Color Detection Using Webcam with Matlab HSV Color Model Segmentation Based

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ABSTRACT

This reserach is explained in detail how it works so that the color detection algorithm can run. We used in this study is the color segmentation method, namely HSV. The basis of the RGB color model not only represents color but also represents light intensity. Lighting in the color of an object is caused by the lighting around it. Therefore, direct representation of the color of objects with RGB components is very efficient. In this study, we have been able to detect several primary colors, namely RGB. However, this research can be further developed to be able to recognize several other colors. Digital image segmentation methods can be classified based on the components that serve as a reference for object separation. In this study, we have succeeded in detecting color according to the method we have determined. We have successfully detected the colors Red, Green, and Blue. In this research, we can detect any object or person. The level of accuracy that can be given to detect RGB color itself is 90%. Several factors that can make colors undetectable are lighting, the lack of clarity of an object, to the hardware factor itself.

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1. INTRODUCTION

Technological advances in the field of image processing or what is often called Image Processing at this time have become a special attraction for humans to explore so that it becomes knowledge that can be accepted and understood in everyday life. In current technological developments, data and information cannot be separated from multimedia. Data and information are no longer presented in the form of text but are also presented in the form of images, audio, and video. One component in multimedia that plays an important role as a form of information is Image (Image) [1]. Digital image processing (digital image processing) is a scientific discipline that studies image processing techniques. Along with these developments, creativity in identifying an object cannot be separated from digital image processing. The pre-processing process is used to obtain images that will be continued and utilized for the designed system. This process consists of cropping, resizing, segmentation, and removing noise in the image [2]. Digital image processing is an image processing technique that aims to improve image quality so that it is easily interpreted by humans or computer machines that can be in the form of photos or moving images. Digital Image Processing itself is a branch of knowledge in Artificial Intelligence that uses image objects in digital form to solve cases [3].

One of the results of the branch of Artificial Intelligence is software or application. Color detection application is one type of development that can help detect color. In an image, a lot of information can be obtained, and this information can be used for color image analysis, for example, the depiction of objects and color extraction. The image has a color image, one of which is the RGB model color image. In addition, an image also has a grayscale image which has elements consisting of entropy, contrast, energy, homogeneity,

grayscale and standard deviation. A digital image is formed from a limited number of elements, each of which has a certain value and coordinates.

This research was conducted to design a program that can recognize several colors through digital images by applying the HSV method. HSV Digital Image defines color in terms of Hue (Actual Color), Saturation (Color Purity), and Value (Color Brightness) [4]. The image referred to in this study is a static image derived from the vision sensor (webcam). Mathematically, the image is a continuous function with light intensity in a two-dimensional plane. To be processed by a digital computer, an image must be presented numerically with discrete values. A digital image can be represented by a two-dimensional matrix f(x,y) consisting of M columns and N rows.

In image color processing, there are various models, one of which is the hue, saturation, and value (HSV) model. Color segmentation is a segmentation process with an area approach that works by analyzing the color value and each pixel in the image and dividing the image according to the desired features which this time is to detect color. The color segmentation that we will use this time is HSV. Segmentation with HSV detection is carried out by analyzing the color value of each image pixel according to the desired feature with the tolerance value on each HSV color dimension. The HSV color space consists of 3 components: H denotes a color type (such as red, blue, or yellow) or hue, etc, where the color is found in the color spectrum. S represents the level of color dominance, which is a measure of how pure the color is. V represents the brightness level, which is a measure of how much brightness a color has or how much light comes from a color. In this study, the image data captured by the camera has the colors R, G, and B. To reduce the effect of illumination on an image, the color of the image can be converted to another color space, one of which is the HSV color space [5].

One way to detect color is to use Image Subtraction. Image subtraction is a method that separates objects from their background. The Image Subtraction method is used in research to detect an object. The detection results will be marked and the midpoint so that the coordinates are obtained [6]. Another way to detect color is to use the K-means method. It is generally used for grouping color images, and can also be used for creating color image features. These features can be used later as image signatures that refer to images in any application, such as image recognition or search systems. image [7]. Detection of the existence of objects using digital imagery is a process to determine the presence of objects in an image. Apps that can implement object detection. Separation of objects from the background image is the main process of detecting an object. The separation process is known as segmentation. Digital image segmentation methods can be classified based on the components that serve as a reference for object separation. The general reference that is often used for digital image segmentation is object color [8].

In this study, we explain the implementation of our algorithm for color detection using software that uses a webcam. This software itself will be linked to a webcam that will detect the color that we will detect. The way color detection works using the webcam software itself is by detecting it using the HSV algorithm. The color that has been read is RGB. A detection system reproduces one of human's innate abilities namely recognizing color characteristics in the environment with knowledge stored in their memory. This paper provides an approach to identifying basic geometric shapes and RGB primary colors in 2D images using image processing techniques with the help of software.

The research method that we will use this time is Image and Hue Saturation Value (HSV). Image (image) is another term for images as a form of visual information that plays an important role in multimedia components. An image consists of two types, namely continuous image, and discrete image. Continuous image is generated from an optical system that receives analog signals. for examples the human eye and analog cameras. Meanwhile, discrete images are generated through the process of digitizing images. A good image is an image that has high quality and is by the original image and has complete and clear information according to what we want. However, images often experience a decrease in image quality, for example, the occurrence of defects in the image (noise), too much contrast, less sharp colors, too soft, and so on. Images like this are more difficult to interpret because the information conveyed is imperfect or of reduced quality [9].

The results of the current research, we can run the software using a webcam that can detect three colors, namely Red, Green, and Blue. RGB appears using eight opportunities by dealing with red, and green [10]. Next is the blue segment of the image. This software can also be further developed such as adding detectable colors. If more colors can be added, this software can be used in various areas of daily life such as in the fields of Health, Education, and so on. One example of the use of this software is in the field of security and transportation, this software can be developed further so that it can detect license plates on a vehicle. Vehicles are one of the most important things in human life. Vehicles are a means of transportation to go wherever we want. Vehicles are also the target of criminals who commit theft of these vehicles, as well as misuse of vehicles to commit crimes, especially in housing. One of the uses of technology to reduce this is a

vehicle license plate identification system using digital image processing. In this identification system, the author uses the Robert filter method and image framing. There are several stages in this identification system, namely image capture, cropping, grayscale, floating, Robert filter, image framing, and pattern recognition [11]. One way to identify separate vehicle license plates is to identify objects. Identification of objects (object recognition) is a scientific field of computer vision that describes an object based on its main properties of the object. Identification of objects in digital images requires techniques and methods that are capable of extracting and identifying features contained in digital images, where the main component is color as the basis for representing objects in digital images. One method that can implement object color grouping in digital images so that they can become the main features of objects in digital images is Hierarchical Agglomerative Clustering [3].

2. METHOD

2.1. RGB Grayscale Segmentation

The image segmentation process carried out in this study is to combine two color segmentation results, namely based on RGB grayscale and HSV. In the Grayscale RGB segmentation process, the input image will be separated based on three color components, namely Red, Green, and Blue. RGB is the most commonly used standard for storing color information in digital images. In the RGB color model, each pixel of the image consists of three color channels namely red, green and blue. Each channel stores color intensity information for one basic color. When these three channels are combined, they form a more complex color. A normal dark image uses 8 patches, while a hued image uses 24 to enhance color rendition, which incorporates the RGB model [12]. For example, if the intensities of red, green, and blue are 255 (maximum) respectively, then the pixel will display white. One of the HSV components is intensity. The intensity itself is how much brightness or light is [13].

Grayscale is another way to store color information in digital images. In grayscale images, each pixel only stores gray intensity information. The darker the pixel, the blacker the color will appear. For example, if the gray intensity is 0 (minimum), then the pixel will display black. Conversely, if the gray intensity is 255 (maximum), then the pixel will display white. Both of these methods have their advantages and disadvantages. RGB is better suited for storing more complex color information, whereas Grayscale is better suited for storing simpler color information. However, Grayscale images have smaller file sizes compared to RGB images, making them easier to transfer or save.

2.2. HSV Segmentation

HSV (Hue, Saturation, Value) segmentation is a technique used to separate or group objects in an image based on color. HSV is a color model used to store color information in digital images. This color model consists of three channels namely Hue, Saturation, and Value. the HSV process is based on color characteristics by taking RGB (Red, Green, and Blue) values in the image. This model is suitable for processing images that present changes in lighting because the colors of the environment can be distinguished from one another through the Hue component [14].

The hue is a channel that stores information about the basic color of an object. Hue stores basic color information in the form of a degree value (0-360). For example, a Hue with a value of 0 will show a red color, while a Hue with a value of 60 will show a green color. Saturation is a channel that stores information about the clarity or color fade of an object. The higher the Saturation value, the clearer the color of the object will be. Conversely, the lower the Saturation value, the color of the object will fade. Value is a channel that stores information about the brightness or darkness of an object's color. The higher the Value value, the brighter the object color will be. Conversely, the lower the Value value, the darker the color of the object.

To perform HSV segmentation, we first need to change the image color model from RGB to HSV. Then, we can enter value constraints for each channel (Hue, Saturation, and Value). After that, objects that meet these value constraints will be separated from the original image. HSV segmentation can be very useful for grouping objects by color, for example to group fruits by skin color or group cars by body color. There is also segmentation with the workings of digital image segmentation which will then be read as a segmented image result, which is called a thresholding algorithm. This method works in several steps, namely converting the RGB image color space to grayscale, performing image segmentation using the thresholding method, and performing complement operations so that an object has a value of 1 (white), while the background has a value of 0 (black) and performs morphological operations to enhance the image. the shape of the object in the segmented binary image [15]. One of the operations performed when the morphology itself is erosion.

2.3. State of Art

Table 2.1 State of Art

No	Title	Description
1.	The first research from Indrabayu, Nurhikma Arifin, and Intan Sari Areni in 2019 with the title Classification of Strawberry Ripeness Based on Color Segmentation with the HSV Method	The results of this study indicate that the classification of strawberry maturity produces an accuracy of 97% with RBF kernels. Strawberry ripeness can be implemented using Image processing. At the prototype segmentation stage, the classification system for strawberry fruit maturity uses the HSV method. This process produces optimal values lower HSV = (0,48,33) and upper HSV = (77,255,212). This value can separate the strawberry object from the background correctly even though the colors in each class category are different.
2.	The second research from Julian Fuad Fauzi, Herman Tolle, and Ratih Kartika Dewi in 2018 with the title Implementation of the RGB to HSV Method in Android-Based Paper Currency Recognition Applications for the Blind	The results of this study indicate that digital image classification using the RGB To HSV method can work well and can classify according to the design results. In testing the data test, it was concluded that the RGB To HSV method can provide information on the distance of image similarity with an accuracy level of 87%, a precision of 89%, and a recall of 94%.
3.	The third research from Dede Wandi, Fauziah, and Nur Hayati in 2021 with the title Wilting Detection of Roses using the Hue Saturation Intensity (HSI) and Hue Saturation Value (HSV) Color Space Transformation Method	The results of this study indicate that based on the discussion above, it can be concluded that from a total of 230 images of red and white roses tested, 200 images using HSI and HSV obtained a Range value on HSI, H = 0.240634 – 0.5, S = 0.781818 – 1, and I = 0.477124 – 1 in the Fresh category, while the HSI Withered Category, H = 0.170495 – 0.5, S = 0.40239 - 1, I = 0.562092 – 1, and also obtained Range values with HSV with Fresh category H = 0.240634 – 0.5, S = 0 - 0.988235, V = 0 - 0.988235, and Withering category H = 0.170495 - 0.5, S = 0 - 0.996078, V = 0 - 0.996078. With an accuracy value on HSI and HSV of 86.9%. Therefore, it can be concluded that the detection of wilting roses using the HSI (Hues Saturation Intensity) and HSV (Hue Saturation Value) color space transformation method is the fastest in the process using the HSI method because The reading of the min-max value in the HSI range.
4.	The fourth study from Rita Zahara in 2022 entitled Implementation of Hue Saturation Value (HSV) for Identification of Bone Fractures	The results of this study indicate that the image processing application, namely bone fracture images, changes the image pixel graphics when processed with HVS with Hue Saturation Value (HSV). Produces a Hue Saturation Value (HSV) filter method that can increase the pixel color value of the image better than the original image.
5.	The fifth study from Siti Raysyah, Veri Arinal, and Dadang Iskandar Mulyana in 2021 with the title Classification of Ripe Levels of Coffee Fruit based on Color Detection Using KKN and PCA Methods	The results of this study indicate that this research resulted in a classification system for the maturity level of coffee cherries which was developed using the MATLAB R2019b software, where the system can classify the maturity level of coffee cherries, namely utilizing the image of the coffee cherries by inputting images of coffee cherries that have been preprocessed into the white background for easy segmentation process. The classification system for the maturity level of coffee cherries uses the K-Nearest Neighbor method to classify the maturity level of coffee cherries by utilizing the RGB, HSV, and Area color features using 90 coffee cherries image training data and 45 coffee cherries image test data with 3 fruit maturity classes, namely unripe, moderate ripe and ripe. From this system, the accuracy results obtained from the classification of coffee cherries using the KNN method were 97.77% with a value of K = 3 obtained from 44 test data with accurate classification, and 2.23% from 1 test data with inaccurate classification. It is hoped that the results of this research will not only help coffee farmers but also classify coffee cherries sold to the public so that the quality of coffee received by the community is better based on the level of maturity.
6.	The sixth research from Adelia Kartika Panggabean, Aldina Syahfaridzah, and Nabila Ayu Ardiningsih in 2020 with the title Detecting Objects Based on Color with HSV Color Segmentation Using the Matlab Application	The results of this study indicate that the segmentation process based on HSV color detection is stable. Where HSV separates a color according to the reference of each element. By giving a threshold value to the HSV segmentation model to determine what color to track. Segmentation results are also very influential with color samples, lighting, and also the texture of the object being detected. For further research, it is hoped that further development is expected to add a detection model for color tracking by adding several functions such as more specific recognition of objects.
7.	The seventh study from Alifa Puteri Bilqis Salsabila, Rika Desma Yunita, and Chaerur Rozikin in 2021 with the title Identification of Flower Image Types using the KNN Algorithm with HSV Color Extraction and GLCM Texture	The results of this study indicate that the Identification of Flower Type Image using HSV Color and GLCM Texture is the identification of a digital image of flower type using the feature extraction method for color and texture successfully carried out by dividing the data 70:30 and 60:40 and testing on K-3, K values -5, K-7. Getting the best accuracy on the 70:30 data division by using a K-7 value of 71%, the results obtained are felt to be lacking because the data obtained is very limited for use.

2.4. Object Detection

The research object is the main focus of the research or study. This is what will be researched or analyzed in the research. The research object can be a phenomenon, event, concept, theory, or problem to be

studied. The research object can also be a group of people, an organization, or a system that you want to study. In determining the object of research, it is important to ensure that the object is something that can be studied scientifically using appropriate research methods. Research objects must also have relevance and importance to the scientific community or society. The research object can be determined by identifying the problem or event to be studied, then determining what you want to know about the problem, and determining how the object will be studied. After the research object is determined, the next step is to determine the research hypothesis or theory to be tested, as well as the research method to be used to test the hypothesis or theory. The research objects in this paper include: (1) object color, (2) camera performance.

2.5. Proposed Method

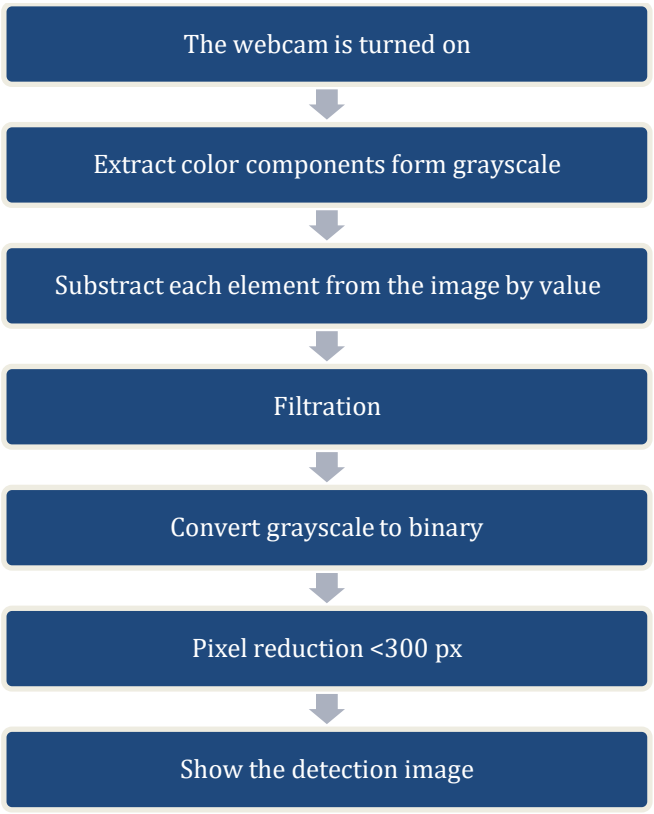

Figure 1. Proposed color detection based on segmentation technique

HSV segmentation has been used in this research method as in Figure 1. The basis of the RGB color model not only represents color but also represents light intensity. Lighting in the color of an object causes lighting in its surroundings. Therefore responding directly from the color of objects with RGB components is very efficient.

3. RESULTS AND DISCUSSION

We realize that the objects around us have colors, both RGB and other colors. The problem in this study is that the system can be designed so that it can work well to perform image processing which aims to detect the color of the image of the object that has been captured. To make color detection capable of detecting the color of object images, HSV segmentation is used. Color detection functions to identify the color of an object even though it overlaps. So that the color of the object can be identified accurately. Currently, several methods can be used to perform varna detection by relying on hue saturation and HSV value.

Image segmentation is a process for separating an object from the background so that the object can be processed for other purposes [16]. Color segmentation with the HSV color detection method has an HSV color scope consisting of 3 elements, namely hue which represents color, saturation which represents the level of color dominance, and value which represents the different brightness levels of each RGB image. Each pure color has a saturation value of 100%. While the value states the intensity of the reflection of the object received by the eye. Expressed as a change in color from white to gray and finally to black, or what is commonly known as the gray level or grayscale.

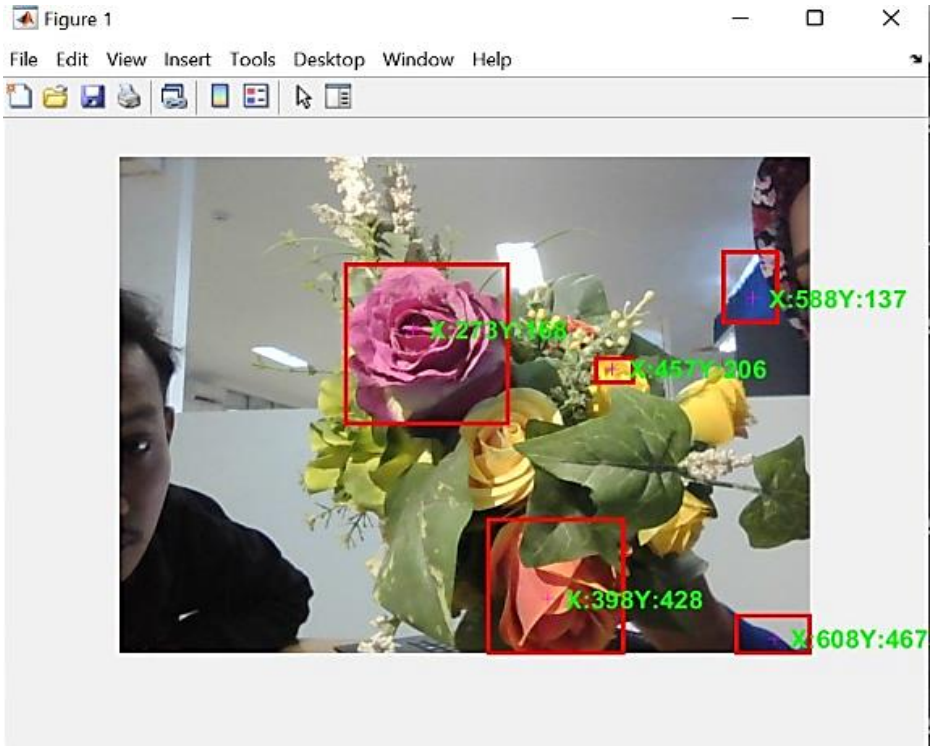

Figure 2. Sample of color detection

Figure 2 shows the results of color detection of object images directly using a webcam on a PC or laptop device. The system detects the captured color and then gives a bonding box that aims to show that the color has been identified. As well as showing the coordinates of objects that are detected in color.

Color will be detected when doing digital image processing. Edge detection itself is widely used, such as to improve the quality of the field of space and to detect an object. Edge detection will occur fast and large changes in gray intensity values in a short time. Edge detection is a series of mathematical methods used to identify points in an image so that the color of the brightness will change with different brightness levels [17].

Table 1. Identified color

No.	Color	Coordinate X	Coordinate Y
1	Pink	273	168
2	Orange	398	428
3	Yellow	457	206
4	Blue	588	137
5	Blue	608	467

The following are the stages in the color detection experiment:

1. Configure the web cam by writing code in the command window
   ```
   imaqhwinfo
   cam.InstalledAdaptors
   dev_info = imaqhwinfo('winvideo',1)
   dev_info.SupportedFormats
   vid = videoinput('winvideo', 1, 'YUY2_640x480')
   preview(vid) % to test whether the camera is working or not
   ```
2. Create a file with a free name then save it in a folder
   Code to set up webcam (device_name, device_id, device_format)
   ```
   vid = videoinput('winvideo','1','YUY2_640x480');
   set(vid,'TriggerRepeat',Inf);
   vid.returnedcolorspace='rgb';
   ```

```
Code to activate the camera
start(vid)

Looping code to retrieve data from the webcam
while (true) % can use while(video.Frame Acquired <= 100) to limit looping

Code to extract images from videos
data = getsnapshot(vid);

Code to extract color components to grayscale images
hsv = rgb2gray(data);

Declaration of container variables for layers of each RGB color
H = data(:,:,1); % red layer.
S = data(:,:,2); % green layer.
V = data(:,:,3); % blue layer.

Code to perform filtering using a median filter to remove noise
diff_im = medfilt2(diff_im, [3 3]);
diff_im2 = medfilt2(diff_im2, [3 3]);
diff_im3 = medfilt2(diff_im3, [3 3]);

Code to convert grayscale to binary
diff_im = im2bw(diff_im,0.18);
diff_im2 = im2bw(diff_im2,0.18);
diff_im3 = im2bw(diff_im3,0.18);

Code to remove all pixels that are less than 300 px
diff_im = bwareaopen(diff_im,300);
diff_im2 = bwareaopen(diff_im2,300);
diff_im3 = bwareaopen(diff_im3,300);

Code to create a container variable to label all connected components in the image
bw = bwlabel(diff_im, 8);
bw2 = bwlabel(diff_im2, 8);
bw3 = bwlabel(diff_im3, 8);

Code to characterize each part of the label
stats = regionprops(bw, 'BoundingBox', 'Centroid');
stats2 = regionprops(bw2, 'BoundingBox', 'Centroid');
stats3 = regionprops(bw3, 'BoundingBox', 'Centroid');

Code to display the snapshot image
imshow(data)

Code loop to display a bounding box surrounding red, green and blue objects
  % loop logic to create a box surrounding the red object.
    for object = 1:length(stats)
       bb = stats(object).BoundingBox;
       bc = stats(object).Centroid;
       rectangle('Position',bb,'EdgeColor','r','LineWidth',2)
       plot(bc(1),bc(2), '-m+')
       a=text(bc(1)+15,bc(2),strcat('X:',num2str(round(bc(1))),'Y:',num2str(round(bc(2)))) );
       set(a,'FontName','Arial','FontWeight','bold','FontSize',12,'Color','gr');
    end

    % loop logic to create a box surrounding a green object.
```

```
for object = 1:length(stats2)
   bb = stats2(object).BoundingBox;
   bc = stats2(object).Centroid;
   rectangle('Position',bb,'EdgeColor','r','LineWidth',2)
   plot(bc(1),bc(2), '-m+')
   a=text(bc(1)+15,bc(2),strcat('X:',num2str(round(bc(1))),'Y:',num2str(round(bc(2)))) );
   set(a,'FontName','Arial','FontWeight','bold','FontSize',12,'Color','gr');
end

% loop logic to create a box surrounding a blue object.
for object = 1:length(stats3)
   bb = stats3(object).BoundingBox;
   bc = stats3(object).Centroid;
   rectangle('Position',bb,'EdgeColor','r','LineWidth',2)
   plot(bc(1),bc(2), '-m+')
   a=text(bc(1)+15,bc(2),strcat('X:',num2str(round(bc(1))),'Y:',num2str(round(bc(2)))) );
   set(a,'FontName','Arial','FontWeight','bold','FontSize',12,'Color','gr');
end

Code to deactivate the camera
stop(vid)
```

4. CONCLUSION

In this research, the segmentation method is used by combining two segments, namely RGB grayscale, and HSV. The results showed that the results of HSV segmentation did not necessarily show perfect results, which were caused by objects that had various levels of brightness and dominant colors. The system captures colors other than the colors that have been set on the system (bright, green, blue). But the system can capture pink, orange, to yellow. Future research development is to carry out more color identification so that colors can be classified and identified more clearly and accurately.

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