Color Recognition Algorithm using a Neural Network Model in Determining the Ripeness of a Banana

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***Abstract*- This paper presents a simple color recognition algorithm using a Neural Network model and applied to determine the ripeness of a banana. The captured image of the banana is resized and its RGB color components are extracted. The color components of the resized images are rescaled using a simple heuristic method. Further, a histogram for the rescaled image is obtained and used as a feature vector to identify the ripeness of the banana. A simple graphical user interface system is developed in MATLAB that classifies the ripeness of the banana. The proposed model has an accuracy of 96%.**

***Keywords* - Color Recognition, Neural Network, RGB, Histogram, Ripeness of Banana.**

I. INTRODUCTION

The normal human eyes have three types of sensors and the signal of these three sensors determine the color response of the observer. The response of this system produces the three-dimensional phenomenon of three dimensional spaces. When a human sees something, the light enters the eye and hit the light detector on the retina. This behaves similarly to a digital camera that records more reading whenever more lights hit the light detector on the back of the camera. Therefore in the electronics graphical system RGB color model is similarly applied to provide such coordinate system of three dimensional spaces. [1]

In electronics graphic system, RGB color model is commonly used for input and output devices such as color TV, digital cameras, video recorder, computer screen, and LCD. Computer monitors for instance use the RGB color and the computer images are commonly stored in RGB color system. [2] RGB color system is based on three basic color components of red, green and blue in pixel {r, g, b}.In a true image color, for each color component, there is a range of intensity, from 0 to 255 and when these three combinations of various intensities are superimposed, a colorized hue is obtained. [3]

From this theory, the color recognition model has been applied widely in industrial sectors, commercial fields as well as in social responsibilities. For instance, it is used as a powerful and reliable parameter in robotics machines, aid for the blind and the color blind people, diamond color sorting, quality control for the manufacture colored paper, [9] and in characterizing the thermal paints. [10]. Rami Al-Hmouz and Subhash Challa in their research in the field of Automatic License Plate Recognition have proposed the application of the information fusion enhanced color recognition technology in stolen vehicle identification. [4]

This application also can be useful in reducing time consuming and work efficiency for customers and cashiers in billing counters. For instance this can be applied when buying fresh vegetables or fruits. Normally, the weighing system is used for cashiers to determine the prices of the fruits or vegetables. However this color recognition system can substitute the weighing system and it is capable to recognize the type of fruits or vegetables based on the color of the scanned image.

Therefore, in this research, a simple algorithm method using the MATLAB is proposed to determine the ripeness color of a fruit and the sample of the fruit used is banana. The image of banana is captured and resized. Later, the image is extracted into the RGB color components and each pixel of the color component is rescaled using a simple heuristic method. As a result, histograms are obtained and used as the feature vector in determining the ripeness of the banana. A simple algorithm method is proposed and the program is eventually presented using the graphical user interface.

II. SYSTEM DESIGN

The RGB images of bananas are captured using a Web Digital Camera. The captured images have the resolution of 320x240 pixels. In this research work, many environmental have to be considered such as the position of the camera, lighting sensitivity, and background conditions as this elements have probabilities to effect the collection of the data. The camera is placed 15 centimeters above the sample as in (A) in Figure 1. The banana is placed on a black paper that laid on the ground as in (C) in Figure 1. The device is equipped with two similar power of bulbs throughout the capturing process in providing sufficient lighting to the sample as in (B) shown in Figure1. It is important to have similar and constant camera and light sources as different cameras and different light sources create different pixel intensities. [5]

III. METHODOLOGY

This system is designed to identify the ripeness of the banana. There are four sets of bananas used in the research with different type of sizes and ripeness. Each set contains of between 10-14 pieces of banana. Each image of the banana is

captured in four different positions and the images are captured daily until all bananas turn to be rotten. It has three main stages; preprocessing, feature extraction and ripeness classification.

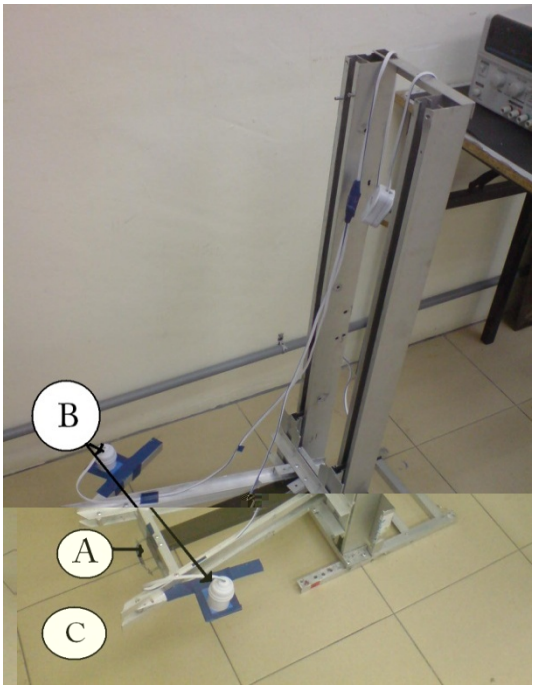

Fig. 1. Stand that holds the web digital camera at (A), two bulbs at (B) and the banana will be laid on the ground on (C)

A. Preprocessing

In the preprocessing stages, the captured images are resized in order to reduce the color index of the images. Each image of the banana will be extracted by pixel into its red, green and blue color component as shown in Figure 3.2, 3.3 and 3.4. These red, green and blue color components are displayed in gray-scale index

B. Feature Extraction

In comparison with the mechanism of normal human eyes, a ripeness of the banana is determined by a simple glance of the eyes to the majority color that dominates the banana. In a micro scale observation, the color of a ripe banana is not totally all yellow as there will some black dotted colors or still any green-yellow color skin. Therefore, from these principles, each pixel of the color component of the image is analyzed and rescaled into three groups.

In the feature color extraction, the histograms are normally used as a feature vector. For example, Swain and Ballard have introduced the original idea of using histograms in indexing of large image database.[5].Besides, a binary histogram have been proposed in utilizing the image gray scale level. In 1995, a color histogram is used as feature in color recognition. [6]

As for the intensity of color component that lies between 0-85,the image will be rescaled to ‘0’,for the color component that lies between 86-170, it will be rescaled to ‘122’ and for 171-255, the color component will be rescaled to ‘255’.

Therefore color histograms are obtained for each color component by counting the number of pixels that have same color scales in the image array as shown in the example in Figure 3.5, 3.6 and 3.7.These histograms are used as the feature vector to determine the ripeness of the banana by using a simple heuristic method.

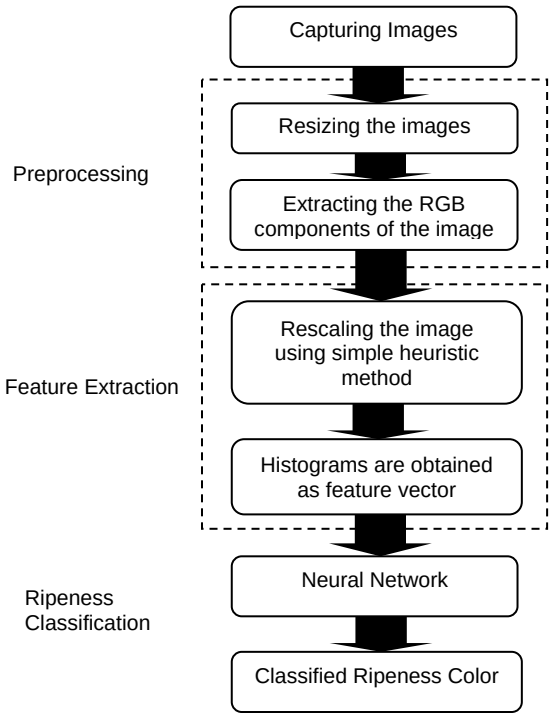

Fig. 2. System Block Diagram

100 samples of ripe banana will be allocated in the ‘ripe’ folder and 116 samples of the ‘unripe’ banana will be allocated in ‘unripe’ folder. The results of these two types of these samples are saved in an Excel file and the data will be sort out randomly and will used to train the network as the input patterns for the Neural Network developed sing MATLAB.

C. Ripeness Classification

Artificial Neural Network (ANN) is a new form of artificial intelligence of brain to compute and analyze the data. [7] In training the Neural Network system, two methods are normally used, the supervised and unsupervised methods. The supervised method means that the system needs to be trained by an ‘instructor’ and if it is compared to the way of the brain, it means that the neurons act differently compared to the rest in guiding the process. [8] For the unsupervised method, the system learns by its own self to determine the process. However in this research, only supervised method is used using a developed Neural Network model using the error back propagation model.

The Network Architecture has one output layer of 9 input neurons, 45 hidden neurons and one output layer with one output neuron. Both the hidden and output layer neurons are activated by binary sigmoid activation function. If the output is 1 then the fruit is ripe and if it is closer to zero then it

Figure 3.1 Resized image of banana

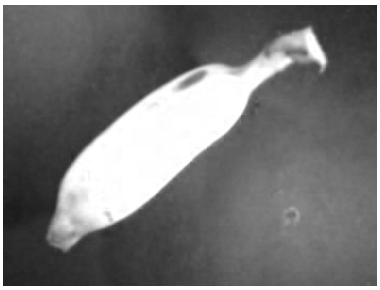

Figure 3.2 Red component image of the banana

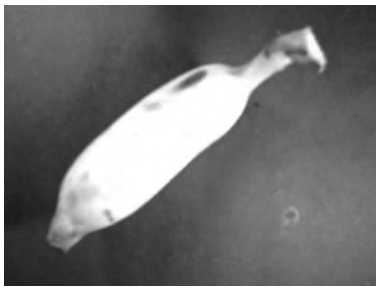

Figure 3.3 Green component image of the banana

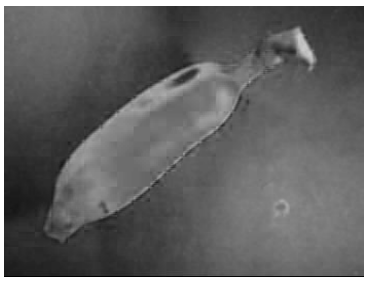

Figure 3.4 Blue component image of the banana

represents the fruit to be unripe. The training tolerance of the network is fixed as 0.01 and the maximum number of epoch is chosen as 400. The initial weights for this Neural Network are randomized between -0.5 and +0.5. A trial weight set consist of 20 sets of randomized weight samples are considered. The testing tolerance used is 0.2. 60% samples are used for training and all 100% samples are used for testing.

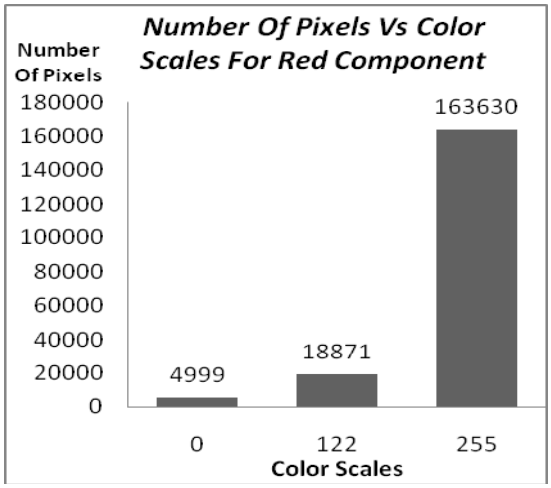

Figure 3.5 The number of pixels versus the color scales for the red component

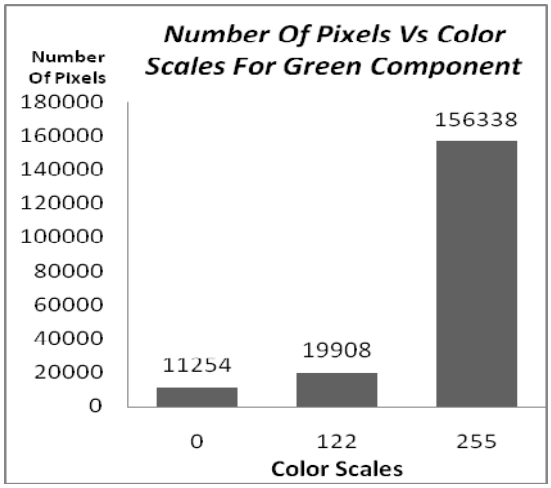

Figure 3.6 The number of pixels versus the color scales for the green component

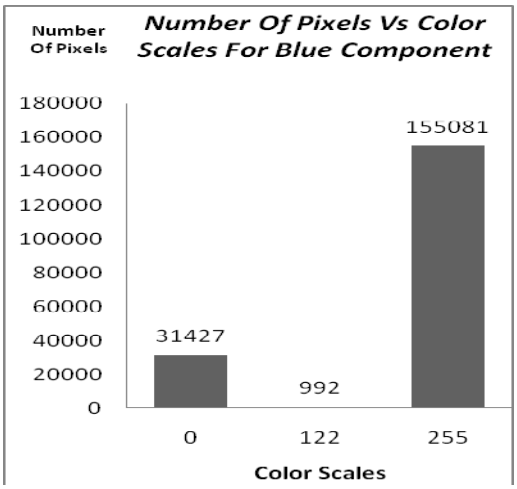

Figure 3.7 The number of pixels versus the color scales for the blue component

IV. CONCLUSION

In this paper, we developed a system for the purpose of recognizing the ripeness of fruit. The system has three main stages; preprocessing, feature extraction and ripeness classification. The work was accomplished by training a set of input data. After preprocessing, the feature extraction stage in applied to each resized captured images. The images are rescaled using a simple heuristic method. Histograms of total pixels for each rescaled color threshold in an image are obtained and used as a feature vector to determine the ripeness of the fruit. A Neural Network model is developed for color recognition. From the experimental results, the simulations show that the ripeness recognition rate is 96%. In future, this method can be applied in increasing the effectiveness for cashiers and customers in counters when determining the prices of fruits or vegetables instead of the conventional weighing method as this method is simpler and will save time

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