

Automated Date Fruits Sorting Machine using Fuzzy Logic Controller



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Abstract - Date palm is the primary agricultural crop in Oman. Date fruits occupy 80% of its share in total fruits production in Oman. Over 50% of agricultural lands are used to cultivate the date palms in Oman. Over 50% of its production is used for human consumption and others used for animal feed. In date fruits packaging industries, sorting system plays a vital role. So many techniques are adopted for this process. But, machine vision based system proved as efficient one. So, in this paper, the machine vision system is realized by color and ultrasonic sensors. The main aim of this work is to sort the date fruits based on its color, size and features. In this paper, the Fuzzy logic controller is used to sort the dates according to the signals from the color and ultrasonic sensors. The sorted fruits collected in separate trays with the help of servomotor which is actuated by neural network. The experimental results show that the proposed system is more precise and accurate in sorting the Date fruits.

Key words - Date fruits, Sorting system, machine vision, Fuzzy logic controller.

I. INTRODUCTION

Date palm is a primary agricultural crop, which have been cultivated even remote areas of Oman. Oman is the eighth largest producer of dates in the world. It has more than over seven million date palms in its area. If the dates are not properly preserved and sorted. Then, it makes heavy loss to the formers.

According to the Oman observer, the country is focusing on date palm-related products to increase the employment opportunities for unemployed Omani youths. So, the government is focusing on cutting edge technologies in the Date fruit processing industries to improve the quality of Date products.

One of the key sections in the date processing industry is the sorting section where the different quality dates are sorted

for sale. Manual sorting is the time consuming process and also it needs more labor resource. So, recently, automated sorting machines are introduced in this section to reduce the labor cost and processing time.

Date sorting and grading is the most difficult part in the date packaging industries. The physical processing is the problems of keeping the uniformity and reliability in date grading. In older days, the farmers have been involved in sorting and grading processes.

Therefore, it is necessary to develop a system which sort and grade the dated effectively at the mean time with reasonable period. In this research work, we proposed a novel system to sort out the dates automatically without human intervention. In which, the date fruits are sorted by its shape, size, color.

An image processing based dates sorting machines proposed in [1]. In that, dates are sorted based on its mechanical and physical features. A computer vision based pattern recognition system is proposed in [2] to sort the dates. color mapping mechanisms proposed in [3]. In this work, the dates are sorted based on their maturity and color. a moisture sensor based sorting mechanism was developed in [4] which sorts the dates based on their moisture content. an ANN classifier mechanism was developed in [5] to sort out the different date fruits. Later, adaptive grading mechanism is introduced in [6].

From the literature survey it is concluded that machine vision based sorting techniques are more efficient and effective system as compared to other approaches. Mostly image processing technology is used to analyze the color and shape of the date fruits. But, this method is costly and also little bit complex method. In this paper, the electronic vision is used to sort out the date according to its color and shape. For better date fruits sorting various intelligent controllers are analyzed like .artificial neural networks [7]-[11] and fuzzy logic controllers[12],[13] etc. but, The literature survey shows that fuzzy logic controller is most efficient controller compared with other intelligent controllers. To gets the good result. It is necessary to study different stages of dates ripening process.

The ripening process of the dates has four different stages:

- a. Kimri-Immature stage
- b. Khalal-Changing color, still immature
- c. Rotab – Mature (Semi ripe)
- d. Tamar-Mature (Completely ripe)

It is not advisable to pack Khalal dates with Rotab. Because, Khalal dates are not good for sale because of its bitter taste. Also, Khalal dates have 50% moisture on its total mass. So, it is easily affected by microbiological activities.

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so, even single khalal date in the Rotab dates pack, affect the entire quality of the pack.

From the above analysis, it is concluded that the dates sorting mechanism needed precise and accurate sorting mechanism. At the mean time. It should be economically viable for small scale industries. Keeping all these points. In this paper, a novel sorting mechanism is proposed based on electronic sensors.

The main aim of this paper to develop a efficient system which sort the dates based on its physical feature and color. This paper is organized as follows. the implementation fuzzy logic controller for sorting mechanism is elaboratively discussed in chapter 2. the proposed method is validated by experimental results in section 3.

II. IMPLEMENTATION OF FUZZY LOGIC CONTROLLER CONTROLLER FOR AUTOMATIC DATE FRUIT SORTING MACHINE

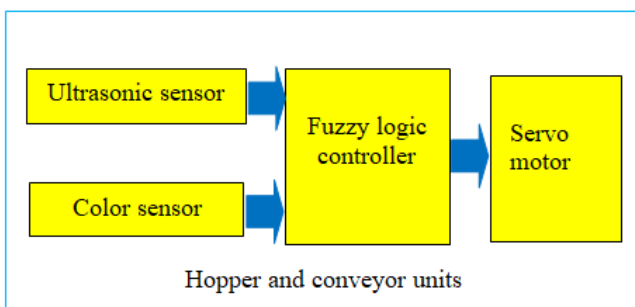


Figure 1 Schematic of the automated date fruit sorting system

Figure 1 shows the schematic of the automated date fruit sorting machine. The color sensor sends the signal to the microcontroller development board (Arduino Mega). In this paper TC 3200 is used to meet out our requirement. In that, frequency scaling is fixed as 20% by selecting S₁ and S₀ pins as HIGH and LOW. Usually S₂ and S₃ pins are used to identify the traces of three basic colors in the color spectrum (RED, GREEN and BLUE). In this paper the color sensor is calibrated to identify only traces red color by keeping these two pins as LOW and LOW.

In this paper, three stages of dates are considered for samples. They are Khalal (light red), Rutab (yellow) and Tamar (dark red). The figures for above date fruits are represented in figure 2.

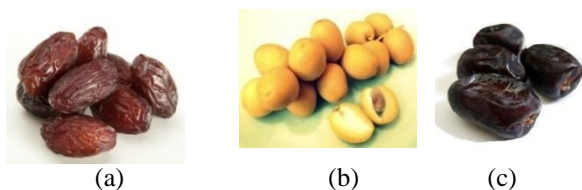


Figure 2 (a) Khalal dates, (b) Rutab dates and (c) Tamar dates

The ultrasonic sensor is used to estimate date fruit shape and size. It is working on the principle of echoing the ultrasonic sound signal. Finally, the microcontroller unit sends the signal to the servomotors which align its vanes to the different trays. In this work, three trays are used to collect Khalal, Rotab and Tamar date fruits.

The hopper and conveyor units fabricated for this work shown in figure 3. The hopper is designed and fabricated in such a way that the date fruits drop on the inclined conveyor unit. This inclined conveyor unit is fabricated with cleat to carry the dates which are falling from the hopper.

180V Permanent Magnet DC motor is used as a drive motor for conveyor system. The speed of the motor is adjusted by SPWM speed controller board. The conveyor drive system is shown in figure 4. Microcontroller unit with sensors is shown in figure 5.



Figure 3 Hopper and conveyor units



Figure 4 Conveyor drive system by PMDC motor

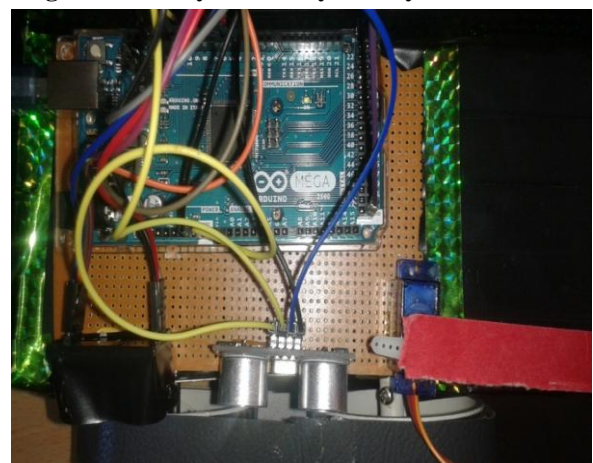


Figure 5 Microcontroller unit with sensors

III. IMPLEMENTATION OF FUZZY LOGIC CONTROLLER FOR SORTING PROCESS

The color and size of the date fruits are considered for input to the fuzzy controller and the output is the movement of the vane attached with the servomotor. During sorting the fuzzy controller fuzzifies the input data and apply fuzzy rules and finally set the position of vanes by defuzzification. As shown in figure 6.

In this paper, the successful fuzzy outputs are combined by the most popular method centre of gravity (COG) [14]-[15]. The discrete triangular linear functions are considered for analysis.

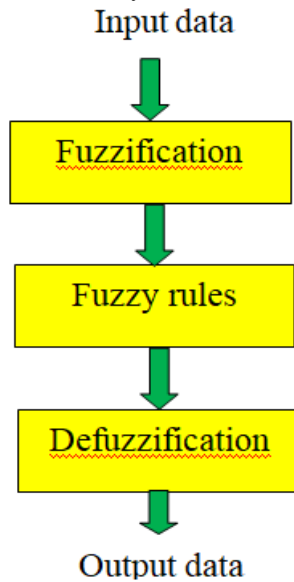


Figure 6 Fuzzy inference system for sorting process

The centre of gravity of the triangular functions are calculated by

$$\frac{\int \mu(\Delta U) \Delta U d(\Delta U)}{\int \mu(\Delta U) d(\Delta U)} \quad (1)$$

Here $\mu(\Delta U)$ is represented as degree of membership for the output ΔU . the rules for ripening stages of date fruits are represented in table 1.

Table 1: Fuzzy rules for ripening stages of date fruits.

Rule		Date's Color		Date's size		Vane position
R1	If	Light red	and	medium	then	Left
R2	If	Yellow	and	Small	then	Centre
R3	If	Yellow	and	Very Small	then	Centre
R4	If	Dark red	and	Large	then	Right
R5	If	Dark red	and	Very Large	then	Right

The system is designed in such a way that Khalal dates are collected in left side trays. Usually they appear in light red in color and Rutab date is collected in centre tray which is usually in yellow color and Tamar dates are collected in right side tray which is usually in dark red in color.

Initially, the date fruits are manually sorted into three groups depends on the ripening stages of date fruits and 50 samples are collected in each category which is given in table 2

Table 2: Appearance of Different Stages Of Date Fruits

Ripening stage	Color	Size
Khalal	Light red	Medium
Rutab	Yellow	Small
Tamar	Dark red	Large

Then, the samples of different stages of date fruits are laid on the conveyor units and according to the ripening stages of date fruits they are collected in the different trays.

IV. RESULTS AND DISCUSSION

Initially the color and ultrasonic sensors, which are connected with microcontroller unit, sends the signal to the controller according to the color and size of the date fruits. Some of the results obtained from the color sensor for different ripening stages of date fruits are given in table 3 under 20% frequency scaling.

Table 3 Color sensor output

Ripening Stages of date fruits	R values	G values	B values
Khalal (Light red)	15	7	2
	16	5	4
	15	6	2
Rutab (Yellow)	12	10	8
	11	10	7
	12	9	8
Tamar (Dark red)	25	16	12
	24	16	13
	25	14	12

The above tabular column clearly shows that color traces are different in proportion for different ripening states of the date fruits. Normally Tamar is the correct state of date fruits for packaging and marketing in the commercial outlets.

The ultrasonic sensors are used to estimate the shape and size of the date fruits on the conveyor system. The table 4 shows its response depends upon the shape and size of the date fruits in the conveyor system.

Table 4: Ultrasonic sensor outputs

Ripening Stages of date fruits	Sensor output based on date fruits shape and size (200ms)
Khalal	123
Rutab	240
Tamar	300

The output from the color and ultrasonic sensors are considered as a input data set for the fuzzy logic controller

Table 5: Sample of color and ultrasonic sensors outputs

Type of Fruit	Colour sensor output	Fuzzy input set equivalent	Ultrasonic sensor output	Fuzzy input set equivalent
Khalal	R:15	Light red	123	Small
Rotab	R:12	Yellow	240	Medium
Tamar	R:25	Dark red	300	Large

Red colour data form the colour sensor is considered for analysis as this colour has the dominating proportion in the dates skin colour. The input membership function for color sensor is shown in figure 7

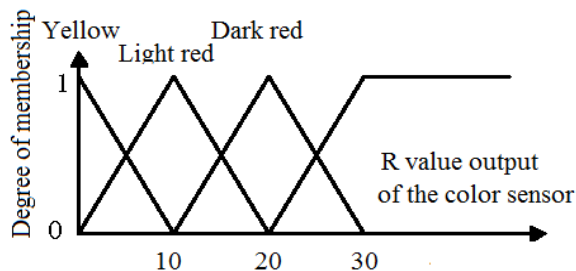


Figure 7 Input fuzzy variable 1: color

The input membership function for ultrasonic sensor is shown in figure 8.

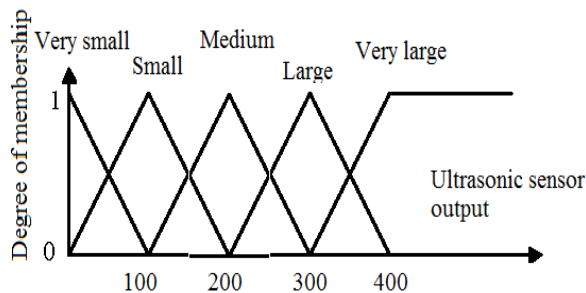


Figure 8 Input fuzzy variable 2 :Size

The output membership function to servo motors to adjust vanes are shown in figure 9

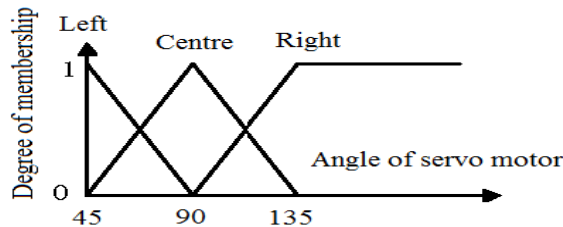


Figure 9 Output fuzzy variable 1: Position of vanes

V.CONCLUSION

In this paper, A fabrication and design of prototype model of automated date fruits sorting machine is discussed to sort the dates according to its color and size. The experimental results shown that the proposed fuzzy logic controller is efficient and also more accurate in sorting the fruits. In this paper three and five membership functions are considered for fuzzy input variables,color and size. In future, may be

additional functions are added to improve the performance of the fuzzy logic controller.

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