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# Multi-Color Recognition based on Mini-Max Color Threshold for Medical Purpose

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**Abstract:** This paper discusses the multi-color recognition using the min-max color threshold for outdoor robot navigation. All colors used in this project are RGB orthogonal color space in order to see how much of each primary color between min and max that can be observed in the color to be recognized. The white color value in the color space is set as the object for which the target color to be recognized belongs, while the black color value is set as the object background. The recognition process is done by summing up first the values of the red, green and blue in each color to obtain the rgb sum value, which is then divided by the individual color element to obtain the color threshold. This threshold is compared to the originally color threshold for the recognition, where a satisfactory result is expected as the project is not yet finished.

**Keywords:** Color recognition, threshold, mini-max, multicolor

## I. INTRODUCTION

WIth the rapid development of the technology, computer vision research keeps progressing and is about to lead many research fields due to its contribution in the domain of security saving many lives. For example most of the recent security systems are computer vision based security systems as well as intelligent machines or navigation systems. The goal of computer vision is recognition is to extract several different kinds of information from image, and much of the processing that takes place has been or is being optimized by evolution and experience to perform very efficiently. But at the same time, other types of the information are either ignored or suppressed and are not normally observed [1-2]. To be recognized, objects, including colors or features must have a name, such as some label that our consciousness can assign. Behind that label is a mental model of the object that can be expressed either in image, memories of associate events, or perhaps in other forms. This model captures the important characteristics of the objects [3]. Swain and Ballard [4] proposed a simple and effective recognition scheme called *Histogram Intersection,* with matches model and image on the basis of color histograms. It shows that color histograms are stable object representations in the presence of occlusion and over change in view, and that they can differentiate among a large number of objects. Their method started with a pair of histograms, I and M, each containing n bins. The intersection of the histograms is defined to be the minimum sum of a pair of the histograms. To obtain a fractional match value between 0 and 1 the intersection is normalized by the number of pixels in the model histogram where the match value is obtained. The normalized histogram intersection match value is not reduced by distracting pixels in the background. The histogram intersection match value is only increased by a pixel in the background if : 1) the pixel has the same color as one of the colors in the model, 2) the number of pixels of that color in the object is less than the number of pixels of that color in the model. However, it has the drawback that when the illumination circumstances are not equal, the object recognition accuracy degrades significantly. This method is extended by Funt and Finlayson [5] to remove the effects of varying conditions of illumination and normalize the images to a standard illuminant.

## II. RRELATED PREVIOUS WORK

### A. Summary of Swain and Ballard work

Swain and Ballard have proposed [4] a pattern recognition method called *Histogram Intersection*, where they used a pair of histograms I and M, each containing n bins, where the intersection of the histograms is defined as:

$$\sum_{j=1}^{n} \min(I_j, M_j) \tag{1}$$

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The result of the intersection of the model histogram with an image histogram is the number of pixels from the model that have corresponding pixels of the same color in the image. To obtain a fractional match value between 0 and 1, the intersection is normalized by the number of pixels in the model histogram. The match value is:

$$H(I,M) = \frac{\sum_{j=1}^{n} \min(I_j, M_j)}{\sum_{j=1}^{n} M_j} \quad (2)$$

The match value of the normalized histogram intersection was not reduced by distracting pixels in the background. This was the desired behavior since complete segmentation of the object from the background cannot be guaranteed. The match value of the histogram intersection is only increased by a pixel in the background if.

- The pixel has the same color as one of the colors in the model and the number of pixels of that color in the object is less than the number of pixels of that color in the model.

To segment the object from the background and scale the image histogram to be the same size as the model histogram, the Histogram Intersection is equivalent to the use of the sum of absolute differences or *city-block* metric if,

$$\sum_{i=1}^{n} M_j = \sum_{i=1}^{n} I_j \quad (3)$$

Where gives (4)

$$1 - H(I,M) = \frac{1}{2T} \sum_{i=1}^{n} \left| I_i - M_j \right| \quad (4)$$

Although a good result has been obtained its drawback is that, when the object intensity is more sensitive to the light variation from the shadow and the distance from the light source, the object color recognition is poor forcing the use of *wb* color.

*Wb* =Analogous to the opponent color axes used by the human visual system [4].

Where:

$$wb = r + g + b \quad (5)$$

B. **Summary of Gevers and Arnold**

Gevers and Arnold proposed color-based object recognition of which the aim of their work is to recognize a multicolored objects invariant to substantial change in viewpoint, object geometry and illumination. Their work is not so far from our work in which we want to recognize a multicolor for robot autonomous navigation system. They proposed a new color constant color ratio not only independent of the illumination color but also discounting the object's geometry as follows:

$$m(C_1^{x_1}, C_1^{x_2}, C_2^{x_1}, C_2^{x_2}) = \frac{C_1^{x_1} C_2^{x_2}}{C_1^{x_2} C_2^{x_1}}, \; C_1 \neq C_2 \quad (6)$$

Expressing the color ratio between two neighboring image locations for

$$C_1, C_2 \in \{R, G, B\} \quad (7)$$

Where:

$X_1$ and $X_2$ denote the image locations of the two neighboring pixels. This method has a perfect range of recognition accuracy of matching process from [86-96] out of 100 of $N_2$=70 test image and N=500 reference image for various colors features. However its provide worse accuracy due to the discriminative sensitivity power of RGB that have the worst performance to its sensitivity to varying viewing direction and object positioning.

## III. BASIC COLOR CHARACTERISTICS

The image processing is used in a wide variety of applications at least for three different purposes:

- Improving the visual appearance of image to human viewer.
- Preparing image for the measurement of the features and structure that they reveal
- Processing image for recognition.

The techniques that are appropriate for each of these tasks are not always the same but there are sometimes considerable overlaps. To do the best possible work on image for pattern recognition it is very important to know about the color characteristics and the use to which the processes image will be put. Most of the work on pattern recognition or image processing involve the conversion of

the brightness of the individual red, green and blue signals to YIQ/YUV, HSL and HSV. The advantage of this process is that there will be no loses of image information except for possible round-off-errors.
Where:

- Y is the luminance signal of the brightness of panchromatic monochrome that would be displayed by black-and-white. It combines the red, green and blue in proportion to the human eyes sensibility to them.

- I and Q or U and V components of the color are chosen for compatibility with the hardware used in broadcasting.

- I is the signal and its can be calculated as follows:

$$I = R - C \tag{8}$$

- Q the color signal is difference between Magenta and Green. Thus

$$Q = M - G \tag{9}$$

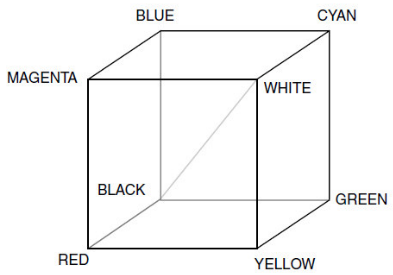


Fig.1 is the color space, showing the additive progression from black to white. Combining red and green produces yellow, green plus blue produces cyan and blue plus red produces magenta. Grays lie along the cube diagonal, with equal proportions of red, green and blue. Cyan, yellow and magenta are subtractive primaries used in printing.

The relation between YIQ and RGB is shown in the Table1 and Table2, while the Fig1 the space color.

**Table1**: Conversion of YIQ to RGB Color Scales

| | | | |
|---|---|---|---|
| Y = | 0.299R | +0.587G | +0.114 B |
| I = | 0.596 R | - 0.274G | -0.322 B |
| Q = | 0.211R | -0.523G | + 0.312 B |

**Table 2**: Conversion of RGB to YIG Color Scales

| | | | |
|---|---|---|---|
| R = | 1.000Y | + 0.956 I | + 0.621 Q |
| G = | 1.000Y | - 0.272 I | - 0.647 Q |
| B = | 1.000Y | - 1.106 I | + 1.703 Q |

Another work can be done by conversion between RGB spaces and the Hue, Saturation and Intensity coordinates. This method can be performed in several ways, depending on the shape of the HSI space that is used. Where,

- Hue is the color describing the wavelength. For instance the distribution between red and yellow.

- Saturation is the amount of the color that is present. For instance the distinction between red and pink.

- The third axis called intensity or lightness is the amount of light distinction between a dark red and light red or between gray and light gray. The space in which these three values are plotted is shown in Fig.2

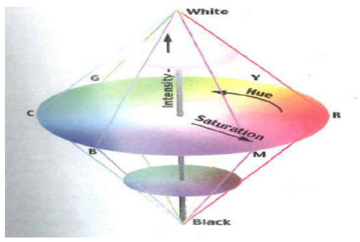


**Fig.2** Bi-conic representation of hue-saturation- intensity space.

But it can be circular or hexagonal cone or double cone or sometimes as a cylinder. In all case the intensity axis is aligned along the body diagonal of the RGB cube, but none of the HSI space geometrics exactly fits the shape of the cube. This means that to represent colors in both spaces, the saturation value must be distorted somewhat in the conversion process. The values for hue and saturation can be calculated as:

$$H = \tan^{-1}\left(\frac{a}{b}\right) \tag{10}$$

$$S = \sqrt{a^2 + b^2} \tag{11}$$

Where:

$$\begin{bmatrix} L \\ a \\ b \end{bmatrix} = \begin{bmatrix} 1/3 & 1/3 & 1/3 \\ -\sqrt{2}/6 & -\sqrt{2}/6 & -\sqrt{2}/6 \\ 1/\sqrt{2} & -1/\sqrt{2} & 0 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ bB \end{bmatrix} \quad (12)$$

The following is the conversion for conical space.

$$I = \frac{R + G + B}{3} \quad (13)$$

$$S = 1 - \frac{3 \cdot \min(R, G, B)}{R + G + B} \quad (14)$$

$$H = \begin{cases} \cos^{-1}(z) & if \quad G \geq R \\ 2\pi - \cos^{-1}(a) & if \quad G \leq R \end{cases} \quad (15)$$

and

$$Z = \frac{\frac{2B - G - R}{2}}{\frac{\sqrt{(B - G)^2 - (B - R)}}{(G - R)}} \quad (16)$$

Here:

A = Axis running from red (+a) to green (-a)

B = Axis running from yellow (+b) to blue (-b)

L = Axis running from black to white, usually the gray-scale axis or luminance.

Here Hue does not have the same angular distribution in this space as in the usual color wheel. These axes offer space that corresponds to hardware and the more spectrophotometers based space such as HSI, which are used in many color management systems [1].

## IV. RESEARCH APPROCH

There are many techniques in the open literature involving the colors recognition, whether it is a single color or a multicolor. But of all these proposed methods none of them proposed a multicolor recognition based image processing involving more than 6 colors. Although the word multicolor is used in many manuscripts describing the color recognition, three is the maximum limit colors used so far. In this work the color space shown in Fig.3 representing the coordinates color consisting of eight colors is used.

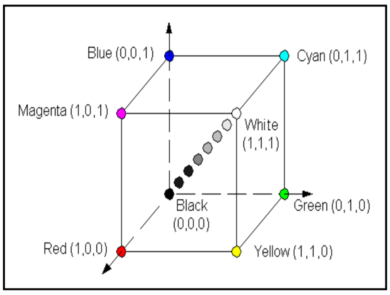


Fig.3 Color space

All colors are based on RGB orthogonal color space as Cyan, Yellow and Magenta are the combination of the RGB color. This color space attempts to qualify how much of each primary color between 0 and maximum, is in the color observed. The white color value in the color space is the object for which the target object color belong to, while the black color value is the object background. In this space the FDMPCI_RGB888 format is used where 8 bits each represent red, green and blue, with no space between data for successive pixels, apart from that at the end of the line due to the 4 boundary condition. Each individual color value of the RGB that contain in each color of Fig.4 is extracted using Eyedropper.

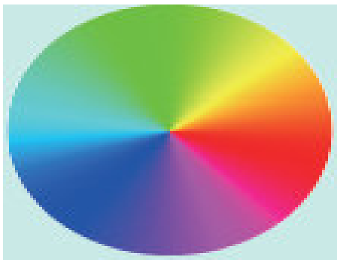

Fig.4 Multicolor to be recognized

To train the vision system to recognize these colors, eye dropper is use for the extraction of the individual value. We first moved the eyedropper over the target color then look at the eyedropper display screen where the value of each individual color is displayed then write it down. This process is repeated over and over until all colors values are extracted. For pure color, example 100% red the individual value is bigger than green and blue and remain constant over all points we moved the eyedropper console, so do for green and blue too. For cyan, yellow and magenta the RGB value vary depending on the dominant color that was used during the mixing process. Individual color value extracted are shown in the Tables below

Table3. Red color value

| Red | Green | Blue | $\sum rgb$ |
|---|---|---|---|
| 238 | 041 | 057 | 336 |
| 242 | 067 | 045 | 354 |
| 244 | 102 | 049 | 395 |
| 247 | 124 | 099 | 470 |
| 249 | 143 | 051 | 443 |

Table4. Green color value

| Red | Green | Blue | $\sum rgb$ |
|---|---|---|---|
| 121 | 193 | 055 | 369 |
| 113 | 191 | 068 | 372 |
| 120 | 189 | 074 | 383 |
| 109 | 190 | 067 | 366 |
| 116 | 192 | 069 | 377 |

Table5. Blue color value

| Red | Green | Blue | $\sum rgb$ |
|---|---|---|---|
| 039 | 089 | 146 | 274 |
| 038 | 087 | 167 | 292 |
| 035 | 086 | 166 | 287 |
| 044 | 088 | 169 | 301 |

Table6. Yellow color value

| Red | Green | Blue | $\sum rgb$ |
|---|---|---|---|
| 231 | 231 | 078 | 540 |
| 215 | 255 | 076 | 546 |
| 241 | 235 | 075 | 551 |
| 238 | 231 | 077 | 546 |
| 240 | 229 | 055 | 524 |

Table7. Cyan color value

| Red | Green | Blue | $\sum rgb$ |
|---|---|---|---|
| 063 | 210 | 218 | 491 |
| 082 | 196 | 227 | 505 |
| 075 | 199 | 219 | 493 |
| 077 | 197 | 222 | 496 |
| 091 | 198 | 221 | 510 |

Table8. Magenta color value

| Red | Green | Blue | $\sum rgb$ |
|---|---|---|---|
| 160 | 089 | 163 | 412 |
| 161 | 090 | 134 | 385 |
| 164 | 091 | 160 | 415 |
| 169 | 085 | 159 | 413 |
| 182 | 079 | 162 | 423 |

## V. RECOGNITION PROCESS

The objective of this work is to train the visual system to recognize the multicolor consisting of six colors for robot navigation system. All value of individual color extracted must be used in order to keep all pixels in the recognition range. Below is how these values are processed and for space constraint only an example one color (Red in table 3) is chosen

- Step1: The values of red, green and blue respectively, 208, 041 and 057 are sum up to obtain the $\sum rgb$ value of 336.
- Step2: Each individual value of the rgb shown in the Table 3 is then divided by the $\sum rgb$ value in step1 to obtain the threshold as shown in table9. This method is repeated for all colors..

Table 9. Threshold values of Red, Green and Blue

| Red | Green | Blue |
|---|---|---|
| 0.70 | 0.48 | 0.53 |
| 0.68 | 0.51 | 0.57 |
| 0.61 | 0.49 | 0.58 |
| 0.52 | 0.52 | 0.56 |

After the color data processing is over, we set the minimum and the maximum value of the threshold of each color for the recognition process as follows:

$$THR1 \le r/s \le THR2$$

$$THG1 \le g/s \le THG2$$

$$THB1 \le b/s \le THB2$$

Where:

THR1 = Minimum threshold value of the red color

THR2 = Maximum threshold value of the red color

THG1 = Minimum threshold value of the green color

THG2 = Maximum threshold value of the green color

THB1 = Minimum threshold value of the blue color
THB2 = Maximum threshold value of the blue color

The same recognition method is used for yellow, cyan and magenta colors. By this method all the color data are contained between 0 and 1. Next we have calculated the center of the gravity (X, Y) of all color based on Sugisaka and Zacharie method (6) as follows:

$$X_c = \frac{\sum_{i=0}^{n-1} (X\_START\_Pixels)}{\sum_{i=0}^{n-1} rgb} \qquad (17)$$

$$Y_c = \frac{\sum_{i=0}^{n-1} (Y\_START\_Pixels)}{\sum_{i=0}^{n-1} rgb} \qquad (18)$$

## V. EXPECTED RESULTS

The camera used for this research is a Pixera PXG-150N-PH's shown in Fig.5 digital image processing that automatically controls white balance, electronic shutter, saturation, hue and luminance, maintaining superior image quality and color reproduction.


Fig.5 Pixera digital image processing camera

Optimal glass pinhole lens produces razor sharp video in a variety of lightning conditions. With 680 by 480 image resolution, for fast computation the width of the output resolution is multiplied by the bit-count (24bit) in order to create a new BYTE which in turn is multiplied by the height of the image frame. Although the final result of this research is not yet been obtained as the work is still going on the pre-result we expect to obtain is shown in Fig.6

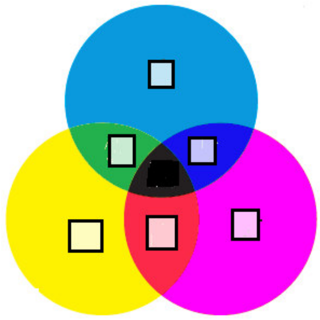

Fig.6 Expected six colors recognition result

Based on the center gravity of each color, when all six colors are once presented to the camera a small square will display in each color center to show that that colors is recognized. The recognition we expect to obtain will not be only on for the, Red, Green, Blue, Yellow, Cyan and Magenta colors but also for all colors having the characteristics of the above mentioned colors. Once all six colors are recognized successfully, a second experiment will be done in each color with a light disturbance to check the effect of light on the recognition system for night recognition and correct it in order to avoid miss recognition. As our final goal is to use this result for robot motion control , medical purpose and other systems as well

## VII. CONCLUSION

In this paper, we have discussed the recognition of six colors using the minimum and the maximum color threshold which is from the sum of each individual RGB color on the orthogonal color space which attempts to qualify how much of each primary color is in the color observed.

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