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Image Segmentation using Color Value of the Hue in CT Scan Result

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Abstract. Object recognition with visual computer techniques is a process necessary to detect different objects in a three-dimensional image to get precise results. Color extraction process Red Green Blue (RGB), Red, Green, Blue (HSV) and other color spaces can produce high accuracy and minimize the number of parameters to speed the computing process. In this study the diagnosis of pneumonia was based on a CT scan of the lungs in the color image segmentation process. The removal of color features is done by using the HSV color segmentation method to classify the pneumonia in CT scans, which makes it possible to detect an image segmenting object as a blob. The color sample generates a value that is the reference point for the filter range during the segmentation process, based on the test results. In this process, it is clear how many objects are found as a color-based pneumonia diagnosis by changing the HSV and RGB thresholds.

Keywords: CT scan, Segmentation, threshold, RGB, HSV, Pneumonia

1. Introduction

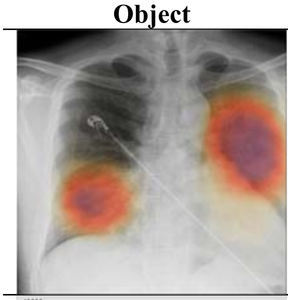
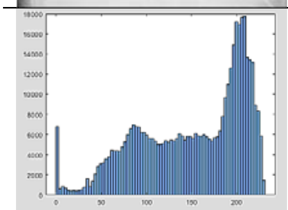
Segmentation is a critical component of digital image processing and is used in a variety of areas of image research [1]. The segmentation of medical images is one of them. Segmentation is used to isolate specific objects or regions within an image for identification. Medical images that identify the object or area of interest contain information that is useful for diagnosing and treating disease [2]. In this study, a CT scan image of pneumonia patients' lungs will be segmented. The lungs are anatomical structures that function as a respiratory system by exchanging oxygen and carbon dioxide from the blood [3]. Numerous lung diseases, including tuberculosis, bronchitis, pneumonia, lung cancer, emphysema, and pleurisy, are frequently encountered [4]. Colors in images vary in size, despite the fact that they all have the same color perception with open eyes. Additionally, color variation is created by combining the intensities of images captured in different color spaces. These variations in image intensity can be detected by the computer when image processing methods are used [5]. This variation in intensity values has a significant impact on image processing results, particularly in color-based object recognition applications [6].

Segmentation is a technique used in image processing to distinguish objects from their surroundings [7]. Thresholding [8] is one technique that can be used to segment images. Thresholding is a segmentation technique that is used to determine similarity between images by setting a threshold for each image processing operation that results in a binary level image [9]. Although the segmentation process is used in a variety of applications, all of them share a common goal: obtaining a concise, useful representation of an image [10]. There are numerous segmentation methods; it is difficult to determine a comprehensive method; thus, the method chosen is determined by the approach taken and the features extracted from the image [11]. Segmentation is closely related to image transformation (image), because the image is transformed into a new form that is distinct from the original image using the segmentation method. This article proposes a thresholding method [12] in the HSV color space for CT Scan images of pneumonia patients that is capable of producing high accuracy while minimizing the number of parameters used to accelerate the computational process. The HSV color space segmentation technique is used to remove color features from pneumonia CT scans, allowing for the detection of CT scans of pneumonia patients' lungs and the determination of the object's optimal threshold value.

2. Methodology

As a basic technique, this study analyzes the global threshold results in two different color spaces: RGB (Red, Green, Blue) and Hue, Saturation, Value (HSV). It then compares the segmentation results for the two color spaces and finally chooses the color space that is optimally adapted to the subsequent color segmentation. The object is a CT scan sample image of the lungs from pneumonia patients. The image is 386x393x3 uint8 in size. The following is an explanation of the CT scan images of the lungs of pneumonia patients that are included in Table 1.

Table 1. CT scan images of the lungs of patients with pneumonia

Object	Description
	Dimensions: 386x393x3 Width: 393 pixels Height: 386 pixels Bit depth: 32 Unit: PNG Size: 126 KB
	The histogram accumulates significantly on the right due to the image's high number of intensity values close to 255. (white).

The segmentation stage employs the Hue Saturation Value (HSV) color space for the purpose of diagnosing pneumonia via a CT scan of the lungs, as illustrated in Figure 1.

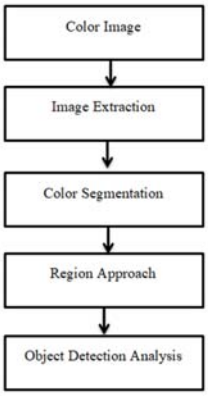


Figure 1. Segmentation Stages

2.1. HSV (High-Saturation Value) Color Space

The HSV color model, in which H denotes hue (color saturation), S denotes saturation (color purity), and V denotes intensity values (color brightness). HSV is also referred to as HSB (Hue Saturation Brightness) and HSI (Hue Saturation Intensity) (Hue Saturation Intensity). Hue is the term used to describe pure color in terms of green, red, or magenta. When expressed in degrees, hue has a range of 0° to 360°. Saturation is a term that refers to the purity of the color. If the value is between 0% (grey) and 100% (pure color), there will be color purity. As shown below, the saturation is normalized from 0 to 1 [13].

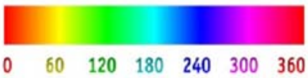


Figure 2. Value range hue

Hue is an angle from 0° to 360°. Usually 0° is red, 60° is yellow, 120° is green, 180° is cyan, 240° is blue and 300° is magenta [14].

Table 2. HSV Color Values

No	Color	***Hue*** (°)	***Saturation*** (%)	***Value*** (%)
1	Black	0	0	0
2	White	0	0	100
3	Red	0	100	100
4	Green	120	100	100
5	Blue	240	100	100
6	Yellow	60	100	100
7	Purple	300	100	50

Source: [15]

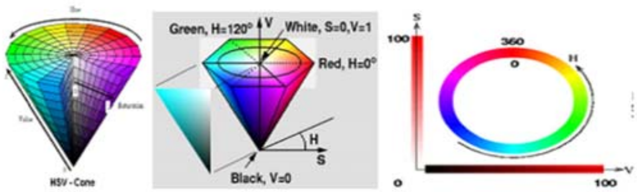


Figure 3. Representation of the HSV color space

2.2. RGB (Red, Green, and Blue) Color Space

Red, green, and blue are the primary RGB color spaces (red, green, blue) used by computer and television screens. The resulting color is a mixture of three colors with an 8-bit red value, an 8-bit green value, and an 8-bit blue value. Gray shades are created by combining the three primary colors in a balanced proportion [16]. When these three colors are fully saturated, white is obtained [5].

2.3. RGB to HSV color space conversion

To begin converting an RGB image to HSV, the Red (r), Green (g), and Blue (b) image components must be extracted. Red extracts the RGB image's other two components (Green and Blue) as zero-intensity pixels. To extract the green component from the RGB image, the red and blue color components are created as zero intensity. Similarly, the Red and Green components are extracted as zero-intensity components [13].

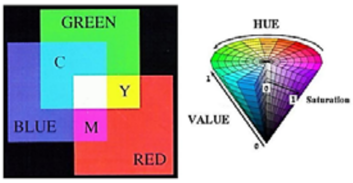


Figure 4. Coordinate system in HSV

2.4. Thresholding

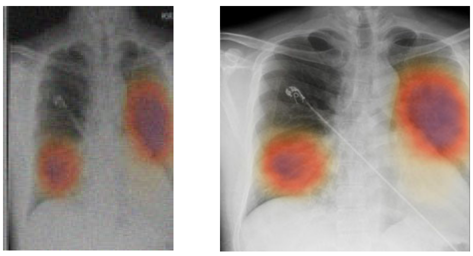
Thresholding is a type of segmentation technique that is used to determine similarity between images by setting a threshold for each image processing operation that results in a binary level image [3]. The iteration method is used to determine the threshold [17][18]:

a) Determine the initial value of the threshold T0.
b) Using the initial threshold value from step 1, the image is divided into two regions. (R1, R2).
c) Calculate the average intensity value for each of the areas (1 and 2).
d) Divide the sum of the average intensity values by two to obtain the new threshold value. [T equals (1 + 2) / 2].
e) Repeat steps 2–4 until the mean intensity values (indicated by 1 and 2) remain constant.

3. Results and Discussion

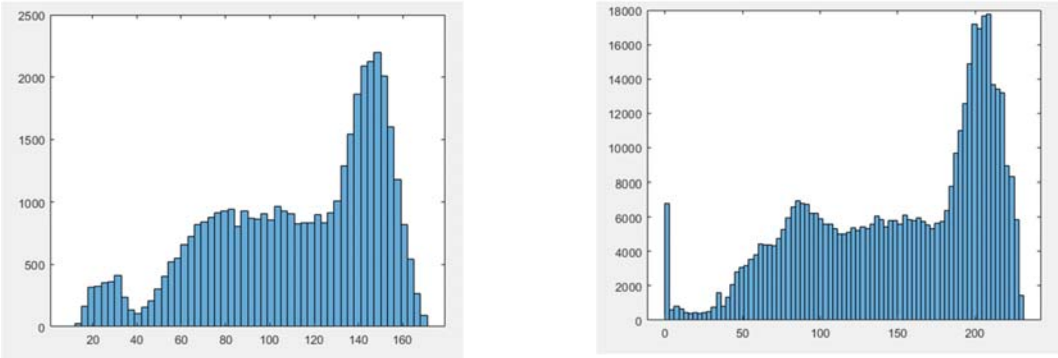
3.1. Processing of Lung CT Scan Image Samples

The Thresholding method was used to segment CT scan images of the lungs in this study. This method was evaluated using CT scan images of pneumonia patients' lungs. MatLab 2019a was used to compile the algorithm. By and large, CT scan images of the lungs are of poor image quality, with low contrast and a high level of noise. This is because image capture in general is different. As a result of image processing, the following is the result.



(a) (b)

Figure 5. (a) The original image; (b) The repaired image



(a) (b)

Figure 6. (a) Histogram of the original image; (b) Histogram of the repaired image

The following is a MatLab 2019a script that assists in segmentation analysis using the color space hue saturation value in the diagnosis of pneumonia via a CT scan of the lungs that displays an image along with the identity of the patient.

```
clear; clc;
[filename,pathname] = uigetfile({'*.jpg;*.bmp;*.png'},'Select an  Image');
Im = imread([pathname filename]); % Baca file citra format dan simpan  pada matriks I
figure(1), imshow(uint8(Im));title('Citra Asli');
```

Segmentation is the next step. Segmentation is accomplished by altering the threshold value in the RGB and HSV space, such that pixels with a value less than the threshold are black, while those with a value greater than the threshold are white. It is hoped that this segmentation will enable the detection of colored spots on CT scans of the lungs of pneumonia patients. The RGB and HSV spaces have threshold values of 0.2; 0.3; 0.4 (HSV) and 2; 3; 4 (RGB) (RGB). The pixel position reading is performed in order to perform a threshold calculation based on the provisions made. The test results and script are included below.

```
Th_HSV= 0.4; Th_RGB= 4;
p = impoint(gca,[]);
p = wait(p);
x=round(p(1,1));
y=round(p(1,2));
RGB=Im(y,x,:);
R=RGB(:,:,1);
G=RGB(:,:,2);
B=RGB(:,:,3);
HSV=rgb2hsv(RGB);
H1=HSV(:,:,1);
S1=HSV(:,:,2);
V1=HSV(:,:,3);
citra_hsv=rgb2hsv(Im);
[m,n,l]=size(citra_hsv);
cit_hasilHSV(1:m,1:n,1:l)= uint8(0);
cit_hasilRGB(1:m,1:n,1:l)= uint8(0);
```

Table 3. Test Results

HSV	RGB	HSV Space Reference Color	RGB Space Reference Color	HSV Color Range	RGB Color Range
0.2	2	HI: 0.9506 SI: 0.3885 VI: 0.5451	R: 139 G: 85 B: 101	dH: -0.9506 S2: 0 dV: 0.1695	dR: 0 dG: 0 dB: 0

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HSV	RGB	HSV Space Reference Color	RGB Space Reference Color	HSV Color Range	RGB Color Range
0.2	3	HI: 0.9497	R: 133	dH: -0.9497	dR: 0
		SI: 0.3985	G: 80	S2: 0	dG: 0
		VI: 0.5216	B: 96	dV: 0.1507	dB: 0
0.2	4	HI: 0.9510	R: 133	dH: -0.9510	dR: 0
		SI: 0.3835	G: 82	S2: 0	dG: 0
		VI: 0.5216	B: 97	dV: 0.1507	dB: 0
0.3	2	HI: 0.9497	R: 139	dH: -0.9497	dR: 0
		SI: 0.3813	G: 86	S2: 0	dG: 0
		VI: 0.5451	B: 102	dV: 0.1696	dB: 0
0.3	3	HI: 0.9583	R: 136	dH: -0.9583	dR: 0
		SI: 0.3824	G: 84	S2: 0	dG: 0
		VI: 0.5333	B: 97	dV: 0.1600	dB: 0
0.3	4	HI: 0.9561	R: 139	dH: -0.9561	dR: 0
		SI: 0.4101	G: 82	S2: 0	dG: 0
		VI: 0.5451	B: 97	dV: 0.1696	dB: 0
0.4	2	HI: 0.9583	R: 135	dH: -0.9583	dR: 0
		SI: 0.3852	G: 83	S2: 0	dG: 0
		VI: 0.5294	B: 96	dV: 0.1569	dB: 0
0.4	3	HI: 0.9497	R: 135	dH: -0.9497	dR: 0
		SI: 0.3926	G: 82	S2: 0	dG: 0
		VI: 0.5294	B: 98	dV: 0.1569	dB: 0
0.4	4	HI: 0.9598	R: 143	dH: -0.9598	dR: 0
		SI: 0.4056	G: 85	S2: 0	dG: 0
		VI: 0.5608	B: 99	dV: 0.1827	dB: 0

Following the segmentation process, the next step is to determine the color of similarity to aid in the detection process. The similarity process employs the selection function via the if branching function, ensuring that the results are displayed in the order determined by the if branching function. The following script and image illustrate the comparison of the RGB and HSV threshold values.

```
for i=1:m
 for j=1:n
          dR=(abs(Im(i,j,1)-R))^2;
          dG=(abs(Im(i,j,2)-G))^2;
          dB=(abs(Im(i,j,3)-B))^2;
          check=sqrt(double(dR+dG+dB));
 if (check<=Th_RGB) % warna similar?
    cit_hasilRGB(i,j,:)= Im(i,j,:);
 end
          dH=citra_hsv(i,j,1)-H1;
          S2=citra_hsv(i,j,2);
          dV=(citra_hsv(i,j,3)-V1)^2;
          Dcyl=sqrt(double((dV +(S1^2)+(S2^2)) - (2*S1*S2*cos(dH))));
 if (Dcyl <=Th_HSV)
    cit_hasilHSV(i,j,:)= Im(i,j,:);
 end
 end;
end;
figure(2), imshow(cit_hasilHSV), title('Citra hasil HSV');
figure(3), imshow(cit_hasilRGB), title('Citra hasil RGB');
```

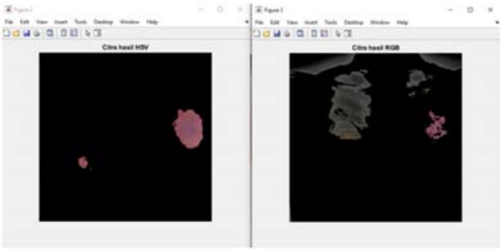

Figure 7. HSV:0.2 – RGB: 2

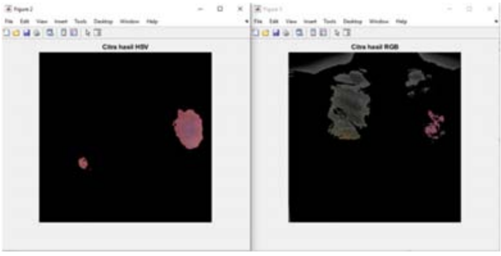

Figure 8. HSV:0.2 – RGB: 3

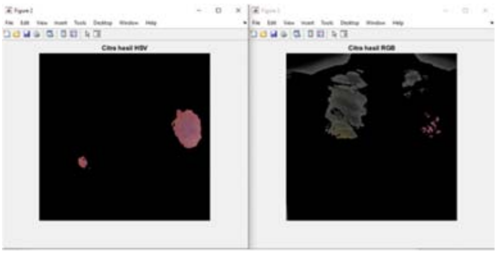

Figure 9. HSV:0.2 – RGB: 4

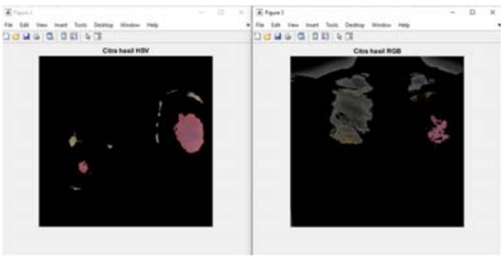

Figure 10. HSV:0.3 – RGB: 2

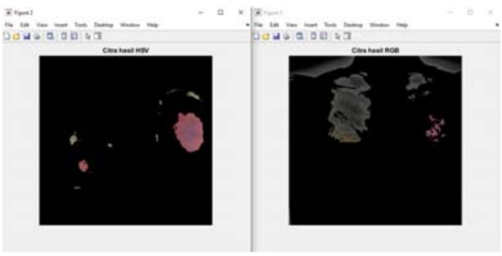

Figure 11. HSV:0.3 – RGB: 3

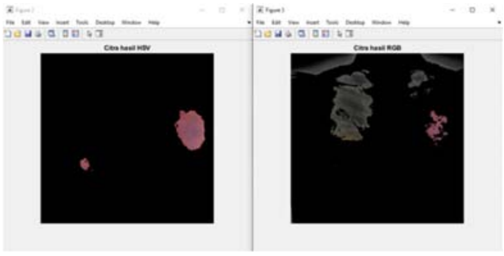

Figure 12. HSV:0.3 – RGB: 4

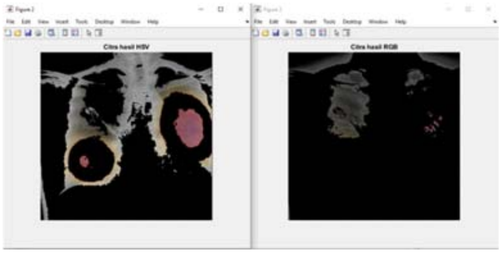

Figure 13. HSV:0.4 – RGB: 2

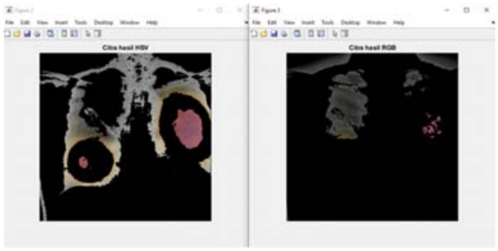

Figure 14. HSV:0.4 – RGB: 3

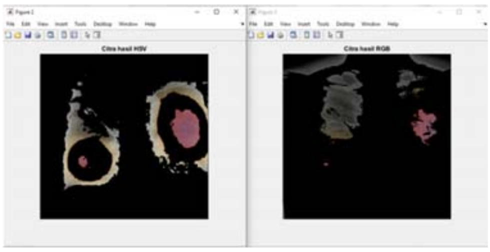

Figure 15. HSV:0.4 – RGB: 4

Numerous analysis results were obtained by comparing the threshold values in the RGB and HSV color spaces to CT scans of the lungs of patients with pneumonia.

Table 4. Analytical Findings

HSV	RGB	Explanation
0.2	2	HSV Image can recognize 2 objects and RGB Image can recognize 1 faint object + detected another object
0.2	3	HSV Image can recognize 2 objects and RGB Image can recognize 1 faint object + detected another object
0.2	4	HSV Image can recognize 2 objects and RGB Image can recognize 1 faint object + detected another object
0.3	2	HSV Image can recognize 2 objects + detected other objects and RGB Image 1 can recognize faint objects + detected other objects
0.3	3	HSV Image can recognize 2 objects + detected another object and RGB Image can recognize 1 faint object + detected another object
0.3	4	HSV Image can recognize 2 objects and RGB Image can recognize 1 faint object + detected another object
0.4	2	HSV Image can recognize 2 objects + detected another object and RGB Image can recognize 1 faint object + detected another object
0.4	3	HSV Image can recognize 2 objects + detected another object and RGB Image can recognize 1 faint object + detected another object
0.4	4	HSV Image can recognize 2 objects + detected another object and RGB Image can recognize 1 faint object + detected another object

As illustrated in Table 4, the lower the HSV threshold value, the more accurate the segmentation results. This is illustrated in Figures 7, 8, and 9. The greater the HSV threshold value, the greater the number of detected objects. The RGB threshold values all have faint segmentation results in this case.

4. Conclusions

According to the results of research on segmentation using color space, the hue saturation value can be used to diagnose pneumonia via a CT scan of the lungs. The results demonstrate that by adjusting the threshold value in the HSV and RGB color spaces, objects can be recognized.

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