Detection Of Foreign Fibers And Cotton Contaminants By using Intensity And Hue Properties.

Pooja Mehta
Electronics and Communication Department
UIET, Panjab University
Chandigarh, India
er.pooja86@gmail.com

Naresh Kumar
Electronics and Communication Department
UIET, Panjab University
Chandigarh, India
naresh_uiet@yahoo.com

Abstract— **In view of the harm of cotton contaminants, the image processing method based on machine vision provides a good solution to eliminating the foreign fibers and contaminants. Digital image processing typically is executed by the special software programs that can manipulate the image in many ways. An automated cotton contamination detection system is economical and efficient to guarantee higher textile quality and lower production cost. There are various techniques used to detect the cotton contaminants and foreign fibers. The major contaminants found in cotton are plastic film, nylon straps, jute, dry cotton, bird feather, glass, paper, rust, oil grease, metal wires and various foreign fibers like silk, nylon, polypropylene of different colors and some of white color may or may not be of cotton itself. After analyzing cotton contaminants characteristics adequately, the paper presents various techniques for detection of white foreign fibers and contaminants from cotton. For machine vision system YCbCr color space has been implemented previously in which the performance parameters like speed of detection and time for detection need to be improved and also the problem of detection of white foreign fiber need to be consider, in this paper the detection has been carried out on HSI color space. By HSI we mean hue, saturation and intensity. 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. The HSI has been implemented on same platform as that of YCbCr color space and results has been compared on the basis of performance parameters like time for detection and no of targets detected, no of missed targets and no of false targets detected. The hardware used for the simulation are Processor: INTEL® core™ i3 CPU, Clock frequency: 2.27 GHz , RAM: 3 GB , Operating system: 32 bit, Hard disk: 320 Gb. The software used is the image processing tool box in MATLAB.**

Keywords—YCbCr, HSI, Matlab

1.1 Introduction

Cotton is a natural fiber harvested from the cotton plant. It is one of the oldest fibers under human cultivation, Cotton is also one of the most used natural fibers in existence today, with consumers from all classes and nations wearing and using cotton in a variety of applications. Foreign fibers or other contaminants can enter into the cotton during harvesting, field storage and ginning. Module covers and tie downs have been major source of fiber

Vol:1 Issue:1 ISSN 2278 - 215X

contamination. Once this material gets into the gin or the mill, it is distributed throughout the fibers and is difficult to remove. It is very difficult to detect until the fabric has been dyed. Fire neps, trash particles and seed coat fragments are visible foreign matters in cotton fiber. These foreign matters in raw cotton influence yarn quality the running characteristics of spinning machine, dyeabilty and also the quality of woven or knitted fabric. The improved blow room machinery and card play a key role in the efforts to reduce the quantity of undesirable particles in cotton. However this required detailed information on the type, size and number of such particles. The digital image made it possible to distinguish between fiber Neps, trash and other foreign fibers.

1.2Methods of Detection of Cotton Contaminants

1. Manual vision system [22]: Manual vision system of detection of cotton contaminants is the oldest method which is used to detect the foreign particles in cotton at small scales. A lot of manual workforce is engaged in the whole process. It is very costly and time consuming process and the accuracy of this system is also very poor.

2. Gravimetric mechanical model [22]: In this method of detection of cotton contaminants a mechanical model is used. For the vision system and the sorting system synchronized with the movement of cotton on the conveyor, an encoder is installed at the shift of the conveyor and driven by the belt. It includes a lot of mechanical parts which reduces the efficiency of system and increases the time of detection and also increases the hardware cost

3. Electro optical model [22]: The electro optical method used for cotton contaminant is based on the High Volume Instrument (HVI). HVI system is suitable for the extensive quality control of all the bales processed in a spinning mill.

1.3 New System of Detection of Cotton Contaminants[5]

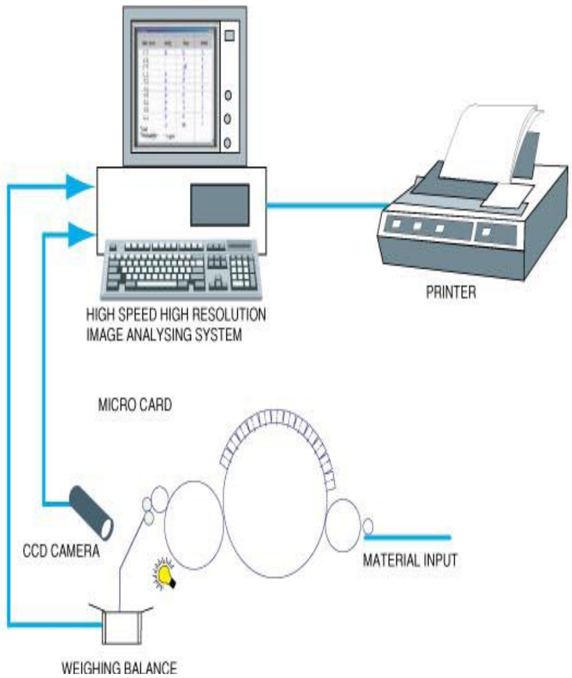


Fig 1:- System for detection of cotton contaminants

In the fig 1 the cotton contamination analyzer specially designed micro cards which convert the raw cotton into thin uniform web without removing any impurities scanned by charged couple device camera (CCD) camera and processed by imaging system to classify undesirable particles in term of size and number. The analyzer will provide help to spinning experts, machinery manufactures and cotton specialists to precisely determine the quantities and type of undesirable particles contained in the cotton. Image processing helps in detection of the contamination from the cotton.

1.4 Performance Parameters[7]

There are several parameters on which the existing detection system can be categorized

1) Ease of operation: The complexities in performing the operation should be less, less the complexity better the performance of the system.

2) Time consumption: The time consumption should be less, we will compare our thesis work on the basis of time taken to complete the operation. Time taken at different stages will be calculated in both the color spaces and then we will compare both the color spaces.

3) Product and Maintenance cost: The hardware used in the operation should not be costly and the maintenance cost should also be less. If the product and the maintenance cost will be high then the expenditure will be more.

4) Performance consistency: The performance level of the system should be consistent; we will check the consistency of the system by applying the algorithm on the different images.

5) Speed of Detection: The speed of detection of the system depends upon the time taken to complete the operation, the lesser the time taken greater will be the speed of the operation.

1.5 Motivation

The traditional competitive advantage conferred to West African cotton has been lost in recent years. A consistent decline in the region's market share is primarily to cotton contaminants: the presence of foreign organic matter such as leaves, stems and pest residue and foreign fibres like nylon fibre, polypropylene, paper and other manufactured agent. Contamination in any raw cotton product causes down time in processing, customer rejection of raw and finished product, costly claims and penalties. As a result of contamination issue, west African cotton is priced less and spinners refuse to purchase the contaminated cotton altogether. The problem of cotton contamination and foreign fibres is damaging the production and earning in developing and some developed countries also. As shown in table below India comes under the category of high contaminants a country, So there should be a proper and effective method for the detection and removal of cotton contaminants.

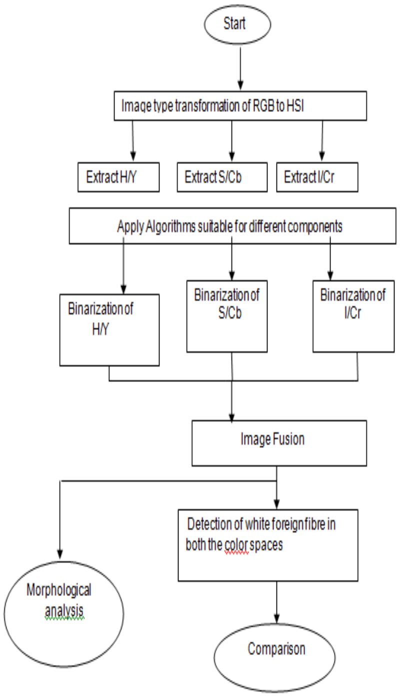
Table 1 shows the percentage of contaminants in cotton bales in many countries

	Origin	% of bales contaminanted	% of fibrous contaminants
Group I (Low contamination)	Australia Brazil China Mexico United States	10%-20%	60%-75%
GroupII (moderate contamination)	Mozambique Paraguay Uzbekistan West Africa Zambia	60%-80%	75%-85%
Group III (high contamination)	**India** Pakistan Uganda Zimbabwe	**90%-100%**	**80%-90%**

Data Showing the contamination percentage in several countries

(Source: M.N Vijayshankar, Vice President PT Apac Inti corpora, Indonesia)

1.6 Proposed work approach

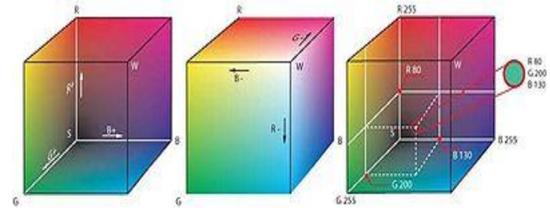


1.7 Selection of Color Spaces

There are different types of color spaces exit. All the color spaces are for different applications.

1.7.1 RGB[18]: RGB color space is any additive color space based on the RGB color model. A particular RGB color space is defined by the three chromaticity's of the red, green, and blue additive primaries, and can produce any chromaticity that is the triangle defined by those primary colors. The complete specification of an RGB color space also requires white point chromaticity and a gamma correction curve.

RGB is initials for Red, Green, and Blue. But these RGB signals are not efficient as a representation for storage and transmission, since they have a lot of mutual redundancy. An RGB color space can be easily understood by thinking of it as "all possible colors" that can be made from three colorants for red, green and blue. Imagine, for example, shining three lights together onto a white wall: one red light, one green light, and one blue light, each with dimmer switches.



1.7.2 HSI: 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.

$$H' = \begin{cases} \text{undefined}, & \text{if } C = 0 \\ \frac{G-B}{C} \bmod 6, & \text{if } M = R \\ \frac{B-R}{C} + 2, & \text{if } M = G \\ \frac{R-G}{C} + 4, & \text{if } M = B \end{cases}$$

$$H = 60^\circ \times H'$$

$$I = \tfrac{1}{3}(R + G + B)$$

$$S_{HSV} = \begin{cases} 0, & \text{if } C = 0 \\ \frac{C}{V}, & \text{otherwise} \end{cases}$$

$$S_{HSL} = \begin{cases} 0, & \text{if } C = 0 \\ \frac{C}{1-|2L-1|}, & \text{otherwise} \end{cases}$$

1.7.3 YCbCr[5]: YCbCr space allows coding schemes that exploit the properties of the human vision by truncating some of less important data in color pixel. **YCbCr** or **Y′CbCr**, sometimes written YCBCR or Y′CBCR, is a family of color space 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; it is a *way of encoding* RGB information. The actual color displayed depends on the actual RGB colorants used to display the signal. Therefore a value expressed as Y′CbCr is only predictable if standard RGB colorants are used

$$Y' = 16 + (65.481 \cdot R' + 128.553 \cdot G' + 24.966 \cdot B')$$
$$C_B = 128 + (-37.797 \cdot R' - 74.203 \cdot G' + 112.0 \cdot B')$$
$$C_R = 128 + (112.0 \cdot R' - 93.786 \cdot G' - 18.214 \cdot B')$$

2. 1 Experiment in YCbCr color space

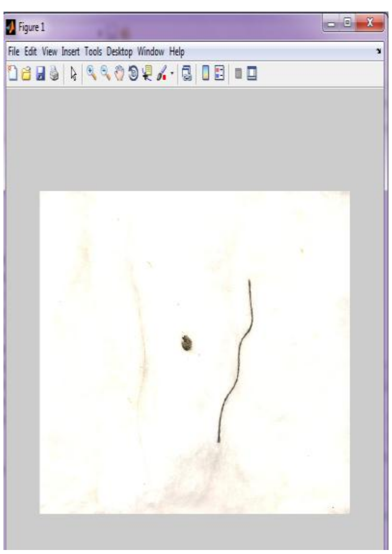
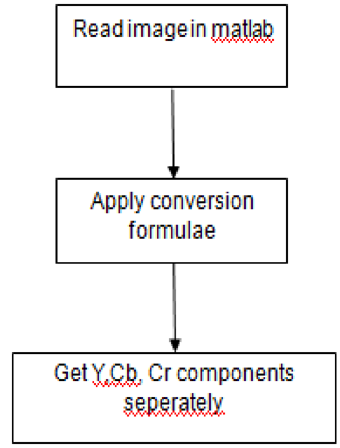


Fig 2 Original image having two foreign fibres and one insect

STEP 1: TO CONVERT THE RGB IMAGE INTO YCbCr IMAGE



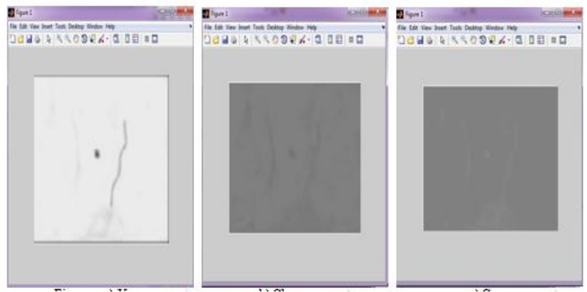
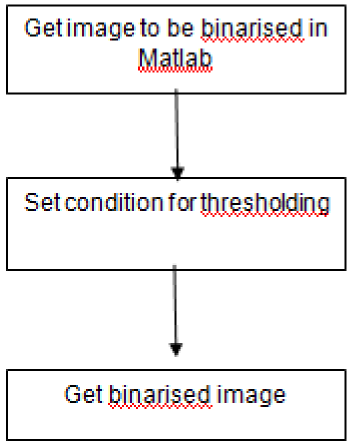


Fig 3 Y component Cb component Cr component

The above figure 3 shows the different components of YCbCr color space Luminance and chrominance components separately. All the components show different components. Next step is to get the binarised image of the different components which clearly shows the contaminants separately from the cotton.

Vol:1 Issue:1 ISSN 2278 - 215X

STEP 2 BINARISATION OF DIFFERENT COMPONENT



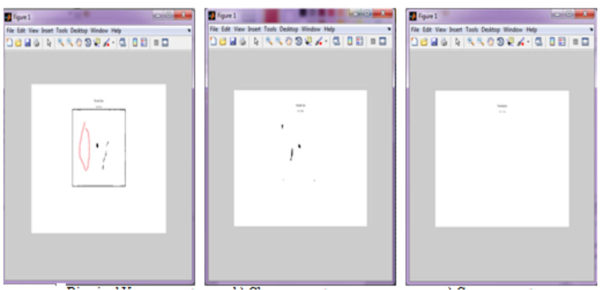
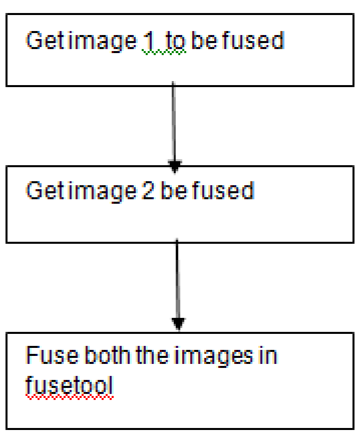


Fig 4 Binarised Y Cb Cr component

STEP 3 FINAL FUSED IMAGES



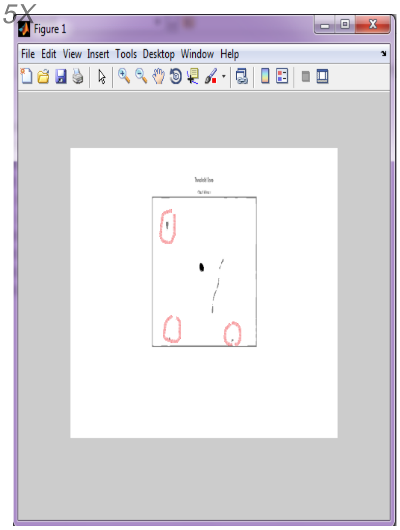
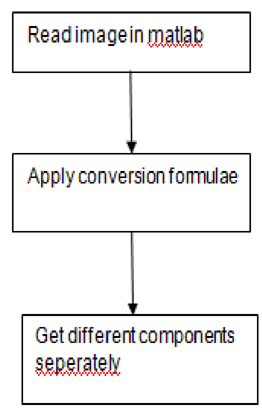


Fig 5 final fused image

As shown above in fig 5 there are so many false targets and also the white color fiber which is visible in the original image has not been detected by the YCbCr color space. The fig 4 shows the binarised Y component which is also not showing the white fiber. Next experiment will be carried on HSI color space.

2.2. Experiment in HSI color domain

STEP 1: TO CONVERT THE RGB IMAGE INTO HSI IMAGE



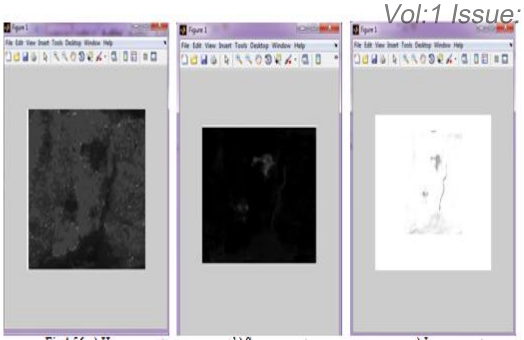
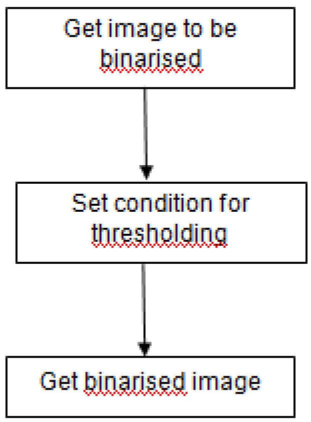


Fig 6 H component S component I component

STEP 2 BINARISATION OF DIFFERENT COMPONENT



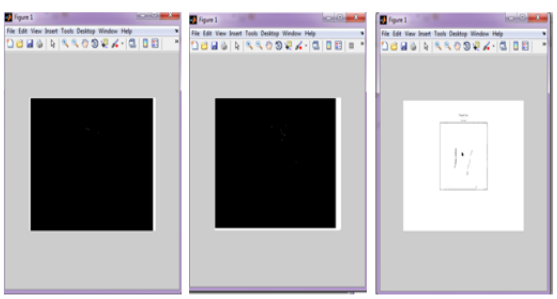
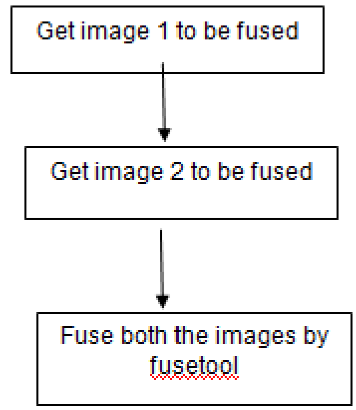


Fig 7 Binarised H Scomponent I component

The fig 6 shows the hue, intensity and saturation components and the fig 7 shows the binarised images of hue, intensity and saturation components. As shown in binarised image of the intensity component the white fiber has been detected efficiently which has not been detected by the YCbCr color space. The next fig 8 shows the final fused image which shows all the contaminants detected along with the two false targets

STEP 3 FINAL FUSED IMAGES



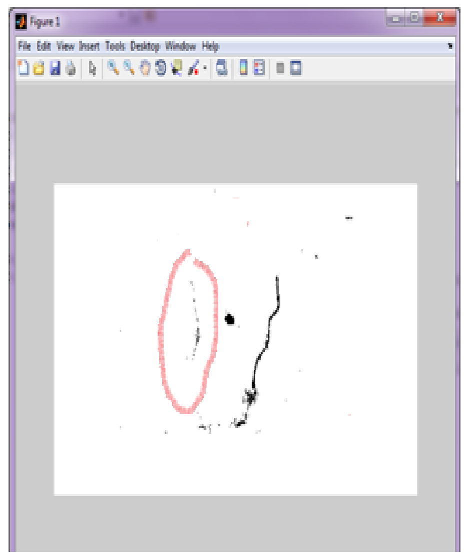


Fig 8 final fused image

The fig 8 shows the final fused image in which the detected fibers and insects has been clearly shown . It is clear that the white foreign fiber has been detected by the HSI color space as shown in red incircle which has not been detected in the YCbCr color space as shown where the white thread has not detected. This is the advantage of HSI color space over that of the YCbCr color space.

3.1Results And Discussions

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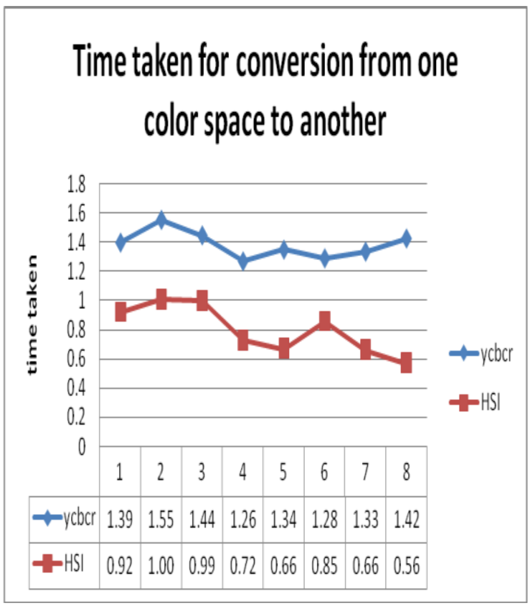
The graphs below shows the comparison of time taken in HSI and YCbCr color space algorithm at different stages and also concluded that the time taken for the HSI color space is less as compared to that of the YCbCr color space.

3.2 Hardware Used

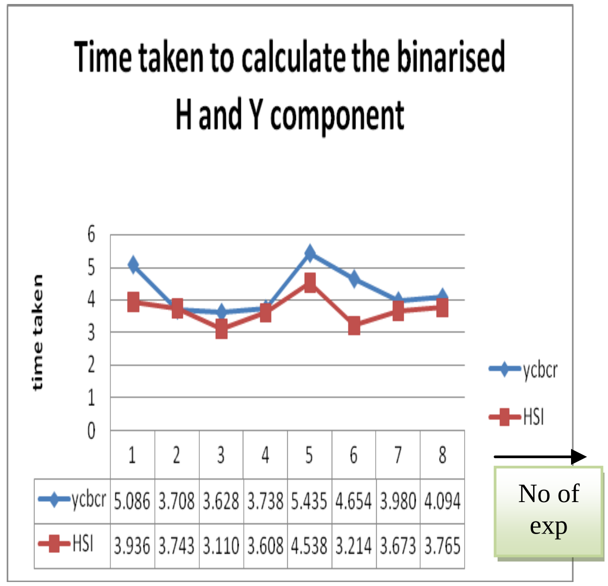
The hardware used for the simulation is as below:

1. Processor: INTEL® core™ i3 CPU
2. Clock frequency: 2.27 GHz
3. RAM: 3 GB
4. Operating system: 32 bit
5. Hard disk: 320 Gb

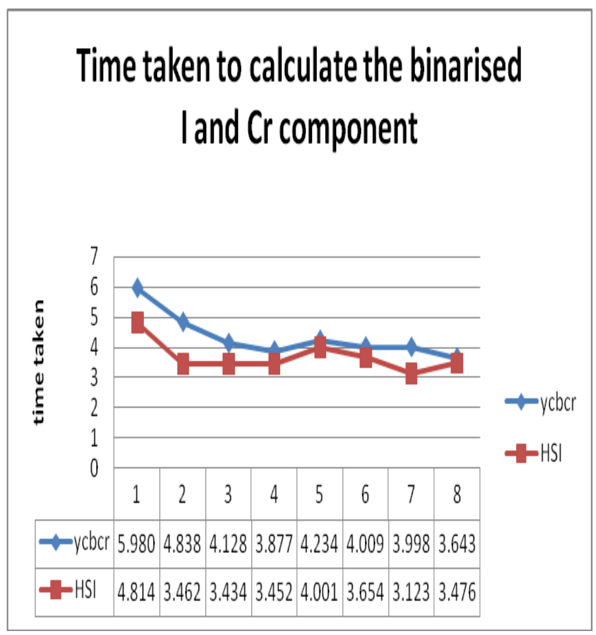
3.3Time Taken To Calculate The Conversion Time From RGB To Other Color Space



3.4Time Taken To Calculate The Binarised H And Y Component

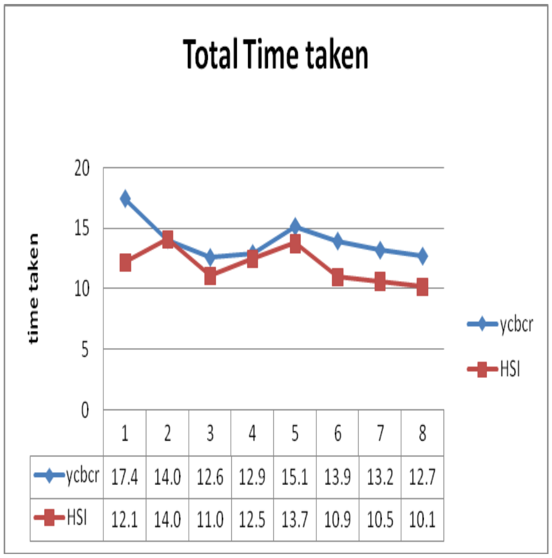


3.5Time Taken To Calculate The Binarised I And Cr Component



Vol:1 Issue:1 ISSN 2278 - 215X

3.6Graph Showing Total Time In Both Color Spaces



4 Conclusion

The paper presents the implementation and comparative analysis of the HSI and the YCbCr color spaces for the detection of the contaminants and the foreign fibers from the cotton. One of the main objective of this paper is to detect the white foreign fiber from the cotton which is not possible in YCbCr color space as discussed in reference [19] and in HSI color space it is possible to detect the white foreign fibre from the cotton. Graph shows the comparison between the HSI and the YCbCr color space clearly on the basis of time taken for detection in the form of graphs. Figure also shows that it is also possible to detect the white fibre from the cotton in HSI color space which is not possible in YCbCr color space as shown in figure. 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, white etc. the time taken in whole algorithm in HSI color space is also less as compared to Ycbcr color space as shown in graphs above.

5 Future Scope

In future scope it may be possible to design a system which is able to differentiate the foreign fibres on the basis of material like silk, cotton and nylon etc so that it may be possible to reuse that contaminants further for use. This model can be implemented in real time applications.

6 Acknowledgment

I feel extremely privileged and honored for getting this opportunity to express my sincere thanks and deep sense of gratitude for **Prof. Renu Vig**, Director, UIET. It is my heartful pleasure and deepest sense of gratitude to offer my humble and sincere thanks towards my esteemed guide **Mr. Naresh Kumar**, Asst. Prof. (ECE), UIET whose expert guidance, invaluable experience, intellectual advice and extreme generosity helped me a lot throughout the pursuit of the work without whose guidance the project would have never materialized.

I owe much of the success of the work to my parents, family and friends for constantly encouraging and supporting me in each possible way throughout present span.

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