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Determination of Accuracy of Intensity Based Segmentation in HSV Color Space

Seema Panwar, Bipan Kaushal

Abstract— Image segmentation is an important step in any image processing. It helps us to partition the image into its constituent region so as to thoroughly study the region of interest. This partitioning can be on the basis of texture, color, intensity etc. In this paper HSV color space is used and intensity window based segmentation is applied to segment a particular color from an image. Here we have preferred HSV based color segmentation over the RGB or CMYD, since the color used in HSV is clearly defined by human perception. This algorithm can be used in any application where a particular color has to be segmented out from background which is also of uniform color. Here, the algorithm is applied on the manually prepared geometrical samples, where green and yellow papers are used to prepare those samples. The algorithm segments the yellow region from the whole region and also calculates the ratio of yellow region over the rest of the region. In order to check the accuracy of the algorithm the ratio is also calculated mathematically and then compared with the experimental value.

Keywords— *HSV color space model, Image segmentation, median filtering, morphological operations*

I. INTRODUCTION

Image segmentation is the process of partitioning a digital image into multiple segments i.e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as colour, intensity or texture, so as to locate and identify objects and boundaries in an image [1]. Image segmentation finds application in a wide range of field such as face detection, locating objects in satellite images, finger print recognition, medical imaging, intelligent transportation etc. The most widely used technique for segmentation are thresholding method, edge detection based techniques, region based techniques, clustering based techniques, watershed based techniques etc[2].The selection of the segmentation method is application dependent. There is no robust segmentation algorithm available which can be applied in all situations.

Since we have to deal with colored images in our day to day life and color being the important vision property of an image[3], so segmentation on the basis of color finds a wide range of application. The most widely used color models are the RGB and HSV color models. The RGB color model is based on Cartesian coordinate space that represented x, y and z axes and is mostly used for computer applications [3] while when it comes to human thinking HSV color space model is used. The proposed method does the segmentation on the basis of HSV color space and also finds out the ratio of a particular color which we can choose from the histogram of the hue channel, and the background color.

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Seema Panwar*, Department of electronics and communication,PEC university of technology, Chandigarh, Chandigarh, India*
Bipan Kaushal*, Department of electronics and communication,PEC university of technology, Chandigarh, India*

II. HSV COLOUR SPACE MODEL

HSV (Hue, saturation, value) color model is mostly used when it comes to human interpretation. Given a colour a human being never thinks of how much of red, how much of green or how much of blue is contained in a given colour. But what we really think of is what the prominent colour is in that particular specified colour. The other importance of HSV model is that it decouples the chromatic information from the intensity information.

Fig. 1 shows the HSV model in the form of H-S-V hex cone. The hue which varies from 0 to 360o representing hues of red (starts at 0), yellow (starts at 60), green (starts at 120), cyan (starts at 180), blue (starts at 240), and magenta (starts at 300). Similarly, there is saturation which indicates as to how much a pure spectrum colour is really diluted by mixing white colour to it [4]. Then we have the value that actually gives the chromatic motion of brightness of black and white image.

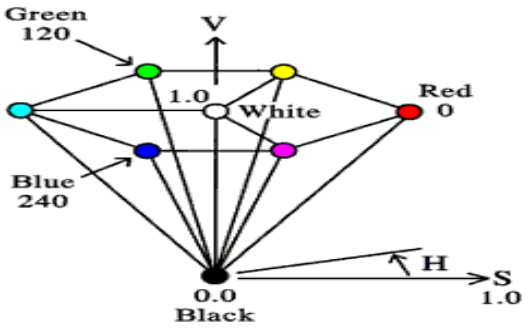

fig. 1 HSV colour space representation

Many of the image processing algorithms which are developed for black and white images can be applied to the images specified in the HSV domain. So it becomes very important to convert the image from RGB color space to HSV color space. The hue, saturation and value component for each pixel in an image is obtained by using the following equations [5]

$$H = \begin{Bmatrix} \theta \ if \ B \leq G \\ 360° - \theta \ if \ B > G \end{Bmatrix} \quad (1)$$

Where

$$\theta = arccos\left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{\frac{1}{2}}} \right\} \quad (2)$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)] \quad (3)$$

$$V = \frac{1}{3}(R+G+B) \quad (4)$$

III. THE PROPOSED METHODOLOGY

The flow of proposed algorithm is given in figure 2 and it is applied on manually prepared (using green and yellow papers) geometrical figures. Its accuracy is validated by comparing the ratio we get from our proposed method and the mathematical calculation [6]. The steps followed are:

Step 1: RGB image is taken as the input and pre-processing is done to remove salt and pepper noise using median filter.

Step 2: RGB image is converted into HSV image and then hue and value channel are separated. Now we go for background removal, which we consider of low intensity value. In most of test images v < 0.3 is considered as background and all the pixel values less than 0.3 are set to zero.

Step 3: After this the area of the remaining portion is computed.

Step 4: From the histogram of the hue channel threshold of particular colour (here yellow) which we need to segment is determined.

Step 5: Morphological erosion followed by dilation (image opening) to connect nearby yellow leaf patches and remove noise is done. This is followed by connected component analysis to remove very small patches. Here we have removed all the pixels whose value is less than 500.

Step 6: The ratio of the area of the desired(here yellow) region to the rest of the region (here green) is calculated.

Step 7: The ratio that we get from step 6 is compared with the mathematical value of the ratio.

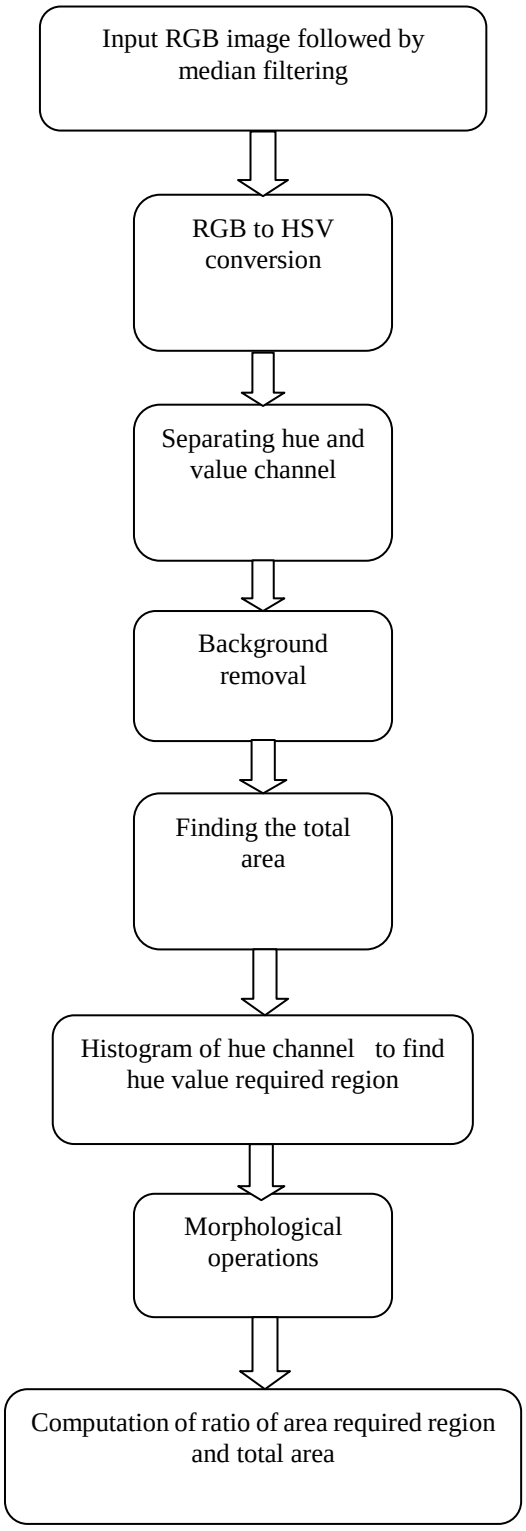

Fig. 2 Flowchart of the proposed algorithm

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IV. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed algorithm is implemented on Matlab 2013 and applied on 20 samples, results of 8 samples are shown in figure 3

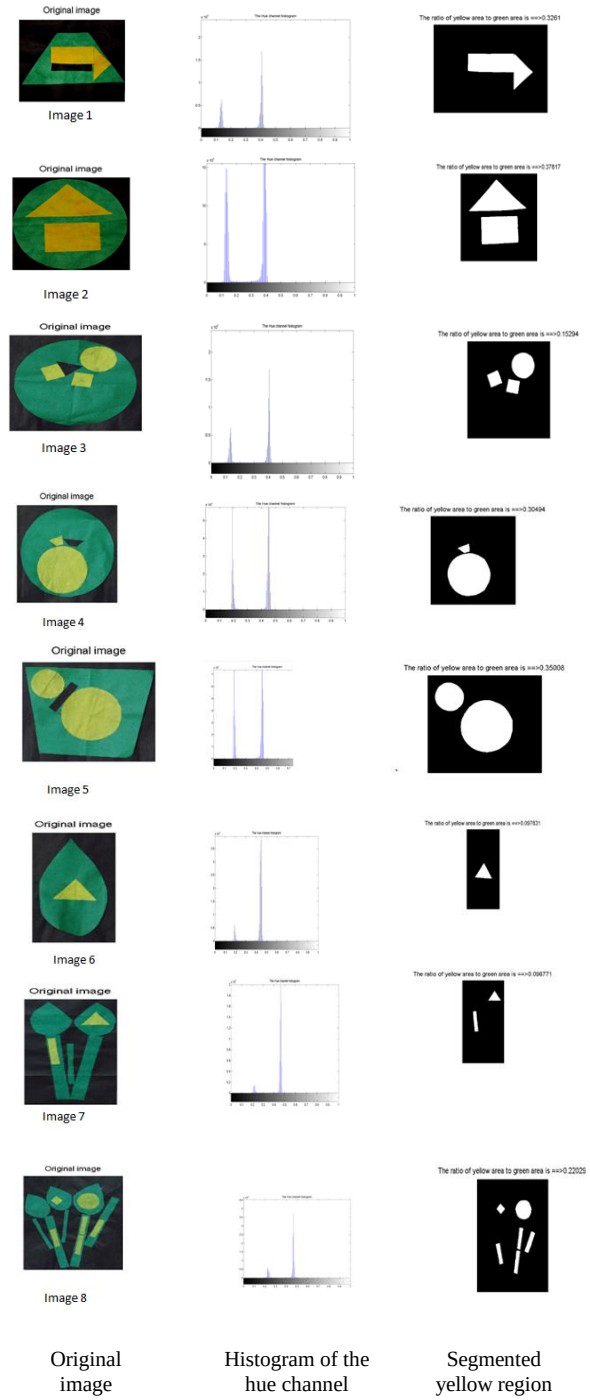

Fig. 3 Result of the algorithm when applied on the manually prepared samples

In the above shown samples we have calculated the hue value for yellow from the hue channel histogram and then segmented the yellow region and finally calculated the ratio of area of yellow region and green region. Here we have considered the black region as the background and it is not included in the area calculation. The area of geometrical figures like square, rectangle and triangle are calculated by using mathematical formula and for leaf like shape we have used the grid counting method. Then the ratio obtained by the algorithm is compared with the mathematically calculated ratio. The results given in table 1 and the graphs shown in figure 4 clearly depict the closeness between the results obtained by the proposed algorithm and the mathematically calculated results.

Table 1: Comparison table

S.NO.	IMAGE NAME	EXPERIMENTAL RATIO(ER)	MATHEMATICAL RATIO(MR)	DEVIATION BETWEEN (ER) AND (MR)
1.	IMAGE 1	0.3261	0.32656	0.00046
2.	IMAGE 2	0.37817	0.3753	0.00287
3.	IMAGE 3	0.15294	0.154	0.00106
4.	IMAGE 4	0.30494	0.3022	0.00274
5.	IMAGE 5	0.35008	0.3226	0.02748
6.	IMAGE 6	0.097831	0.1008	0.002969
7.	IMAGE 7	0.096771	0.09633	0.000441
8.	IMAGE 8	0.21907	0.2255	0.00643

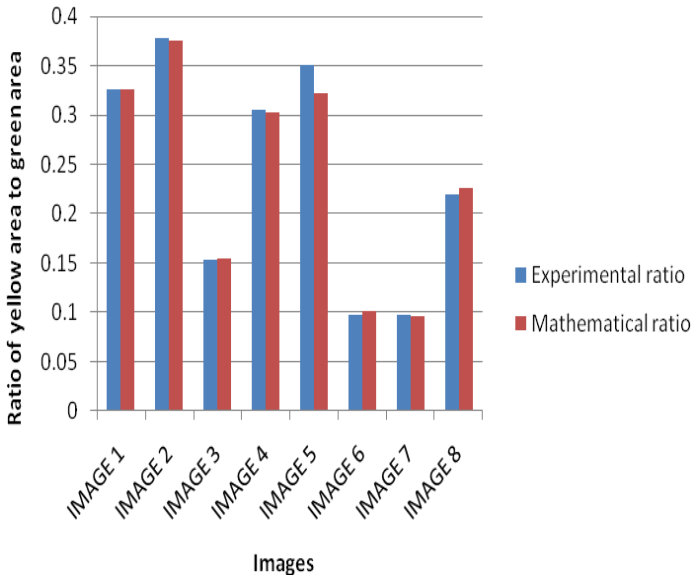

Fig. 4 comparison graph

V. CONCLUSION

In this paper intensity based segmentation in HSV color space is done to find out the ratio of a particular color in the image. Further the accuracy of this algorithm is determined by

comparing the results obtained by the algorithm with the mathematically calculated results. The algorithm can be used in wide application like yellow rust detection or defect segmentation in fruit. The algorithm is quite simple and gives fast result.

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