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RESEARCH ARTICLE

IMAGE PROCESSING SYSTEM FOR AUTOMATED CLASSIFICATION DATE FRUIT

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Abstract

Saudi Arabia is one of the most important countries in the world in the production of dates, with an estimated number of palms in the kingdom about 21 million trees, and estimated the number of items about 400 products. Postharvest losses in handling and processing and the increased demand for food products of high quality and safety Requires a search for methods more accurate, fast and logically for quality determination of food and agricultural products. A first and an important step in the postharvest chain is sorting and grading of harvested produce. Dates are harvested at different levels of maturity that require different processing before the dates can be packed. Manual sorting and grading are based on traditional visual quality inspection performed by human operators, which is tedious, time-consuming, slow and non-consistent. This word presents a computer vision system based on image processing for classification date fruit (*Khalas Variety*) according to color and size. Based on feature extraction with in image it classifies dates into three color categories and four size categories. This system able to classification dates into ten grades according to color and size. The results showed that the used system in classification dates is more efficient, precise, fast and low cost.

Introduction

Saudi Arabia is one of the most important countries in the world in the production of dates, with an estimated number of palms in the kingdom about 21 million trees, and estimated the number of items about 400 products such as (Ruzeiz, Rebeaa, Thawee, Deglet Noor, Khodry, Khesab, Hulwa, Beid, Barhi, Khalas, Sukkari, Sari, Ajwa, Segae, Safri, Nabtat Seif, Nabtat Sultan, Wannana and Hilali and etc….) are spread in various agricultural areas, and according to statistics of 2005 increases the annual production of 970 thousand tons is classified as one of the first States in the global production of dates **Saudi Arabia Ministry of Agricultural and Water (2005)**. Huge postharvest losses in handling and processing and the increased demand for food products of high quality and safety necessitates the growth of accurate, fast and objective quality determination of food and agricultural products. Major areas of application of computer vision technology in food industry include quality evaluation of food grains, fruits, vegetables and processed foods such as chips, cheese and pizza. The technique had also found useful for determination insect infestation in grains and blemishes in fruits and vegetables (**Narendra and Hareesh, 2010**). Suitable handling (Post harvest) process of date fruits is considered the most important process that leads to conserve date fruits quality until reach to the consumers, improve the quality of industry food products and decrease the losses of fruits. The method used by the farmers and distributors to sort and grade agricultural and food products are through traditional quality inspection and handpicking which is time-consuming, laborious and less efficient. Manual sorting and grading are based on traditional visual quality inspection performed by human operators, which is tedious, time-consuming, slow and non-consistent. The quality attributes often used for deciding on the harvest maturity are color, appearance, texture and odor (**Sun and Brosnan, 2003)**. The date grading and sorting is a repetitive process. In practice, it is carried out by humans manually through visual inspection. The manual inspection poses further problems in maintaining consistency in grading and uniformity in sorting (**Al Ohali, 2011**). Many of the decision that are made during manual inspection are based on qualitative measurements, and **Muir *et al.* (1989)** illustrated individual "human sensors" are quite variable and difficult to calibrate. When qualified inspector were asked to quantify the amount of surface defect on a potato (in percentage of the total tuber surface), the values for a single sample ranged from 10 to 70%. The repeatability of individual inspectors was also very poor. Differences between two consecutive readings were as high as 40 percentage points in some cases. Appropriate imagines sensors are more accurate, with a maximum variation of 15 percentage points. **Tao, *et al.* 1990)** observed that the basis of quality assessment is often subjective with attributes such as appearance, smell, texture and flavor frequently examined by human inspectors. A first and an important step in the postharvest chain is sorting and grading of harvested produce. Commercially human senses are employed to sort or grade. Human perception could easily be fooled. It is pertinent to explore the possibilities of adopting faster systems, which will save time and more accurate in sorting and grading of agricultural and food products. One of such reliable method is the automated computer vision system for sorting and grading (**Francis, 1980)**. Dates are harvested at different levels of maturity that require different processing before the dates can be packed. Maturity evaluation is crucial to processing control, but conventional methods are slow and labor-intensive. Because date maturity level correlates strongly with color, automated color grading could be used. A novel and robust color space conversion and color index distribution analysis technique for automated date maturity evaluation that is well suited for commercial production is presented in this paper. In contrast with more complex color grading techniques, the proposed method makes it easy for a human operator to specify and adjust color preference settings for different color groups representing distinct maturity levels. The performance of this robust color grading technique is demonstrated using date samples collected from field testing **Jiangsheng and Yibin (2006)**.

Computer Vision (CV) is the process of applying a range of technologies and methods to provide imaging-based automatic inspection, process control and robot guidance in industrial applications. Computer vision is a novel technology for acquiring and analyzing an image of a real scene by computers to control machines or to process it. It includes capturing, processing and analyzing images to facilitate the objective and non-destructive assessment of visual quality characteristics in agricultural and food products. The techniques used in image analysis include image acquisition, image pre-processing and image interpretation, leading to quantification and classification of images and objects of interest within images **(Relf, 2004**). Computer vision systems have been used increasingly in the food and agricultural industry for inspection and evaluation purposes as they provide suitably rapid, economic, consistent and objective assessment. They have proved to be successful for the objective measurement and assessment of several agricultural products. Over the past decade advances in hardware and software for digital image processing have motivated several studies on the development of these systems to evaluate the quality of diverse and processed foods. Computer vision has long been recognized as a potential technique for the guidance or control of agricultural and food processes. Therefore, over the past 20 years, extensive studies have been carried out, thus generating many publications **(Brosnan and Sun, 2004)**. Development and application of image analysis and computer vision system in quality and maturity evaluation of products in the agricultural field. Present a method which is able to segment images of date fruits and to classify them by their quality depending on the level of maturity and size using a HSV representation color, a method that can be applied to types of fruit, used it to distinguish between good or mature and yellow or green date fruits **(Halimi, *et al.*2013)**. Designed and implemented a prototypical computer vision based date grading and sorting system. The system uses RGB images of the date fruits. From these images, it automatically extracts the aforementioned external date quality features. These features are flabbiness, size, shape, intensity and defects. Based on the extracted features it classifies dates into three quality categories (grades 1, 2 and 3) defined by experts (**Al Ohali, 2011**). Color information of the input digital image acquired by a camera or scanner that can recognize three primary ingredient spectrums; red, green, and blue from the light beam that considered the primary components. The properties that used to distinguish different colors are brightness, hue, and saturation; these parameters are classified into two components; luminance (the brightness) and chrominance (hue and saturation), so each color is represented with two characteristic components luminance and chrominance that are suitable for human interaction since they can represent the human skin pigment regardless the lightning used (**Gonzalez and Woods, 2009**). The RGB color space could be represented as a cube by normalized RGB color values in the range [0,1] with gray values on the main diagonal of the black values (0,0,0) and on the opposite corner the white values (1,1,1). It is considered as the base color model for most image applications since the acquired image does not need any further transformation for displaying in the screen (**Adrian and Roberts, 1998**). Description RGB (Red, Green and Blue) of a color refers to the color composition in terms of the intensity of the light primary colors: red, green and blue. It is a color model based on the additive synthesis, which allows represent a color by mixing of the three primary colors of the light. Most digital camera models using the RGB color model where each sensor capture the light intensity in the red level (R), green (G) or blue (B) of the light spectrum (**Hunt, 2004**). RGB color model is classified into two types according to Linear RGB Color Space, and Nonlinear RGB Color Space. Referring to linear RGB color model as (RGB), and to nonlinear RGB color model as (R'G'B'). Linear RGB space attains color consistency via various appliances using color management system. The mapping to nonlinear done using gamma correction factor of the camera or any input device, in the range [0,1] for both of the models. The data of input image captured with a camera or scanner are the R'G'B' values represented in the range from 0 to 255 (**Plataniotis and Venetsanopoulos 2000)**. The CIE L* a* b* (CIELAB) is chromatic model normally used to describe all the colors that the human eye can perceive. It was developed specifically for this purpose by the Commission Internationale d'Eclairage (Illumination International Commission), reason why is abbreviated CIE. Asterisks (*) following each letter are part of the name, as they represent L*, a* and b.* The three parameters in the model represent the lightness of color (L*, L* = 0 black yields and L* = 100 indicates white yields), its position between red and green (a*, negative values indicate green while positive values indicate red) and its position between yellow and blue (b*, negative values indicate blue and positive values indicate yellow). This color model is three-dimensional and can only be adequately represented in three-dimen-sional space (**Hunter Labs, 1996**). The appearance and color of food are important factors which influence consumer preferences. During the ripeness time, olives follow different phases. Firstly, they are of a deep green color with predominantly high levels of chlorophyll and give rise to bitter oil. In their final phase, they present a black color paste, their chlorophyll is degraded and replaced by anthocyanin and they are more sensitive to external damage and infections. The maturity index is useful for producers to identify the optimal time for harvesting the olives. Using this index may also help to increase the quantitative and qualitative characteristics of olive oil production. Segmentation based on color/grey and classification this segmentation based on color can be performed by supervised or unsupervised methods in order to get and quantify the predominant color in the olives. This step requires transforming the RGB image using various functions to transform RGB format in L*a*b color space. The CIE L*a*b* color notation system was ap- plied to determine the parameters L*, a* and b*; where L* indicates the lightness, a* means the color axis from green to red and b* refers to the blue-yellow one. On the one hand, in the supervised methods a region containing the color of interest (color markers) is selected and then averaged. This classification is performed by using the method of the k-nearest neighbours (KNN), where each pixel is classified in the same group as the color markers with a similar intensity. The k nearest neighbours assign a value of "a" and "b" for each marker and, therefore, it is possible to classify each pixel of the image so as to calculate the Euclidean distance between pixels and color markers **(Guzmán, *et al* 2013)**. Size, which is the first parameter identified with quality, has been estimated using machine vision by measuring projected area, perimeter or diameter. Size measurement is important for determining produce surface area. The fruit size is another quality attribute used by farmers the bigger size fruit is considered of better quality. The size is estimated by calculating the area covered by the fruit image. To compute the area, first the fruit image is binarized to separate the fruit image from its background. The number of pixels that cover the fruit image is counted and considered as an estimate of size. We categorize fruits as big, medium and small using the average area and variance relationship (**Al Ohali, 2011**). The size of cherries was calculated based on the area of related images. The area of cherries was calculated by counting the number of related pixels after removal of the background, and implementation of the defect detection algorithm .Although the area for each fruits calculated in pixels, since these areas are used in doing the classification, the units of area will not affect the results. In order to evaluate the accuracy of the algorithm sin classification, before processing, the cherries were classified into three groups, small (diameter smaller than 1c), medium (diameter between 1 and1.5cm) and large(diameter larger than1.5cm).and the amounts were converted to pixels in the same way that small cherries were in the range of smaller than 8000 pixels, medium cherries were between 8000 and 12000 pixels, and large cherries were more than 12000 pixels (**Asghar, *et al.,* 2012)**.

Materials and Methods

2.1. Date Fruits samples

Tested date fruits samples Khalas variety were selected for the experiment. Samples were obtained from the "Date Palm Research Center of Excellence" at different ripeness. All date fruit samples were individually numbered, 100 samples, 2 images for each sample with static and various positions (right and left), totalizing 200 images for date fruit. Half of the images for database building purpose, the other half for testing purpose.

2.2. Computer vision system

The designed prototype consists of two parts Image acquisition unit and Computer vision system (CVS). The lighting chamber has been designed in order to provide diffuse illumination over the fruit surface, was made of wood painted matt black inside to avoid highlights specular reflections and outsides dimensions of the chamber 75×75×40 cm for length, width and height respectively. Samples were illuminated using four Philips fluorescent tubes, day light, 18 W (length 60 cm) with a color temperature of 6500K (D65, standard light source commonly used in food research) corresponding to daylight and a color index (Ra) approximately 95% and placed horizontally, forming a square on the camera located vertically at a distance 35 cm from the sample and at an angle of 45° to the sample. A Color Digital Camera (CDC), Camera Lumenera's Lu075 (CCD) was located vertically over the background at a distance of 30 cm. The angle between the camera lens and the lighting source axis was approximately 45°. The images were capture at resolution (640x480) pixels, and storage in JPEG format. The camera was connected to the USB port of a PC Core as shown in **Fig.(1)**.

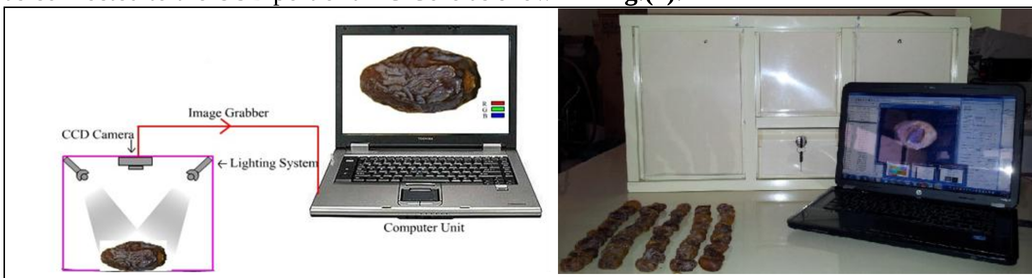

Figure (1): Computer vision system prototype.

The image analysis was composed of two parts hardware (computer Pc) and software (programing language). All the algorithms for preprocessing of full images, segmentation from the background, size and color analysis were written in MATLAB (The Math-Works, Inc., USA). Image processing in agricultural applications may consist of three steps: image enhancement, image feature extraction, and image feature classification. Once image features are identified, the next step is feature classification. The processing code consists of a multi-steps and **Figure (2)** described below.

2.3. Measurements

2.3.1. Physical characteristics

The mean dimensions length (L), width (W), thickness (T) for each fruit estimated by digital vernier caliper with accuracy of 0.01 mm. Geometric mean diameter of the measured samples was calculated according to as follows:

$$D_g = \sqrt[3]{LWT} \quad \text{.........................(1)}$$

The mass of each date fruit was determined by using an electronic digital balance having a sensitivity of 0.01 g. The obtained measured surface area of each fruit calculated by the following equation (**Mohsenin, 1986**).

$$S_a = \pi \, (Dg)^2 \quad \text{..........(2)}$$

Where: S_a = *surface area (cm^2)* and D_g = *Geometric mean diameter (mm)*

Projected area of date fruit obtained from a proposed device is based on image processing. Captured images from a camera are transmitted to a computer. Digital images were then processed to the software and the desired parameters are determined. Through three normal images of each fruit, this device was capable for determining length, width and thickness diameters as well as projected area that perpendicular to these dimensions. Total error for these objects was less than 2%, as shown in **Fig. (3).**

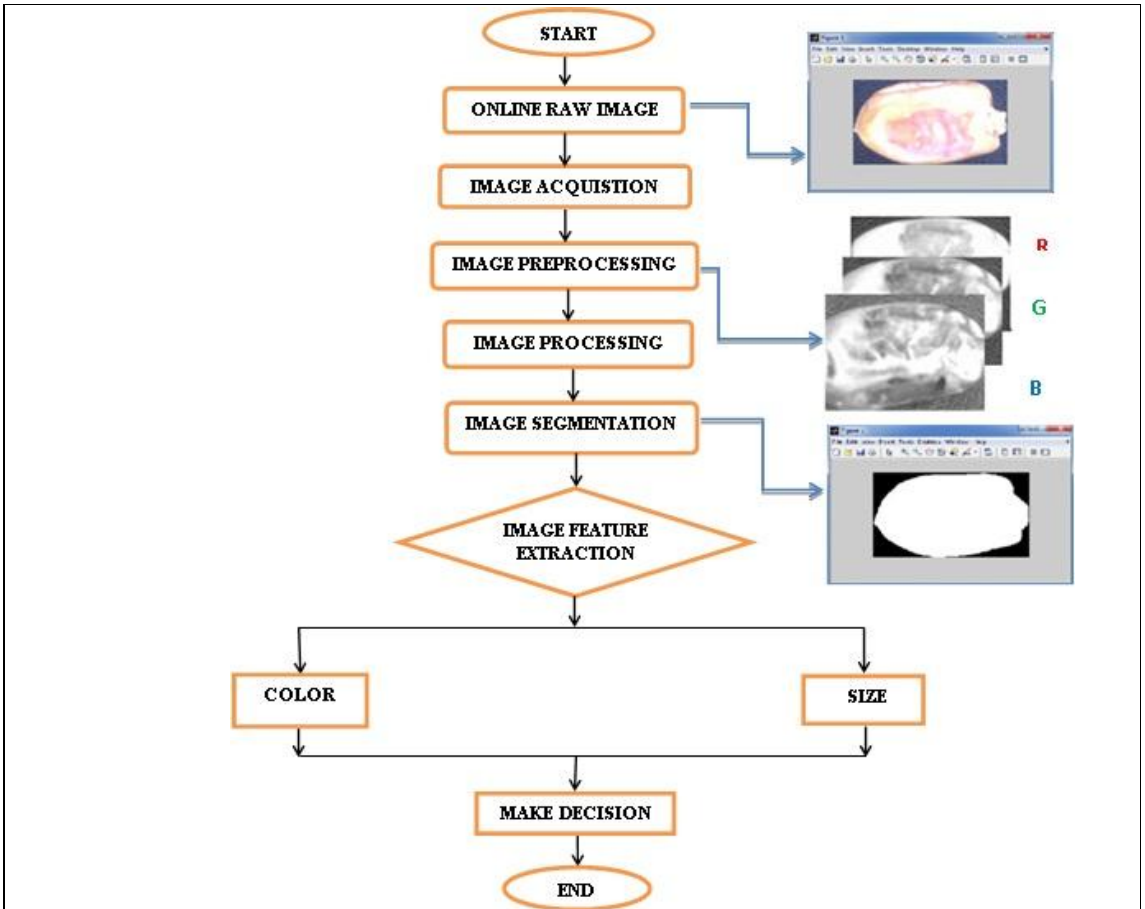

Figure (2). Showing flowchart sequence steps for image processing and analysis.

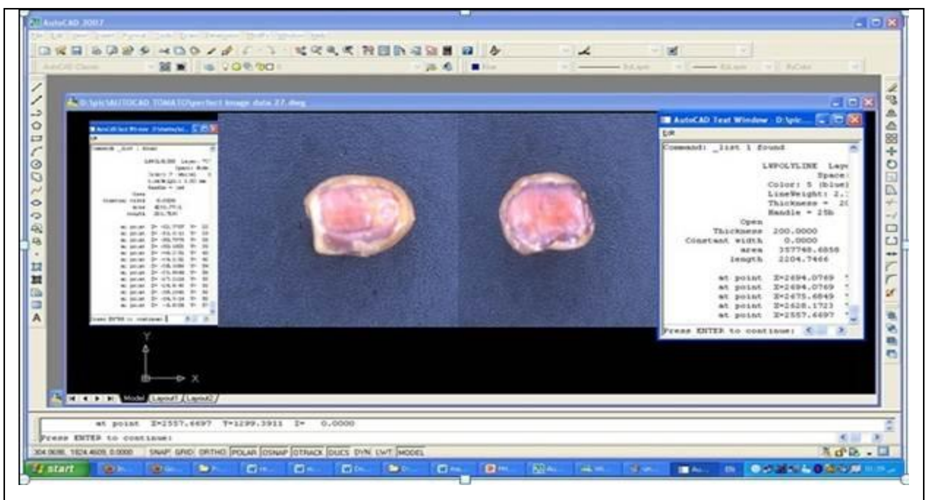

Figure. (3): Calculated projected area by AutoCAD program.

2.3.2. Image processing and image analysis

1. Segmentation

A robust algorithm for segmenting fruits color images from the background was developed using MATLAB code, **Fig. (4)** show the Segmentation Steps of the algorithm. This segmented image is a binary image consisting only of black and white pixels, where ‘0’ (black) and ‘1’ (white) mean background and object, respectively.

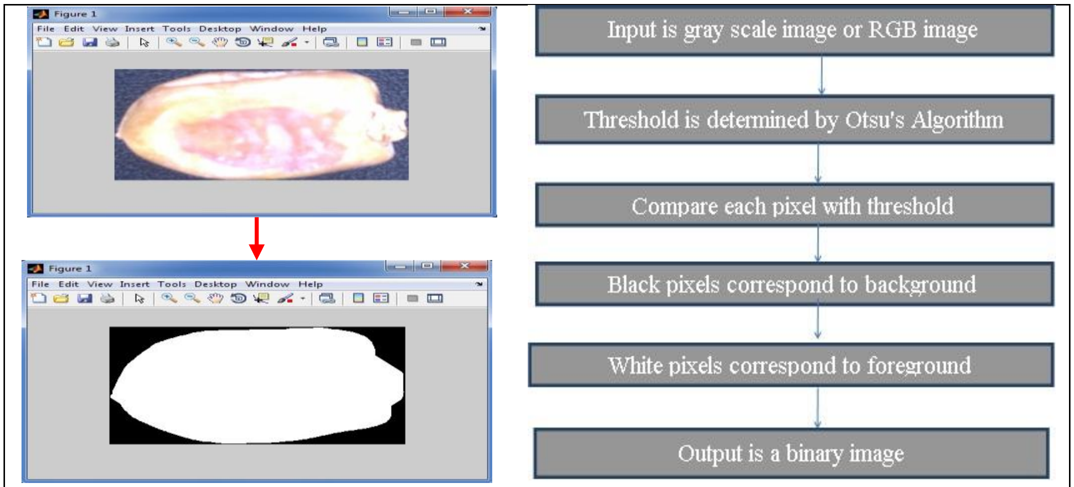

Fig. (4):- Show segmentation steps and output.

2. ***Color analysis***

The main function of the program developed here is to calculate the histogram of Red, Green, and Blue (RGB) colors in the cropped area of the captured image, calculate its mean values, transform the nonlinear $R' G' B'$ values to linear standard RGB (sRGB) and transform to *CIE* $L^* a^* b^*$ color space.

$$
\begin{aligned}
R'_{sRGB} &= R_{8bit} \div 255 \\
G'_{sRGB} &= G_{8bit} \div 255 \\
B'_{sRGB} &= B_{8bit} \div 255
\end{aligned}
\qquad \text{..........(3)}
$$

$$
if R'_{sRGB}, G'_{sRGB} and B'_{sRGB} \le 0.04045
$$

$$
\begin{aligned}
R_{sRGB} &= R'_{sRGB} \div 12.92 \\
G_{sRGB} &= G'_{sRGB} \div 12.92 \\
B_{sRGB} &= B'_{sRGB} \div 12.92
\end{aligned}
\qquad \text{.......... (4)}
$$

$$
else R'_{sRGB}, G'_{sRGB} and B'_{sRGB} > 0.04045
$$

$$
\begin{aligned}
R_{sRGB} &= \left[\left(R'_{sRGB} + 0.055\right) / 1.055 \right]^{2.4} \\
G_{sRGB} &= \left[\left(G'_{sRGB} + 0.055\right) / 1.055 \right]^{2.4} \\
B_{sRGB} &= \left[\left(B'_{sRGB} + 0.055\right) / 1.055 \right]^{2.4}
\end{aligned}
\qquad \text{.......... (5)}
$$

Where:- R_{8bit}, G_{8bit} and B_{8bit} values are signals from (CDC), R'_{sRGB}, G'_{sRGB} and B'_{sRGB} values are average RGB signals from (CDC) and R_{sRGB}, G_{sRGB} and B_{sRGB} values are linear standard RGB.

Standerd RGB values are transformed to L* a* b*

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} R_{sRGB} \\ G_{sRGB} \\ B_{sRGB} \end{bmatrix} \quad ....(6)$$

If X/X_n, Y/Y_n and Z/Z_n are all greater than 0.008856

$$L^* = 116 f\left(\frac{Y}{Yn}\right) - 16$$
$$a^* = 500\left[f\left(\frac{X}{Xn}\right) - f\left(\frac{Y}{Yn}\right)\right] \quad ....(7)$$
$$b^* = 200\left[f\left(\frac{Y}{Yn}\right) - f\left(\frac{Z}{Zn}\right)\right]$$

If X/X_n, Y/Y_n or Z/Z_n is equal to or less than 0.008856

$$L^* = 7.78 f\left(\frac{Y}{Y_n}\right) + \frac{16}{116}$$
$$a^* = 7.78 f\left(\frac{X}{Xn}\right) + \frac{16}{116} \quad ....(8)$$
$$b^* = 7.78 f\left(\frac{Z}{Zn}\right) + \frac{16}{116}$$

Where:-

- X, Y and Z are the CIE tristimulus values,
- f (q) = (q)^1/3 q > 0.008856
- f (q) = 7.787q + (16/116) $q \le 0.008856$.
- Y_n , X_n and Z_n are the trismulus values of the illuminant and observer angle. For illuminant D65, observer angle 10°, X_n = 94.83, Y_n = 100 and Z_n = 107.38, L^* representing lightness (+L*) to darkness (-L*). The chromaticity coordinates are a* and b* and their axis indicates color directions: +a* is the red direction, -a* is the green direction, +b* is the yellow direction and –b* is the blue direction, **Fig.(3-9**).

In the quadrant between the a* and b* axes. Chroma is the saturation or vividness of color. It is measured radially from the center of each quadrant with the a* and b* axes. The relationship is defined as follows:-

$$C^*_{ab} = \sqrt{a^{*2} + b^{*2}}$$
$$h^\circ_{ab} = \arctan\left(\frac{b^*}{a^*}\right) .....(9)$$

Where $\mathbf{C^*_{ab}}$ indicates chroma (an indication of color saturation) and is equal to zero at the center of the color space and increases based on the distance from the center. $\mathbf{h^\circ_{ab}}$ is the hue angle and it is expressed in degrees. Starting from the +*a*∗ axis, 0◦ is +*a* (red), 90◦ is +*b* (yellow), 180◦ is –*a* (green), and 270◦ is –*b* (blue).

Results and Discussion

Depending on the maturity level, date colors range from yellow to dark red with many shades in between, **Fig. (5)** shows the color range of dates at all observed maturity levels. Image is stored in three matrices, called R, G and B, respectively, which contain the intensity values of the red, green and blue components of the image. The intensity of a pixel is expressed with a given range between a minimum and maximum, inclusive. For instance, the weakest intensity is black (0), the strongest intensity is white (255) and many shades of gray in between. **Fig. (6)** show an example of the color channel splitting of a full RGB color image. The computer program extracts RGB of the date sample.

Figure. (5): Color range of dates at all observed maturity levels.

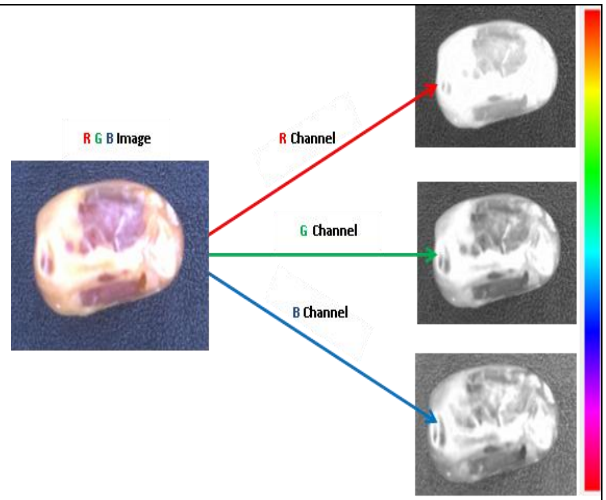

Figure. (6): RGB image and the channels splitting.

Depending on the maturity level, dates color range from yellow to dark red with many shades. First color gamut yellow and shades the mean raw RGB and standard sRGB values were, red channel (R) was 215 ranged from 175 to 255(±24), green channel (G) was 188 ranged from 123 to 255 (±41.7) and blue channel (B) was 200.88 ranged from 138 to 255 (±34.2) while the mean standard sRGB values were sR was 0.62 ranged from 0.55 to 0.72 (±0.05), sG was 0.36 ranged from 0.31 to 0.41 (±0.03) and sB was 0.41 ranged from 0.36 to 0.48 (±0.04). Second color gamut light red and shades the mean RGB values were, red channel (R) was 215.75 ranged from 113 to 255 (±33.74), green channel (G) was 158.54 ranged from 83 to 253 (±29.86) and blue channel (B) was 160.35 ranged from 96 to 255 (±29.1) while the mean standard sRGB values were sR was 0.73 ranged from 0.62 to 0.91 (±0.08), sG was 0.43 ranged from 0.35 to 0.53 (±0.05) and sB was 0.35 ranged from 0.28 to 0.46 (±0.06).Third color gamut dark red and shades the mean RGB values were, red channel (R) was 174 ranged from 91 to 255 (±28.49), green channel (G) was 155 ranged from 65 to 255 (±25.99) and blue channel (B) was 204.1 ranged from 76 to 255 (±30.55) while the mean standard sRGB values were sR was 0.39 ranged from 0.25 to 0.49 (±0.07), sG was 0.37 ranged from 0.19 to 0.50 (±0.09) and sB was 0.66 ranged from 0.37 to 0.84 (±0.14). Experimental results obtained of RGB color gamut for dates fruits (Khalas variety) are charted in **Fig.(7)**.

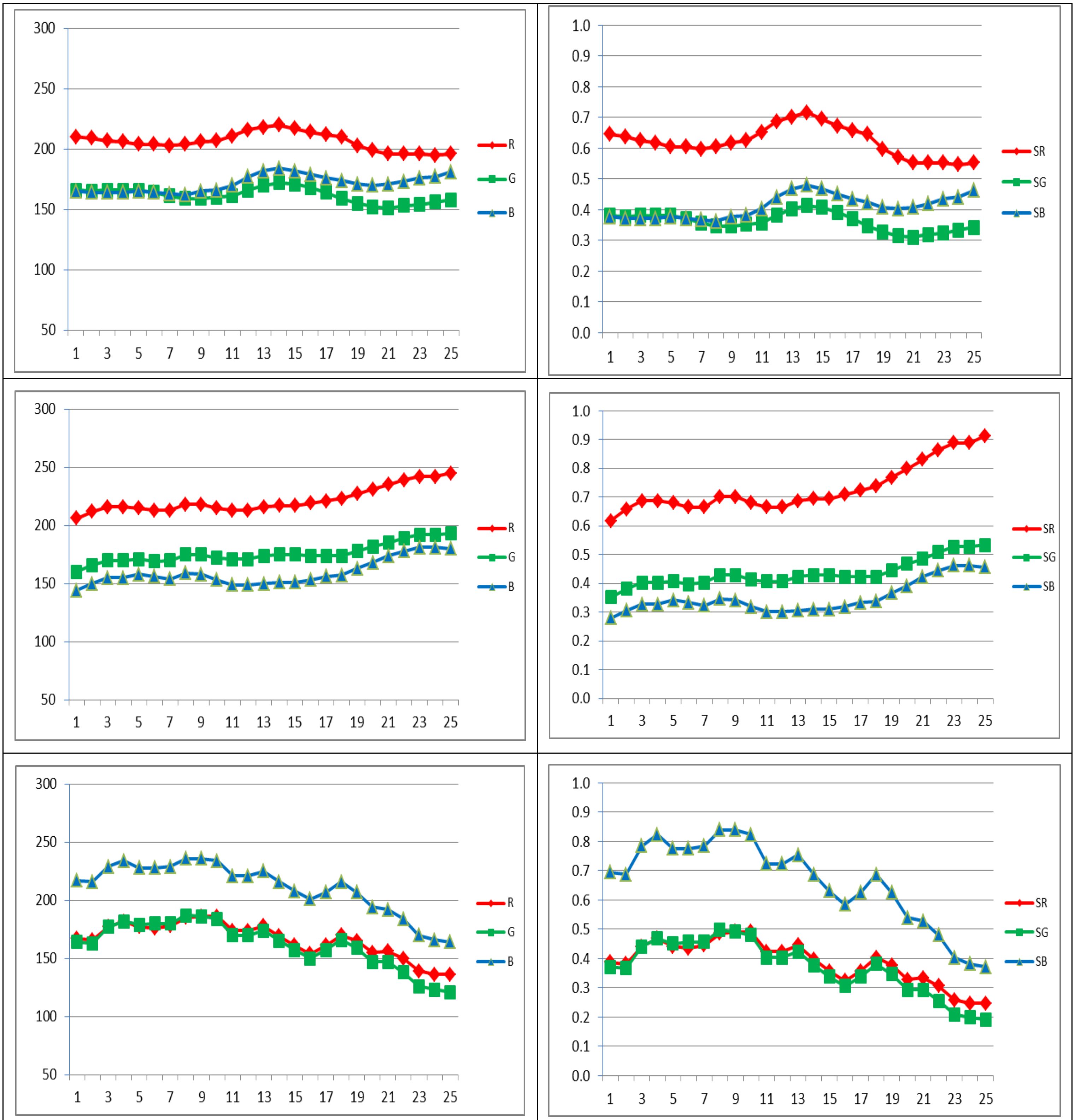

Figure. (7):- The RGB and sRGB intensity of color gamut (yellow, light red and dark red) of date fruits respectively.

3.1. *L* a* b* and L* C* h$^{\circ}$ Color Space*:-

The ***CIE*** *L*a*b** color space is one of the uniform color spaces recommended by **CIE in 1976** as a way of a better representation of the perceived color and color difference and is frequently applied in quality estimations of the fruits color. The computer program takes the average *RGB* values for each pixel and translates the color measurements to *L*a*b** of the *CIE L*a*b** color space and calculating chroma (*C*) and hue angle (h°) from these components throw some sequence steps as read image, binary image, edge detection and convert it to *CIE L*a*b** color space. First, it explicitly separates lightness (L*) on a first dimension from chroma (a*b*) second, a*b* represents colors along two color-opponent dimensions. Depending on the maturity level, dates color range from yellow to dark red with many shades.

Mean values of *L** 75.53 ranged from 65.77 to 83.14 (±4.92), 69.38 ranged from 60.61 to 75.62 (±4.29) and 64.86 ranged from 56.99 to 74.92 (±4.41), mean values *a** was 9.72 ranged from 4.05 to 16.05 (±3.37), 15.20 ranged from 9.92 to 18.48 (±2.22) and 12.01 ranged from 9.54 to 14.82 (±1.49), mean values of *b** was 0.6 ranged from -3.46 to 5.99 (±2.85), -6.41 ranged from -12.86 to -1.39 (±2.73) and was -14.88 ranged from -20.08 to -10.13 (±2.69) for yellow, light red and dark red color gamut respectively, **Fig. (8)** show color curves of *L**, *a** & *b** for color range of date fruit. While the mean values of chroma *C** 10.22 ranged from 5.06 to 16.26 (±3.05), 16.67 ranged from 10.02 to 19.07 (±2.4) and 19.18 ranged from 13.92 to 24.03 (±2.63) for yellow, light red and dark red color gamut respectively and hue angle h° for yellow category Was divided into two parts, the first part ranged from 0° to 60° and the second part ranged from 352° to 360°, light red category was ranged from 317.22° to 351.9° and dark red category was ranged from 295° to 317°. This implies that imaging technology can be used to evaluate color change in ripening dates fruits and be incorporated into sorting systems for fast and accurate determination of fruit color.

3.2. Detect size of date

Fruit size is another quality attribute used by farmers and consumers, where the bigger size fruit is considered of better quality. The size is estimated by calculating the area covered by the fruit image throw the algorithm implementation is included in the MATLAB as "graythresh" which returns the appropriate threshold to use to separate background and foreground. Segmented image is binary, where ‘0’ (black) and ‘1’ (white) means background and object, respectively. The size of date fruits was calculated the area of related images where the number of pixels that cover the fruit image is counted and considered as an estimate of size. In order to evaluate the accuracy of the size of date by the algorithm of image processing, before run processing algorithm the Dates fruits were classified into four categories, jumbo, big, medium and small according to geometric mean diameter (GM) and calculated projected area (PA) by AutoCAD program. Where the obtained result of detect size of date fruit by image processing found that the jumbo category of the date fruit more than 70835 pixels which was equivalent to the values of (GM) and (PA) more than 26.88 mm and 10.32 cm^2, big category was ranged from 44169 to less than 70835 which was equivalent to the values of (GM) and (PA) ranged from 21.2 to less than 26.88 mm and 7.06 to less than 10.32 cm^2, while the medium category ranged from 36201 to less than 44169 pixel which was equivalent to the values of (GM) and (PA) ranged from 18.22 to less than 21.14 mm and 5.21 to less than 7.06 cm^2 and small category of the date fruit less than 36201pixels which was equivalent to (GM) and (PA) less than 18.22 mm and 5.21cm^2. From initial results to determine the size of dates fruits using image processing technology that the projected area by image processing of a binary object was closely related to the geometric diameter (GM) and projected area (PA) of date fruit. Date fruits were divided by the image processing algorithm into three categories for color and four size categories, where classified the three color categories with the first three categories of size, except the small category and **figure (9)** below illustrates the classification process.

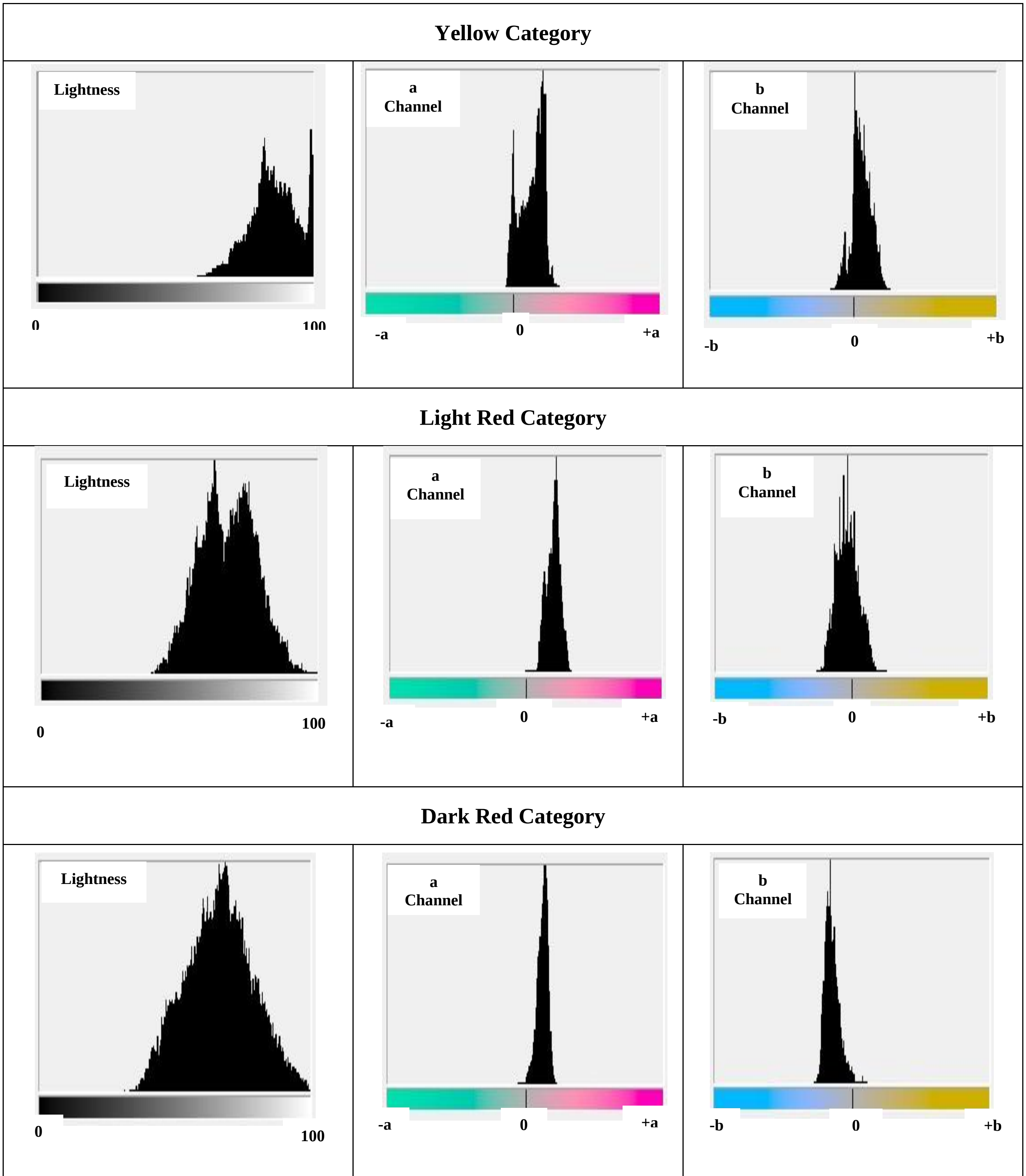

Figure (8):- Show *CIE L* a* b**color model for date fruit categories

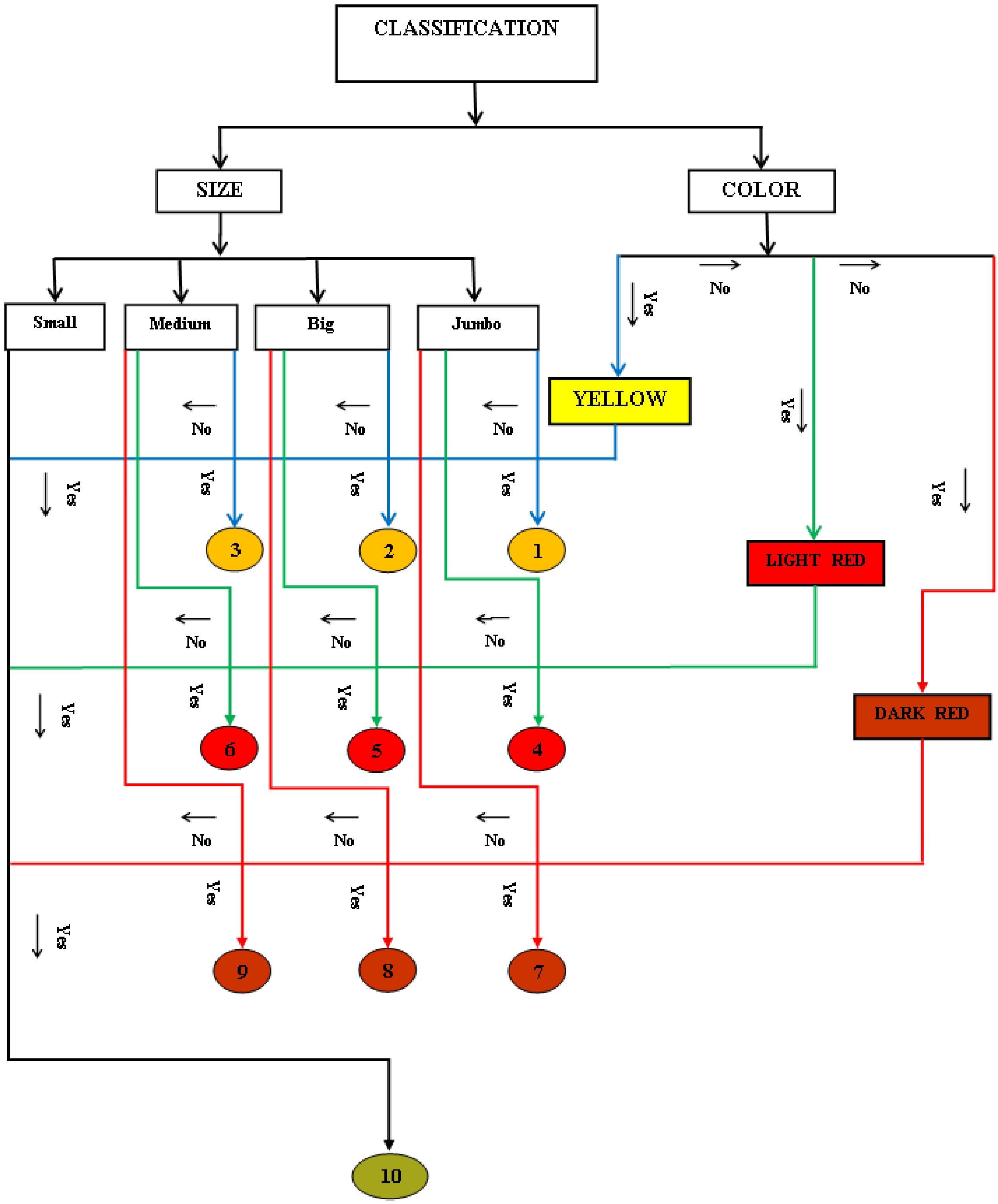

Figure (9):- Illustrates the classification process of date fruit according to color and size.

Conclusions

The present work is an application of computer vision system based image analysis for automated classification of date fruit according to color and size. Different image processing techniques were evaluated, to extract different features from the images of date. Prototype for sorting the date fruits was developed and successfully commissioned, which take time processing 0.3 second for one fruit. It could be conclude that the system can be grading ripe category of date fruits (*Khalas variety*) according to its color to more than color such as (yellow, light red and dark red), according to Chroma (C^*) and hue angle (h°) for each variety of date fruits. This technique found to be low cost effective and moreover intelligent. This prototype of sorting succeeded for purpose as a step forward to the complete design for optimal sorting machine on line. From the initial results of the date fruit color analysis we recommended that can be linked to the moisture, sugar content and level of acidity through the color tone and saturation for date fruit.

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