Applying Smart System for Object Color Classification Using Color Average Technique

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Abstract

The objective of this research was to design an object color classification algorithm. The system design principle utilizes the color average technique consisting of 3 color groups: red, blue, and green. These colors were employed in object color classification. The results found that the efficiency assessment of the system was based on a newly developed algorithm from 3 sample groups with 30 images per group, which are 90 images in total. The images were 640x480 pixels in quality with average of 95.5% precision. The precision of group 1: Red had 96.6% precision; Group 2: Blue had 96.6% precision and Group 3: Green color had 93.3 % precision. The total average of the system was considered as high precision, which indicated the quality of the color group. Moreover, the results from this experiment can be applied in color sorting of objects.

Keywords: Comparison, Image Proceeding, Algorithms, Digital Image, Color Intensity

Introduction

In the present, robot applications automation and artificial intelligence come into play in our daily life and will become more important in the future. Not only in the industrial sector that leads to lower production costs but also increases work efficiency. Various technological developments enhance the quality of life, namely health tech, healthcare technology, food tech, food, and agriculture technology, housing facilitation including safety, rescue tech, entertainment, and recreation, etc. Fruit Recognition using Color and Texture Features Technology (Arivazhagan, Shebiah, Nidhyanandhan, & Ganesan, 2010). Also has been used in organizations to accelerate the performance of the company (Rogalski, 2011). More and more companies will depend on IT systems and be less dependent on human resources due to the human limitations. The IT systems might need higher initial costs, but these costs will pay off and generate revenue as time passes due to less maintenance and more efficiency. Moreover, every day the technology is becoming more affordable and available to all people regardless of their financial capabilities. Today, the color object classification and color analysis generally depend on human judgment. This task requires experienced employees with specific qualifications and training to be in charge of this job. It is uncertain whether the quality of the job done is affected by speed. The researchers consider the essential aspect of the job mentioned earlier; thus, the researchers designed and developed a comparison and classifying color of object algorithm. The results of the research can be applied in Classification the color of an object in a realtime system. It can also perform physical classifying, focusing on dark shades of the objects from the camera that is used to capture the image (Ring, 1984). In addition, it can be employed in the comparison process in the average color database and embedded as a guideline for research and adaptation, to improve AI technology in the future to benefit the application and increase system efficiency. This paper aims to design the classifying color object algorithm. And the application in Classification of Selected Citrus Fruits Based on Color Using Machine Vision System, etc (Iqbal, Gopal, Sankaranarayanan, & Nair, 2016).

Objective

To design an object color classification algorithm

Related Literature

Basic Principle of Intelligence

In computer science, Artificial Intelligence (AI), sometimes called machine intelligence because its intelligence demonstrated by machines. In contrast, to the natural intelligence displayed by humans. Leading AI textbooks define the field as the study of intelligent agents, any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goal (Russell & Norvig, 2010; Legg & Hutter, 2007). Colloquially, the term "artificial intelligence" is often used to describe machines (or computers) that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem-solving." As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI effect (McCorduck, 2004).

1. Spectral Color: Human eyes are able to adjust level of lights for 1010 levels and classify the differences of objects in the intensive level of light in visible light wavelength as shown in Figure 1 (Nowak, 2013).

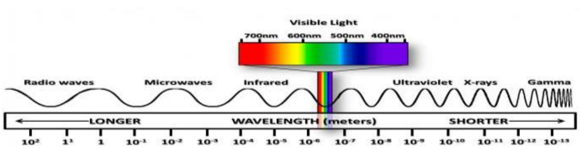

Figure 1 Spectral Colors

Adapted from (Climate Science Investigations, 2016)

2. Image in Computer System: Humans and computers see an image differently whether the image is taken by regular or digital cameras. Computers project an image as several color bits which connected until it is identified as an image; however, how human eyes see the image

compared with a computer is entirely different. Humans are able to tell the details and express their feelings toward the image, but computers comprehend the image as several color bits with sensible correlation, as shown in Figures 2 and 3. The figures show a digital image in 2D array of pixels and represented by f[m, n] (Russell & Norvig, 2010), as shown in the dimensional equation (Nowak, 2013).

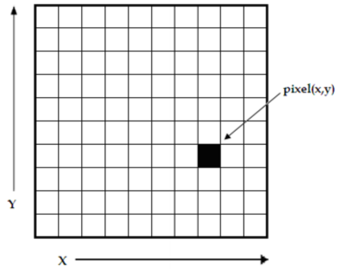

Figure 2 Illustration of a “pixelized” in 2D array
Adapted from (Lyra, Ploussi, & Georgantzoglou, 2011)

It is simply said that array of finite number of bits of an object recorded by image sensor then recorded and transferred to computer processing and temporarily stored in buffer in order to be displayed or recorded, as seen in Figure 3 (Castleman, 1996).

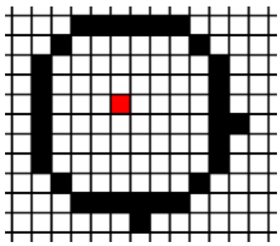

Figure 3 Image display
Adapted from (BelgianGuy, 2017)

3. Image Processing: Digital image as we commonly see whether it is taken by the regular or digital camera, in computer's vision, a picture comprises of several color bits that orderly placed until it is formed as an image (Castleman, 1996), as shown in Figure 4.

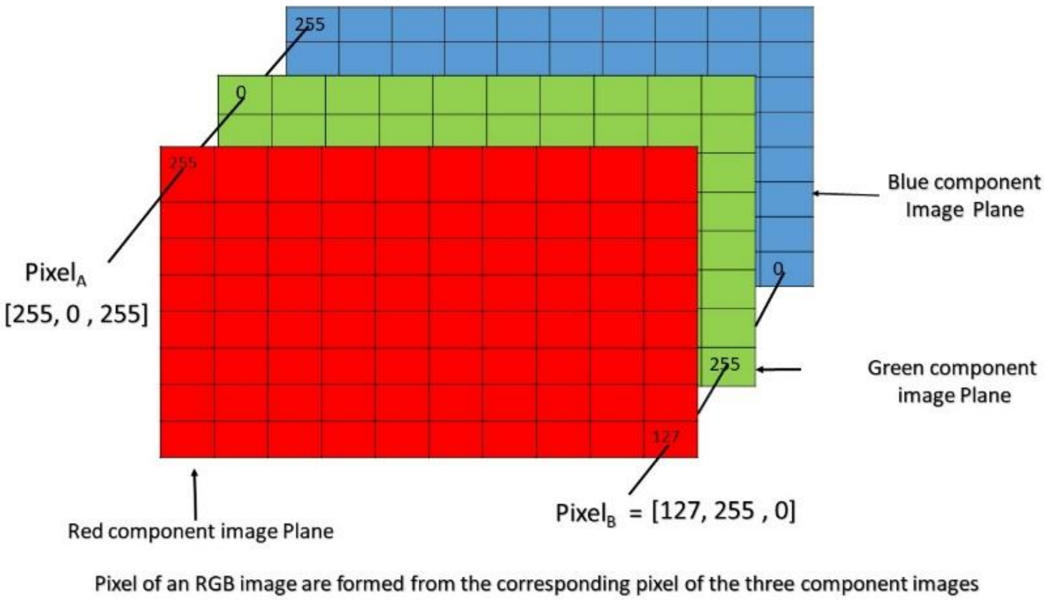

Figure 4 Coloring
Adapted from (Ihritik, 2018)

To see the details of the image whether it is a regular or digital image, human and computer sees it in completely different perspective. A digital image is an image that converts 2D using spatially sampling which randomly picks some positions in an image. A unit of sampling is pixel when spatially sampling image converts 2D to digital feature image and partially chooses some positions in the image that result in the high definition of the chosen position as seen in Figure 5.

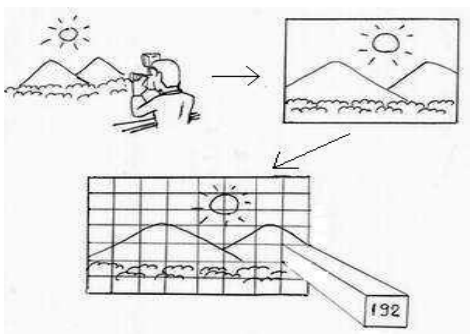

Figure 5 A unit of sampling is pixel
Adapted from (Wettayaprasit, 2012)

4. Image Quantization: When we have an image from the sampling, each bit in the image will be replaced with the image in gray scale that consists of black. And it will be gradient shades until it reaches white shade as seen in Figure 6.

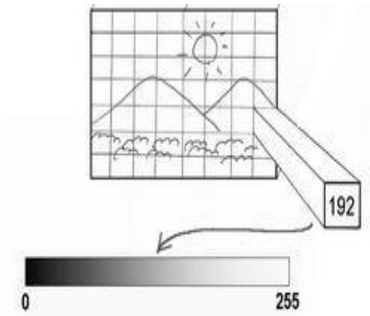

Figure 6 Image Quantization
Adapted from (Wettayaprasit, 2012)

Histogram Comparison

The histogram is created from each part of an image which can be used to explain colors occurring in the feature image of the overview image. Swain and Ballard suggested the method called Histogram Intersection by pairing histogram ***H(I)*** and ***H(Q)*** of image ***I*** and acquired image ***Q*** .The size of each image is n bins which is defined by Histogram Intersection shown as follows:

$$S\{H(I),H(Q)\} = \frac{\sum_{j=1}^{n}\min\{h_j(I),h_j(Q)\}}{N_Q \times M_Q} \quad (1)$$

When $h_j(I)$ is a number for pixels of the color subject **j** in the image ***I***. $h_j(Q)$ is a number for pixels of the color subject **j** in image ***Q*** and N_Q X M_Q is the size of the query image .This measurement method can be displayed by histogram dissimilarity such as L_1 -norm.

$$D\{H(I),H(Q)\} = \sum_{j=1}^{n}\left|\frac{h_j(I)}{N_1 \times M_1} - \frac{h_j(Q)}{N_Q \times M_Q}\right| \quad (2)$$

When N_1 X M_1 represents the size of the image, T represents a reference value employed to classify the similarity and difference of 2 histograms. It will be similarly defined when ***S≥T*** or ***D≤T*** and the image in the database that is retrieved related to an original image of the query. Nonetheless, a major problem of retrieval of histogram comparison is the recalled images might be a different type of the original image.

Connected Color Region (CCR)

Kim and Han suggested a theory of Connected Color Region (CCR) to solve the problem of histogram comparison. It addressed that CCR can distinguish a spatial distribution of the same histogram using an algorithm for CCR calculation as follows:

1. Consider the spatial destitution of color of image size NxM, which is divided into blocks of nxm pixels to find adjacent colors or color groups.

2. Compute the color density of adjacent color groups to find the mean of agglutination of colors.

3. Consider the most common colors considering the colors that appear together with the most specific colors and the opportunity that the colors will appear together.

4. Measure the image homogeneity which is a comparison of the amount of cohesion of each color group and compare to the similarity of the position information of each of color group.

$$S_1(I,Q) = \frac{\sum_{kc} \min\left\{H_{kc}\left(R_1\right), H_{kc}(R_Q)\right\}}{\sum_{kc} H_{kc}\left(R_Q\right)} \tag{3}$$

$$\Delta O_{kc} = \frac{\min\left\{Q_{kc}\left(R_1\right), O_{kc}(R_Q)\right\}}{\sum_{kc} 1} \tag{4}$$

$$S_2\left(I,Q\right) = \sum_{kc} \begin{Bmatrix} \Delta O_{kc} & if \ T_{kc}\left(R_1\right) = T_{kc}\left(R_Q\right) \\ 0 & if \ T_{kc}\left(R_1\right) \neq T_{kc}\left(R_Q\right) \end{Bmatrix} \tag{5}$$

$$S\left(I,Q\right) = \left(S_1 + S_2\right)/2 \tag{6}$$

However, using CCR has some limitations which is a parameter of blocks will affect image retrieval. Therefore, blocks must be an inappropriate size for agglomeration. The bigger the size the better it affects the accuracy of image retrieval that results in a low precision because a large-sized block is not obviously classified. However, if the size of the block is small, it will affect the high precision of image retrieval, but the calculation time (CCR) is much longer.

Research Methodology

1. Problem Identification and Research Method

1.1 Problem Identification

Recently, AI or professional systems need to be crucially developed and applied as tools to assist humans. Due to the lack of automatic process systems and effective AI systems; moreover, a variety of system applications is limited and has low precision for a complex system. As mentioned earlier, the development of an AI system needs to be stressed. In the future, it is essential to develop the AI system to help specialists in specific jobs, and it can replace the positions that require highly skilled workers, lower the cost of the highly paid human resource and elevate efficiency and profit for organizations.

1.2 Research method

Sample group

The efficiency test of precision which measures image similarity, considering the data from the database model, and following by matching with 3 groups of original colors with all the sample images. Each group of each color included 30 images used in efficiency measurement.

Experiment Variables

Efficiency measurement of recall could be tested by using precision measurement. This process was the precision measurement of system recall considering number of images compared with images on the database implemented for recall to identify images in the same group or different group with sample images.

Tools used in the experiment

System structure: The system structure composed of the hardware as a computer, software for processing and a camera for accepting the image into the system as shown in the Figure 8.

Experiment

System process: The system process is shown in Figure 9 and describes how system works as follows.

1. Image input includes methods which are;
2. Image resize used to resize images to the same size.

Bitmap objBitmap = new Bitmap (objImage, new size (640, 80)); Color average can be used to calculate mean of pixels by using the total number of color in the system divide by the number of pixels. Color average = Sum of total color average/number of pixels

3. Intensive analysis of colored image model used in the comparison algorithm
4. Color comparison of the pixel of 3 colors of original colors in the testing
5. Voice message

When comparison and processing are finished, a voice message will be sent to notify what color is used in the testing comparing with the original colors in testing.

Data analysis

The table of results in Table 1 illustrates the efficiency test of precision which measures image similarity, considering the data from the database model.

System Design

1. System Overview: The system design is shown in Figure 7. The image from a camera input into the system, the system processes four steps to compare the image size, color average, intensive analysis, and color comparison. Finally, the voice message will be sent the color with determination as to the system.

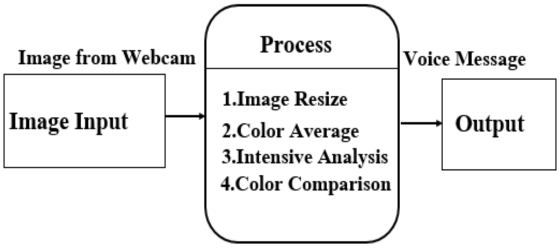

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Figure 7 Context Diagram of the System

2. System structure: The system structure composed of the hardware as a computer, software for processing and a camera for accepting the image into the system as shown in the Figure 8.

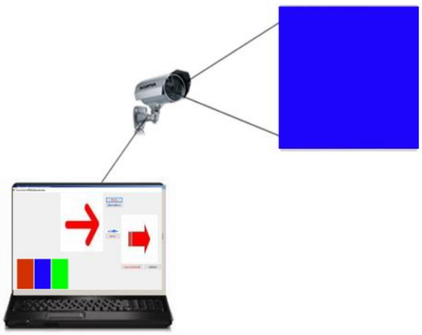

Figure 8 System Structure (adapted from system)

3. System process: The system process is shown in Figure 9 and describes how system works as follows.

3.1 Image input includes methods which are;

3.2 Image resize used to resize images to the same size.

Bitmap objBitmap = new Bitmap (objImage, new size (640, 80)); Color average can be used to calculate mean of pixels by using the total number of color in the system divide by the number of pixels. Color average = Sum of total color average/number of pixels

3.3 Intensive analysis of colored image model used in the comparison algorithm

3.4 Color comparison of the pixel of 3 colors of original colors in the testing

3.5 Voice message

When comparison and processing are finished, a voice message will be sent to notify what color is used in the testing comparing with the original colors in testing.

SpeechSynthesizer synthesizer = new

```
SpeechSynthesizer();
synthesizer.Volume = 100;
    synthesizer.Rate = 0;
    synthesizer.Speak(text1);
```

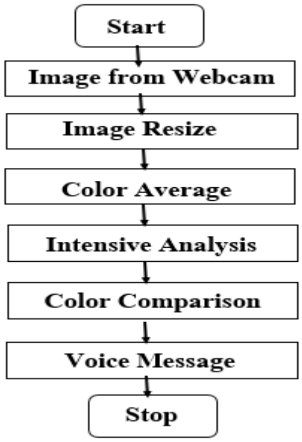

Figure 9 System process

4. System algorithm: The algorithm of this work proposed as follows.

```
for (int i = 0; i < bmap.Width; i++)
    {
            for (int j = 0; j < bmap.Height; j++)
      {   color  c = bmap.GetPixel(i, j);
              Sum_R=Sum_R+c.R;
          Sum_B=Sum_B+c.B;
          Sum_G=Sum_G+c.G;
        }
    }
  Intensive_R= Sum_R/(bmap.Width*bmap.Height);
  Intensive_B= Sum_B/(bmap.Width*bmap.Height);
  Intensive_G=Sum_G/(bmap.Width*bmap.Height);
              if (intensive_R >= 100)
```

```
{
        text1 = "Red";
  else if (intensive_B > =100)
  {
        text1 = "Blue";
  }
     else if (intensive_G > =100)
     {
        text1 = "Green";
     }
 SpeechSynthesizer synthesizer = new
 SpeechSynthesizer();
 synthesizer.Volume = 100;
 synthesizer.Rate = 0;
 synthesizer.Speak(text1);
```

1.3 System Design and Development

This research aims to develop a model used in automatic analys and classification from 3 color groups to employ in the experimental images using Visual C# program as a research instrument. This program was used for designing the model and user interface. The webcam was the image receptor for data processing.

1) Context Diagram of System: The system design was demonstrated in Figure 10. The figure showed an overview of Context Diagram of the System that received the data from the image folder or camera, processed and sent out as a voice message to notify the user of the color of the object of the image.

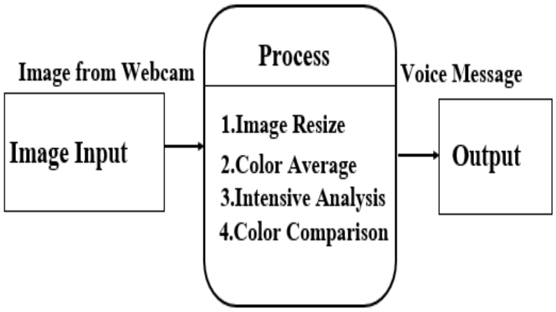

Figure 10 Overview of Context Diagram of System

2) System Structure: The structure of the system is an overview of the system receiving the image via camera or image folder, then processed and sent the information in the form of a voice message to notify user the color of the object.

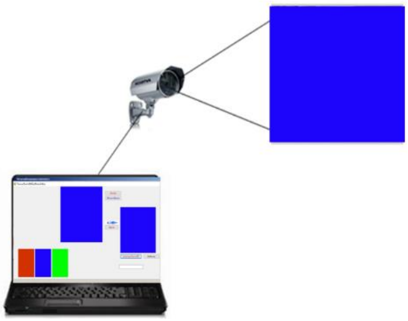

Figure 11 System Development using Visual C# (adapted from system)

Other devices used for model developing were laptop, camera and speaker as seen in Figure 12

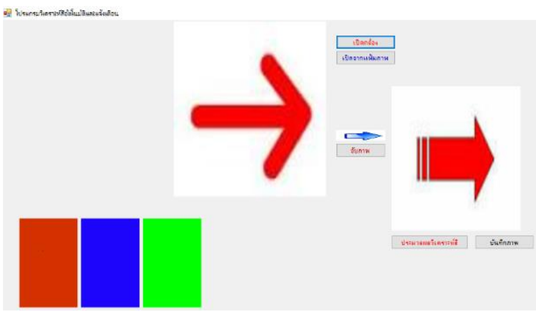

Figure 12 User Interface of System Process (adapted from system)

1.4 System Testing

Efficiency measurement of recall could be tested by using precision measurement. This process was the precision measurement of system recall considering number of images compared with images on the database implemented for recall to identify images in the same group or different group with sample images. Next, those images would be calculated the precision as shown in the equation (Metz, 1978; Taylor, 1997).

$$\text{Precision} = \left| \frac{x_i - x_m}{x_m} \right| \tag{7}$$

$$x_m = \frac{1}{n} \sum_{i=1}^{n} x_i$$

x_m equals sum of measurement

x_i equals each time of measurement

Research Findings

System Efficiency Assessment of comparison and analysis of the color of the image. The result of the mean of the number of color images and mean of quality of image data of 3 group colors, including 30 images from each group of color on the database. After testing the software using the Black Box method, the next step was to be assessing the software to find the software efficiency; moreover, it was tested for acceptance test by the user.

The assessment process was used to assess the efficiency of information technology and software, which were divided into 4 parts; 1) Functional Requirement Test; 2) Functional Test; 3) Usability Test; and 4) Security Test.

In this case, the experiment focused on system and software efficiency; thus, program efficiency measurement was employed in this process. The criteria for testing were a functional test for data preparation, which were the standard color digital images with file format in *.jpg. Each group of each color included 30 images, 90 images in total, consisting of Group 1: Red, Group 2: Blue and Group 3: Green. Some parts of the user interface are shown in Figure 13.

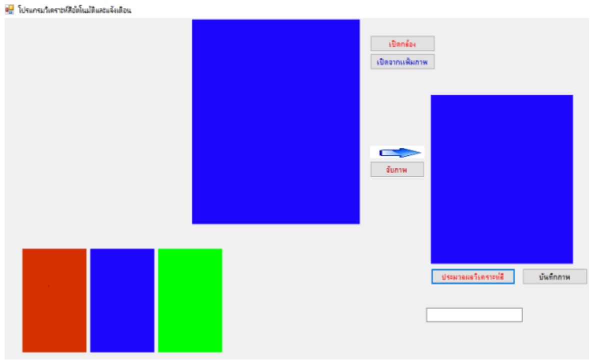

Figure 13 User Interface (adapted from system)

Table 1

Table of comparison of color object precision of 3 color groups, 90 images in total

Color Group	Number of Image	Precision of Testing	Average of Precision
Group 1: Red	30	29	96.6%
Group 2: Blue	30	29	96.6%
Group 3: Green	30	28	93.3%
Total	90	86	95.5%

The table of results in Table 1 illustrates the efficiency test of precision which measures image similarity, considering the data from the database model, and following by matching with 3 groups of original colors with all the sample images. Each group of each color included 30 images used in efficiency measurement. The results found that the efficiency assessment of the system was based on a newly developed algorithm from 3 sample groups with 30 images per group, which are 90 images in total. The images were 640 x 480 pixels in quality with average of 95.5% precision. The precision of Group 1: Red had 96.6% precision; Group 2: Blue had 96.6% precision and Group 3: Green color had 93.3 % precision. The further suggestion for the algorithm precision process is to ensure that the room must have the appropriate brightness of light. In addition, the limitation of the system that is implemented on personal devices and camera devices needs to have standard quality definition for precision purpose of the utility. The results from this experiment can be applied in color sorting of objects such as color sorting of fruits, etc.

Discussion

The results of system assessment, using the newly developed average color processing algorithm of the 3 color objects, using 30 images of each group were compared. The image definition was 640x480 pixels had a precision of 95.5%, which means high proficiency. It showed that the efficiency of color comparison of 3 groups of color was rather precise and suitable for color classification application using color object classification utilizing the technique of color intensive. This technique is considered a basic processing system, but it is convenient for implementation because the essential devices are a laptop and a camera. However, the further suggestion should be the comparison of the developed system and the results obtained from this experiment can be applied in color sorting of objects such as color sorting of fruits and vegetables, etc. Other systems should be applied to find the precision of this system to be beneficial for AI technology in the future study.

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