the green channel sub-image is chosen to segment, and the speed of image process is another concern.

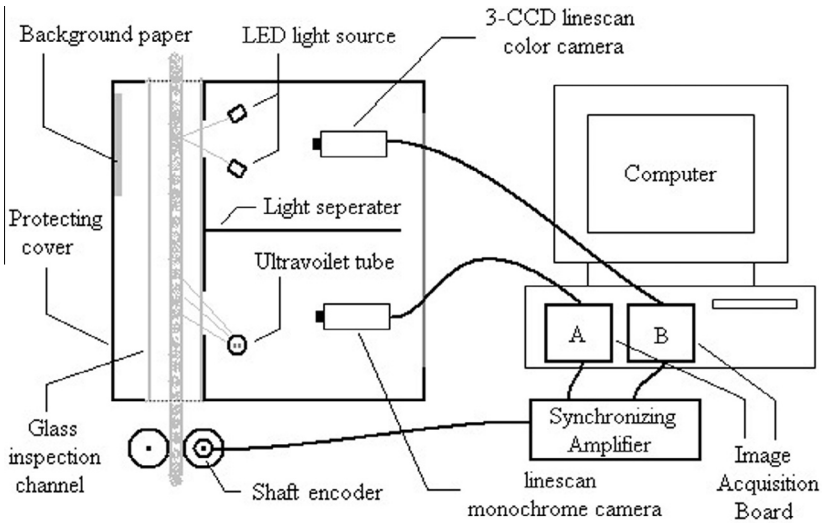

Fig. 1. Setup of image acquire system.