International Journal of Engineering Research and General Science Volume 3, Issue 4, July-August, 2015
ISSN 2091-2730

Detecting Foreign Strands From Cotton Using RGB Saliency Map And Morphological Segmentation

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Abstract— This paper presents an image segmentation method aiming at detection of foreign strands from cotton. Detecting foreign strands from the background is difficult due to their various shapes, size and colors of foreign strands. In this method, saliency features are identified. Color objects are identified by their color feature while gray objects are by brightness feature. Final foreign strands is obtained by fusion of the color and gray objects. But this method does not work well when it encounters situations of uneven thickness of the layers of cotton and the different colors and shapes of foreign strands. So, to get better result, in the proposed method, morphological edge detection is performed to detect the edge of the foreign strands. Also, an iterative thresholding method is used to segment the gray gradient images. The experimental results show that the foreign strands are detected with high accuracy than the conventional image segmentation methods.

Keywords— Cotton, Foreign strands, Fusion, Image Segmentation, Morphological edge detection, Saliency feature, Thresholding.

INTRODUCTION

Cotton is a natural fiber easily available in abundant quantity. It is the most suitable fiber for textile spinning and clothing. Contamination of cotton with foreign strands has caused the textile industry serious problems. Contamination sources vary considerably and are often occurred accidently during picking, storing, drying, transportation and packing baled lint. Some of the common contaminants are polypropylene strands, feathers, plastic films.etc as shown in the Fig.1. Manual detection methods like hand picking such strands requires more time, money and has low efficiency [1]. Therefore automatic inspection of foreign strands [2] to separate it from the background is an important discovery in machine vision system. Foreign objects in a captured image are very difficult to separate out from the background employing traditional image segmentation methods due to the inhomogeneous background brightness and various types of foreign fibers in different colors and shapes.

Fig.1 Foreign Strand Samples

Image segmentation is a technology to divide an image into different components to extract the important features. It is an important step in machine vision technology with the aim of image analysis and interpretation, object classification, feature measurement. Thus, image segmentation [3] is very important in processing the image. The commonly used approaches are edge based methods, region based methods, color based methods, texture based methods [4]. These methods might well in certain situations but an accurate segmentation method is needed for detection of foreign strands due to their low contrast, inhomogeneous image gray level and small area ratio of the target image. In this paper such a method is employed.

LITERATURE SURVEY

Wenzhu Yang, Sukui Lu, Sile Wang and Daoliang Li [5] proposed an approach for fast recognition of foreign fibers in cotton lint using machine vision. The captured image was firstly segmented according to the mean and standard deviation of R, G and B values of each pixel in the image. Then noises were removed using the area threshold method. Afterwards, color features, shape features and texture features of each foreign fiber object were extracted. Finally, a one-against-one directed acyclic graph multi-class support vector machine (OAO-DAG MSVM) was constructed and used to perform the classification. But it has problems with the occurrence of pseudo-foreign fibers.

Yutao Wu, Daoliang Li, Zhenbo Li and Wenzhu Yang proposed a new approach for the fast processing of foreign fiber images by image blocking [6]. This approach includes five main steps, image block, image pre decision, image background extraction, image enhancement and segmentation, and image connection. Then the image block is segmented via OSTU which possibly contains target images after background eradication and image strengthening. Finally, connect those relevant segmented image blocks to get an intact and clear foreign fiber target image. But it has problems with the image that has low contrast ratio between object figure and background and computation speed is also less.

Xin Zhang, Daoliang Li, Wenzhu Yang, Jinxing Wanga and Shuangxi Liu proposed a fast segmentation method for high-resolution color images of foreign fibers in cotton [7]. An improved morphological edge detection method was firstly performed to detect the edge of the gradient map for cotton foreign fibers; next, an iterative thresholding method was used to segment gray gradient images. But this is not accurate enough for segmentation of high-resolution images of foreign fibers.

Wenzhu Yang, Daoliang Li, Sile Wanga, Sukui Lu and Jingwei Yang proposed saliency-based color image segmentation in foreign fiber detection [8]. Foreign fiber objects can be recognized in the captured image by their color saliency or brightness saliency or both. The thresholds used here are empirical values also the uneven thickness of cotton foreign fibers does not yield an accurate result.

An online image segmentation method [9] for foreign fiber detection in lint is proposed by Daohong Kan, Daoliang Li, Wenzhu Yang, and Xin Zhang. The image of lint containing foreign fiber features that the background (cotton fiber) is homogeneous and has a normal gray-level distribution; the object (foreign fiber) is smaller, darker than the background but its gray-level distributes is a wide range. A background estimation thresholding is used in the online foreign fiber inspection in volumes of lint. Compared with other thresholding methods it segments images with high performance but non uniform thickness of lint slice detects foreign fibers wrongly.

In the present research, the problems mentioned above can be solved. The paper is organised as follows: the saliency features [10] of color and gray scale images [11] are found in the first section, then a suitable thresholding is used to segment these color and gray foreign strands. Finally fusion is done to get the final foreign strand. The next section has morphological edge detection method [12] for shape feature extraction in the next section.

PROPOSED METHOD

The captured input image can be colored or gray. Some of the colored objects are red polypropylene twines, cloth pieces, etc. Black feather or plastic films are gray objects. So for calculating the salient feature of color object, color is taken as prominent feature here. But for gray images, brightness is used as salient feature. The proposed method consists of two stages: Color object detection using saliency features and shape feature extraction using morphological Segmentation.

A. Color and brightness saliency feature calculation

Fig.2 shows the basic block diagram of the color and brightness saliency feature calculation of the proposed system. The input image, I , is a color image of dimension M*N*3, where M and N are the number of rows and columns. It is processed in a RGB color space which is the most fundamental and commonly used color space of image processing. It uses three basic component values of R, G and B to represent color. The red, green and blue channels is represented by R, G, B respectively for image I. First step is the calculation of respective features as:

$$r = R - (G + B) / 2 \quad (1)$$

$$g = G - (R + B) / 2 \quad (2)$$

$$b = B - (R + G) / 2 \quad (3)$$

Next step is to find the mean absolute difference of the color features and is represented as $m_{r,} m_g, m_b$.

$$m_r = 1/M * N \sum_{x=1}^{M} \sum_{y=1}^{N} r(x,y) \quad (4)$$

$$m_g = 1/M * N \sum_{x=1}^{M} \sum_{y=1}^{N} g(x,y) \quad (5)$$

$$m_b = 1/M * N \sum_{x=1}^{M} \sum_{y=1}^{N} b(x,y) \quad (6)$$

Then, saliency is obtained by computing the squared difference of these features with the mean value of this color feature and is represented by $Saliency_{r,}\ Saliency_g, Saliency_b$.

$$Saliency_r = (r - m_r)^2 \quad (7)$$

$$Saliency_g = (g - m_g)^2 \quad (8)$$

$$Saliency_b = (b - m_b)^2 \quad (9)$$

The final color saliency map is obtained by the fusion of the above individual saliency maps.

$$Final\ Saliency\ map = Saliency_r + Saliency_g + Saliency_b \quad (10)$$

Gray objects are detected by brightness feature because they cannot have color as their salient feature. Brightness saliency map, $Saliency_d$, is calculated by transforming the RGB image to a gray one.

$$Saliency_d = 0.299 * R + 0.587 * G + 0.114 * B \quad (11)$$

A suitable threshold value, T_c is computed emperically to find whether a particular pixel (x,y) is color object pixel or not:

$$Color\ Object\ pixel\ (x,y) = \begin{cases} 0 & \text{Saliency}(x,y) \le \text{Tc} \\ 1 & \text{Saliency}(x,y) > \text{Tc} \end{cases} \quad (12)$$

For gray object detection, it uses two threshold values for black, T_B and white, T_W. If the brightness saliency of pixel (x, y) is less than T_B, then this pixel is referred to as a black object pixel; and if the brightness saliency of pixel (x, y) is greater than T_W, then this pixel should be a white object pixel. Both T_B and T_W are empirical values:

$$Gray\ Object\ pixel\ (x,y) = \begin{cases} 1 & \text{Saliencyd}(x,y) < \text{T}B \text{ or Saliencyd}(x,y) > \text{TW} \\ 0 & \text{otherwise} \end{cases} \quad (13)$$

The final objects are obtained by a fusion of the color objects and the gray ones using the bit OR operator.

$$Final\ object = Color\ object\ pixel \mid Gray\ object\ pixel \quad (14)$$

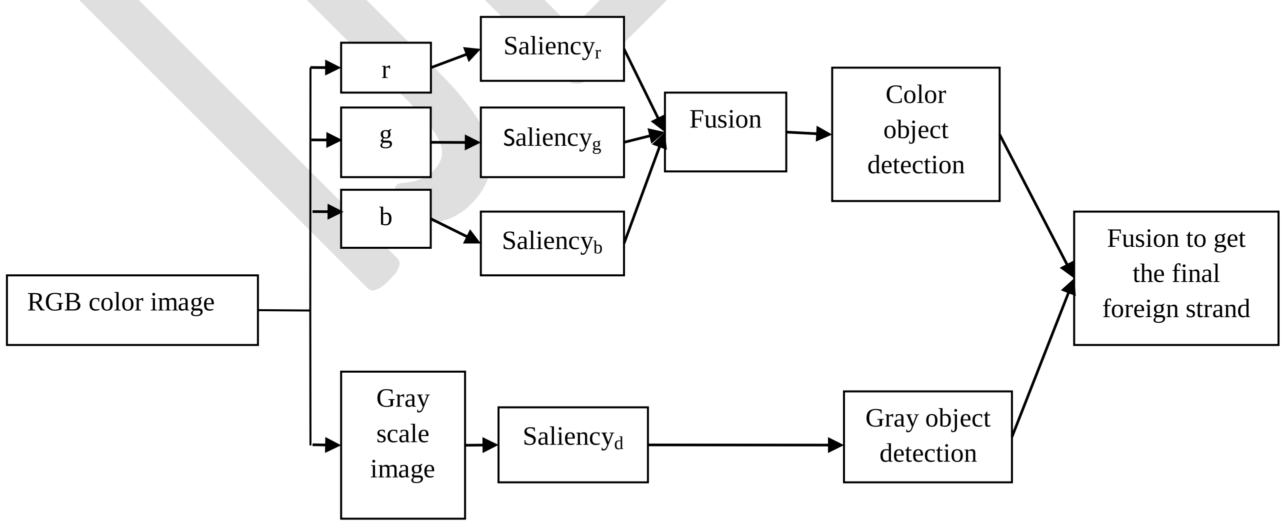

Fig.2 Block diagram of Color and Brightness Feature Detection

B. Morphological segmentation

Although the saliency features alone is enough to perform segmentation but it encounters difficulties in this process. This occurs due to the non uniformity in thickness, colors and shapes of foreign strands. In order to solve these problems a morphological edge detection method is also applied. This helps to extract only the needed details and avoids the irrelevant details of the image. A small binary image with matrix value zero or one, is used as a structural element to compare the neighborhood pixels. The origin or index pixel is usually one of its pixels. It relies on two basic operations used to shrink (erosion) and expand (dilation) image features. Dilation is done by setting index pixel to maximum found within structuring element and erosion is the minimum value. Both dilation and erosion are produced by the interaction of a structuring element with the pixels of interest in the input image. Subtract eroded image from the dilated one to find the edges. This is the morphological gradient edge detection. In order to detect the edge of R, G and B images, perform the same for each channel.

Then, the color images were converted into a gradient map, and iteratively the best threshold value of the gradient map was calculated to extract the background and the object.

$$T_0 = (Z_1 + Z_K)/2 \quad (15)$$

where Z_1 and Z_K are the minimum and maximum gray value of the gradient map.

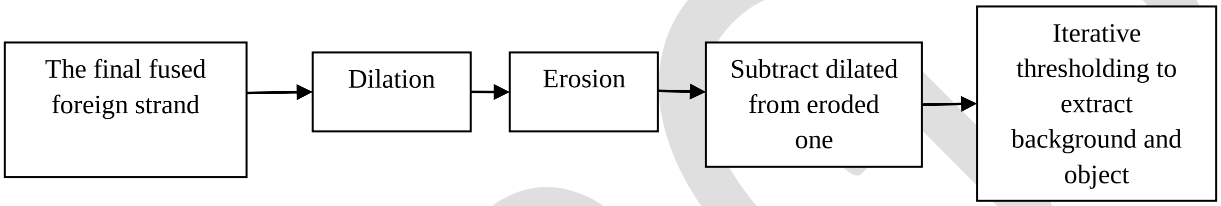

Fig.3 Block diagram of Morphological Segmentation

CONCLUSION

The main aim of this method is to detect images of foreign fibers from background based on their color and brightness saliency features. Also shape features are extracted using morphological edge detection method. The combination of color features and shape features are more effective than any single type of feature in the classification of foreign fibers. Implementation of this paper is done in different images of foreign strands like black feather, red polyproplyne twine, plastic film. As seen visually from the result obtained, proposed method gives result precisely and accurately than Otsu's method and other traditional segmentation methods. The defect of Otsu's method is when the difference between the target and background gray scale is not obvious. The image segmentation results of blue polypropylene, black feather and red twine is shown in Fig. 4.

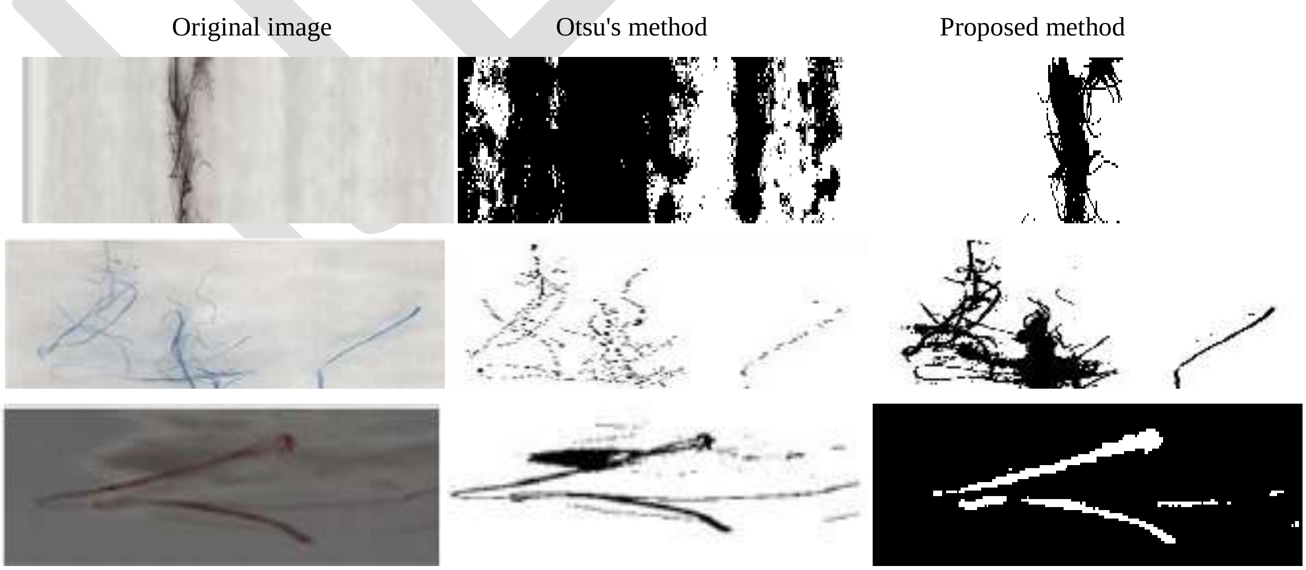

Fig.4 Experimental results of black feather, blue polypropylene and red twine.

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