Detection of Contaminants in Cotton by using YDbDr Color Space

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Abstract

Contaminants in cotton plays important role for its poor quality. The digital image processing techniques based on computer vision provides a good way to eliminate such contaminants from cotton. This paper presents a robust algorithm for detection of contaminants in cotton. By converting the RGB images to YDbDr color space. YDbDr is composed of three components Y, Db and Dr. Y is the luminance, Db and Dr are the chrominance components. By using YDbDr its helpful to distinguish luma and chroma information from RGB image. Iterative threshold segmentation is applied to binarize the image Y, Db, Dr. Performing fusion technique to the three binary images can fuse Luminance and chrominance image information together. For machine vision system, YCbCr and HSI color space has been implemented previously. In which the performance parameters like speed and accuracy of detection and also the detection of small contaminants or insects has to be improved. It is proved by experimental results that the YDbDr is effective and credible.

Keywords: cotton contaminants; detection; YCbCr; HSI; YPbPr; YDbDr

1. Introduction

Contamination has vital role in deciding the quality of cotton apart from essential properties such as length, strength, fineness. Contamination of raw cotton can take place at every step i.e. from the farm picking to the ginning stage. Contamination, even if it is a single foreign fibre, can lead to the downgrading of yarn, fabric or garments or even the total rejection of an entire batch and can cause irreparable harm to the relationship between growers, ginners, merchants, spinner and textile and clothing mills [1]. An International Textile Manufacturers Federation (ITMF) reported that claims due to contamination amounted to between 1.4 – 3.2% of total sales of 100% cotton and cotton blended yarns [2]. A fairly large number of cotton fibers recognition researches are based on RGB color space and YCbCr color space. However, color information is not well presented and extracted in RGB color space due to its limitations and some deficiencies.

Reference [1] proposed Identification of Cotton Contaminants Using Neighborhood Gradient Based on YCbCr Color Space. Reference [2] proposed HSI color space to detect Foreign Fibers And Cotton Contaminants. In this paper we separate luminance and chrominance information in YDbDr color space. And design a cotton contaminants and foreign fibers detection algorithm. Thresholding iteration method is used to image binarizing process.

2. Design of the Proposed System

2.1 Diagram of Contaminants Detection System.

The diagram of cotton contaminants detection system is shown in fig. 1, which consists of two main parts. First part is cotton image collection part and the second part is the contaminants detection part. In first part we collect images of raw cotton layers on the time of ginning and images are converted into digital signal through A/D conversion and sent to image processing system. Where needed features are extracted according to Luminance and chrominance by applying YDbDr color space and after the needed processing of the images of cotton the resulted image will be produced which will collect the information about contaminants or non contaminants. Finally after processing images will be printed in printer.
2.2 Algorithm for Detection of Cotton Contaminants.

Our proposed method firstly transforms the RGB color space images into YDbDr color space to obtain luminance component Y and chrominance components Db and Dr. After getting three different images Y, Db and Dr, the iterative threshold algorithm is used for image binarization of three images Y, Db and Dr. After binarization, the three binary images are fused to get the final fused image. The final fused image is obtained as the resulted image of the contaminants detection algorithm.

3. Analysis of Cotton Contaminants

After analyzing plenty of cotton impurity images, we find that the gray value of cotton fibers is white or mainly concentrates on a range near to it under natural lighting conditions. Due to the different illumination intensity, cotton fiber properties and level, the position of cotton fiber pixel have some difference in color space. On the whole, the pixels in color space meet some certain distributions under certain light. Common foreign fiber contaminants in color space have the following several distributions.[1]

- Color is darker near to black, and the gray value is low, such as black hair and particles from cottonseed, etc.
- Color is much lighter and easy to reflect with high brightness, such as plastic fiber and mulch, etc.
- Color is not pure, but deviate into a kind of color, such as colored cotton thread and polypropylene fiber, etc.
- Color is near to cotton fiber, such as wool and white hair, etc.

4. Selection of Color Space

There are different types of color spaces exit. All the color spaces are for different applications. Selecting the appropriate color space is the primary stage for color image processing. Proper color space can not only save calculation, but also avoid missing useful information as far as possible.[2]

4.1 RGB Color Space

RGB color space is the most fundamental and commonly used color space of image processing. Color information initially collected by image acquisition devices is RGB value, which is also finally used by color display devices. RGB model uses three basic components values of R, B and G to represent color. In this system, any color calculated is all within the RGB colorized cube. However, RGB color space has great shortcomings, the main one of which is that it is not intuitionistic, so it is hard for us to know color’s cognitive attributes expressed by a value from its RGB value. Then, RGB color space is one of the most uneven color spaces, as the visual difference between two colors cannot be expressed as the distance between two color points. In addition, the correlation between RGB is much high, and RGB space is sensitive to noise in low intensity area.[1]

4.2 YCbCr Color Space

YCbCr, Y’CbCr, or Y Pb/Cb Pr/Cr, also written as Y’CgCr or Y’C’bCr, is a family of color spaces used as a part of the color image pipeline in video and digital photography systems. Y’ is the luma component and Cb and Cr are the blue-difference and red
difference chroma components. Y' (with prime) is distinguished from Y which is luminance, meaning that light intensity is non-linearly encoded using gamma correction. Y'CbCr is not an absolute color space; rather, it is a way of encoding RGB information. The actual color displayed depends on the actual RGB primaries used to display the signal. Therefore a value expressed as Y’CbCr is predictable only if standard RGB primary chromaticities are used.[1]

4.3 HSI Color Space

It is more often to think about a color in terms of hue and saturation than in term of additive or subtractive components. hue is the attribute of the visual sensation to one of the perceived colors; red, yellow, green and blue or combination of two of them. Intensity it is the total amount of light passing through a particular area. Saturation represents the purity of color. HSL and HSV are the two most common cylindrical-coordinate representations of points in an RGB color model, which rearrange the geometry of RGB in an attempt to be more perceptually relevant than the Cartesian representation.[2]

4.4 YPbPr Color Space

YPbPr is a color space used in video electronics, in particular in reference to component video cables. YPbPr is the analog version of the YCbCr color space the two are numerically equivalent, but YPbPr is designed for use in analog systems whereas YCbCr is intended for digital video. YPbPr cables are also commonly referred to as Yipper cables. YPbPr is commonly called "component video", but this is imprecise, as there are many other types of component video, mostly RGB which syncs either on green or one or two separate signals.

4.5 YDbDr Color Space

In this paper for our proposed algorithm we using YDbDr color space. YDbDr is composed of three components Y, Db and Dr. Y is the luminance, Db and Dr are the chrominance components. The three component created from an original RGB (Red, Green, Blue) source. The weighted values of RG and B are added together to produce a single Y signal, representing the overall brightness, or luminance, of that spot. The Db signal is then created by subtracting the Y from the blue signal of the original RGB, and then scaling, and Dr by subtracting the Y from the red, and then scaling by a different factor. These formulae approximate the conversion between the RGB color space and YDbDr.

\[
\begin{align*}
\text{Db} &= -0.450R - 0.883G + 1.333B \\
\text{Dr} &= -1.333R + 1.116G + 0.217B
\end{align*}
\]

RGB image                        YDbDr Image
Figure 3: RGB to YDbDr Conversion

These are the two images the first image is RGB image of cotton and the second image is the conversion of RGB to YDbDr color space.

Y component         Db component   Dr component
Figure 4: Separation of layers  Y,Db and Dr

These are the three images of three different components of YDbDr color space. As Y component Db component and Dr component.

5. Experiments and Results

5.1 Experiments in YCbCr Color Space

Fig. 5 shows the conversion of RGB to YCbCr color space.
Fig. 6 shows the separation of Y, Cb and Cr components of YCbCr color space.

Fig. 7 shows the binary images of YCbCr color space. These images are further used for fusion to obtain the final result of the detection algorithm.

Fig. 8 shows the final resulted fused image of YCbCr color space. It detects all three contaminants but it just shows the outlines of the big leaf contaminant; the inner part of the contaminant is not detected by YCbCr color space. This is the biggest drawback of the YCbCr color space. And also the clarity of the final fused image is not as per the requirement. From our more experiments we observed that the YCbCr color space is not well suited for the detection of colors like brown, yellow and many other light colors. YCbCr is only suited for dark colors. This is another drawback of YCbCR color space.

5.2 Experiments in HSI Color Space

Fig. 9 shows the conversion of RGB to HSI color space.

Fig. 10 shows the separation of H, S, I components.

Fig. 12 shows the final fused image of HSI color space. It failed to detect all contaminants as we can see it misses two of the upper side contaminants. So
it is proved that HSI color space is only able to detect large contaminants but its not suitable for detection of small contaminants in cotton.

5.3 Experiments in YPbPr Color Space

Fig. 13 shows the conversion of RGB to YPbPr color space.

Fig. 14 shows the separation of three layers of YPbPr color space.

Fig. 15 shows the binary images of YPbPr.

Fig. 16 shows the final fused image of YPbPr color space. It detect all three contaminants from the cotton image. And also with more accuracy than YCbCr color space and HSI color space.

5.4 Experiments in YDbDr Color Space

Fig. 17: shows the conversion of RGB to YDbDr color space

Fig. 18: separation of YDbDr components.

Fig. 19: binarization of YDbDr

Fig. 20: final fused image in YDbDr color space
Fig. 20 shows the final fused and resulted image of YDbDr color space. It detect all the contaminants from the cotton image. With more accuracy than YCbCr color space and HSI color space. And with more clarity than YPbPr color space.

6. Comparison

We compare these four color spaces on the bases of four parameters like time taken, variance, standard deviation, and mean. The comparison results are as. Figure 21 clearly shows the difference between these four color spaces as we can saw that YDbDr color space takes less time then the other three color spaces. HSI takes more time among all other color spaces.

Fig. 21 shows the mean difference among all the color spaces. Figure shows that mean is almost equal. YCbCr and HSI are little bit on the higher side. While YPbPr and YDbDr are both little bit less than YCbCr and HSI color space.

Figure 21: Time taken by all color spaces

Figure 22: mean difference between color spaces

Figure 23: variance difference between all color spaces

Fig. 21 shows the variance of all the color spaces. As we can saw that the variance difference of YDbDr color space is on the higher side compared to other three color spaces. YCbCr and HSI both color spaces are on the lower side. As we compared them with YPbPr and YDbDr color spaces. YPbPr is also one half as compared with YDbDr color space.

Figure 23: standard deviation difference between all color spaces.
Fig. 23 shows the standard deviation difference between the four color spaces. As we can saw that standard deviation of YDbDr is on the higher side then the other three color spaces.

7. Conclusion
The paper presents the implementation and comparative analysis of the YDbDr, YPbPr, YCbCr and HSI color spaces for the detection of contaminants from the cotton. One of the main objective of this paper is to detect small contaminants or insects from the cotton with more clarity which was not possible in YCbCr and HSI color space. Graph shows the comparison between these four color spaces. on the basis of time taken, mean, variance, and standard deviation. Which shows that YDbDr is better than other three color spaces. Figures also shows that the small contaminants and insects are more accurately detected in YDbDr color space. Compared to Previously implemented color spaces YCbCr and HSI. Various experiments has been carried out on different images of cotton having different contaminants like grass, bark insects, fibres of different materials and colors like red, green, black, yellow etc. the performance of this algorithm in YDbDr color space is also better than other previously implemented algorithms.

8. Future Scope
In future the implementation of this algorithm will be purposed with any neural network technique for classification. For automatic detection of contaminants in real time.

References