Grading of Carabao Mango Using Image Processing

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ABSTRACT

Grading the Quality of the mango is usuallyhandled physically which might not beaccurate due to the judgement of a person. Inthis study, image processing using MATLABis proposed using Mandami-FuzzyInterference System. The Mango is placed onchamber to help the camera in collecting theRed-Green-Blue (RGB) data and the spotdata of the program. This woodenrectangular chamber includes three LEDflashlights and the camera. The resultsshowed that Red mean value less than orequal to 155 are acceptable. The blemishesand maturity of the mango is then analysedbased in the white spots from the image andred means of the image. The paper alsoincludes size detection using boundarytracing and spot detection using the regionprops function. The results show that theprogram is accurate enough to grade themango. The system is strict enough to rejectthe sample mango if it is too large, is toosmall, is yellow or is blemished.

KEYWORDS

Image processing, Edge Detection, RGB values, Carabao Mango, Mamdami Fuzzy Inference System

1 INTRODUCTION

Mango is one of the most common tropical fruit produced worldwide. It is even regarded in the Philippines as its national fruit. As such, it is very important that the mango must be properly treated in its production, its harvest and its delivery. One of the most important processes in handling mango is the grading of the quality of the mango which is normally handled physically as most of the criteria in judging the quality of the mango is usually based on the colour which is usually easier to detect by the use of human senses.

It is possible to grade each individual mango through image processing. Image processing is important in detecting the colour and the height of theCarabao mango as well as detecting the most common deficiencies mangoes may acquire while maturing. The image processing will be monitored by the use of a MATLAB program.

This study can be beneficial to agricultural labour as the program may independently and accurately grade the quality of each individual mango. It may also help lessen the amount of time in the process of mango grading. As it grades Carabao mangoes, it will produce packages of more graded and quality Carabao mangoes to deliver.

It is also beneficial to different companies that endorse the transportation and export quality Carabao mango products and productions as it will standardize the criteria for grading Carabao mango.

2 REVIEW OF RELATED STUDIES

Many studies have shown that it is already possible to grade mango with the use of different sensors. However, these studies focus more on the maturity of the mango rather than the quality of the mango itself. These studies rely on having an external

sensor to gather the data instead of having a camera to directly feed the data to the computer program. The studies are also done with a different breed of mango, which means, their data may be different from the data we have gathered.

A research headed by Ms.Dadwal can "Estimate Ripeness Level of fruits Using RGB Color Space and Fuzzy Logic Technique" This research checks for the ripeness of any fruit by collecting the means of the RGB values of the given fruit through colour segmentation then grade the ripeness of the fruit by the use of the Fuzzy Logic.[1]

A research headed by Mr.Mansor proposes a "Fuzzy Ripening Mango Index Using RGB Sensor Model"which uses a RGB colour sensor to collect the data which will be graded by the fuzzy system into three classes, which are based on maturity mangoes by detecting the distinct colour of the sample mangoes. This research concludes with an accuracy of 85% in its segregation.[2]

Mr.Nandi and his group of researchers has made a "Machine Vision Based Techniques for Automatic Mango Fruit Sorting and Grading Based on Maturity Level and Size" which relies on image processing and edge detection to be able to segregate different samples of Indian mango by the use of Fuzzy logic algorithm. The data is collected with a CCD camera sensor which makes it easier to gather the RGB values of the mango.[3]

A researchheaded by Mr.Razak, which is "Mango grading by using Fuzzy Image Analysis", uses image processing to collect the RGB values of the image and its height and utilize the Fuzzy image analysis to produce the output to different grades. This research yielded an 80% in accuracy. [4]

3 METHODOLOGY

A chamber is produced to help aid the camera in collecting the RGB data and the spot data of the program. This wooden rectangular chamber includes three LED flashlights and the camera. By providing enough lights, the camera will capture the minimum amount of shadows that can affect the data collected. A funnel is provided in case the mango to be sampled needs to be shot upright without interfering in the view of the camera.

From the collected image, the computer program will collect the height and diameter of the sample mango by the use of boundary tracing. From the traced boundary, the program will measure the distance between one boundary to the other and gather the largest X and Y distance for the height and diameter respectively.

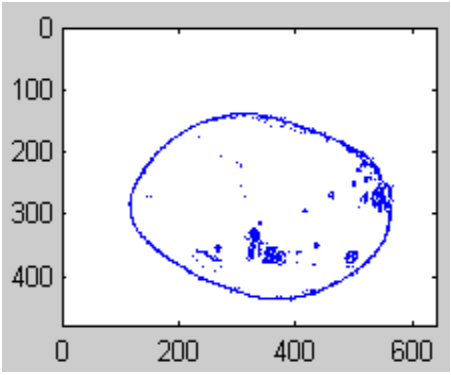

Figure 1. Edge Detection for Height Detection

The program will produce the amount of black spots by subtracting the collected amount of white spots from the maximum number of white spot,

$$B = W_{max} - W_{picture} \quad (1)$$

Where: W_{max} = number of maximum white pixels

$W_{picture}$ = number of white pixels in the picture

and this information will subtract the product between the height and diameter of the sample object.

$$Area = X*Y \quad (2)$$

Where: X = Height of mango

Y = Diameter of mango

Spot = Area - B

The difference will be divided to the product of the dimension of the sample object; therefore, a sample that produces a 100% output means the system does not detect any spot from the sample object.

$$P = Spot/Area \quad (3)$$

Percentage is used to see how much of the mango is already blemished as compared to counting the amount of blemish in the mango.

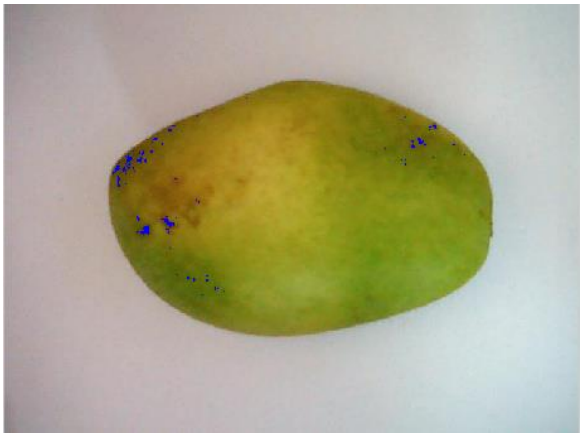

Figure 2. Spot Detection using Regionprops function

The maturity will be based on the red means of the sample object. As the target colours are Green and Yellow, the only value that varies is the Red pixel values as a high red pixel value, a high green pixel value and a low pixel value produces a yellow colour and a low red pixel value, a high green pixel value and a low pixel value produces a green colour. The program will start by segmenting the colour between the mango and the background before collecting the value of the mango to ensure that the colour of the background does not interfere in calculating for the average of the collected value of the mango.

After collecting the values of the segmented picture, the red values will be averaged.

$$Red = \frac{\sum_{x=0}^{N} Red\ pixel}{N} \quad (4)$$

Three data, the height of the mango, the percentage of spots and the red mean value, will be inputted in the Fuzzy Inference system to be able to grade whether the sample mango is acceptable for export or will be rejected instead.

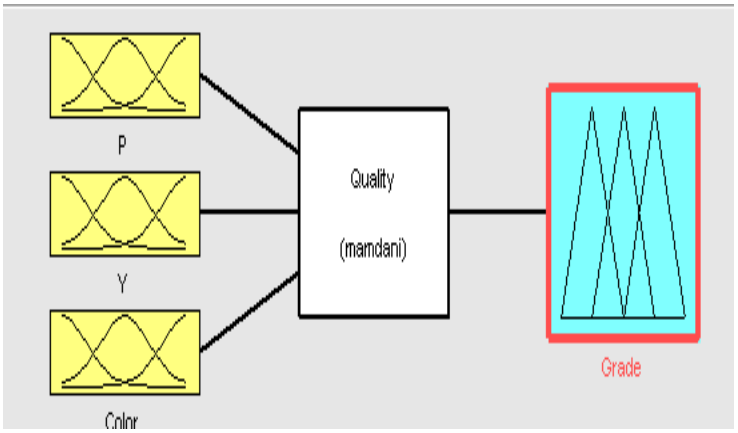

Figure 3. Fuzzy Inference System and its members

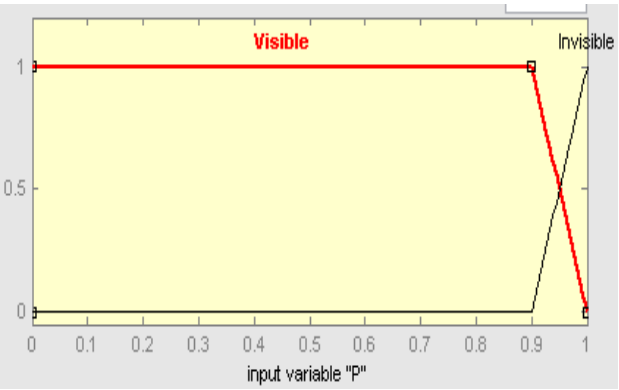

Figure 4. Membership function of Height variable

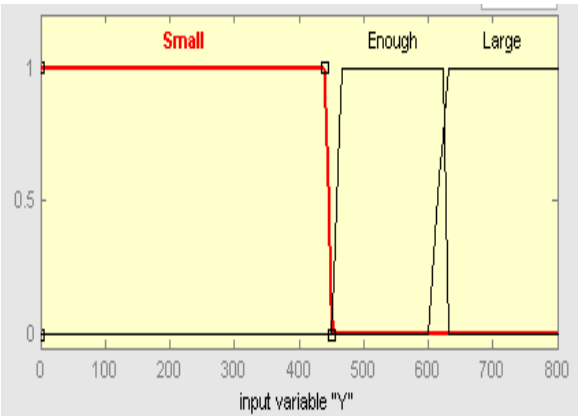

Figure 5. Membership function of Spot variable

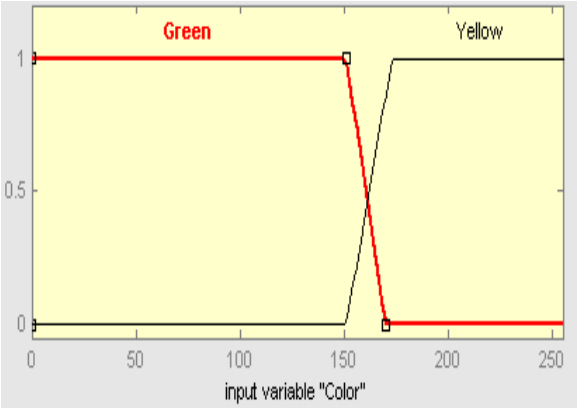

Figure 6. Membership function of Maturity variable

There are five rules in the Fuzzy Inference system

- If height(X) is Large, then the sample is Rejected
- If height(X) is Small, then the sample is Rejected
- If percentage (P) is visible, then the sample is Rejected.
- If color is yellow, the sample is Rejected
- If height(X) is Enough and the percentage (P) is invisible and colour is Green, then the sample is Accepted.

4 DATA, RESULTS AND DISCUSSION

Figure 7. Sample Object

A sample mango (Fig 8) which was 12 cm. tall was used to scale the distance between pixels as well as to check the limit of the height of the mango in pixels. From this mango sample, a 533 px tall mango is produced. Calculating for the limits of the acceptable height of an exportable mango, the for the lowest acceptable height of the mango, which is 10.5 cm, is scaled to 466 px; the highest acceptable height of the mango, which is 14 cm, is scaled to 622 px.

Figure 8. An unripe mango and a ripe mango.

Two sample mangoes(Fig 9), one of which is unripe for a few days, and another which shows yellow skins on both the apex area and the stalk area, is used to calculate for the maturity of the mango. The former produces a mean red value of 155 and the latter produces a mean red value of 173.

After gathering the digital data to set the limits for the Fuzzy Inference System, thirty mango samples were subjected for testing.

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Table 1 Input of the samples and the output from the Fuzzy Inference System

Sample	Length (pixel)	Spot (percent)	Maturity (Red means in pixel)	Output (Accept/Reject)
1	450	0.9747	157	Reject
2	473	0.9929	166	Reject
3	565	0.9932	0	Accept
4	631	0.9980	166	Reject
5	492	0.9673	161	Reject
6	502	0.9715	158	Accept
7	635	0.9893	160	Reject
8	622	0.9912	0	Accept
9	611	0.9703	154	Accept
10	592	0.9961	0	Accept
11	635	0.9886	0	Reject
12	638	1	0	Reject
13	465	0.9656	152	Reject
14	479	0.9557	0	Reject
15	593	0.9954	174	Reject
16	639	0.9953	153	Reject
17	503	0.9879	0	Accept
18	501	0.9951	166	Reject
19	490	0.9940	169	Reject
20	613	0.9889	148	Accept
21	506	0.9918	0	Accept
22	519	0.9887	164	Reject
23	627	0.9954	159	Reject
24	630	0.9934	145	Reject
25	572	0.9917	0	Accept
26	482	0.9764	157	Accept
27	395	0.9903	147	Reject
28	637	0.9997	161	Reject
29	437	0.9819	151	Reject
30	489	0.9972	170	Reject

The results show that the program is accurate enough to grade the mango. The system is strict enough to reject the sample mango if it is too large, is too small, is yellow or is blemished. While the system is more lenient on the grading between the spot detection considering our reference shows that there must be 0% tolerance in the spot detection of the system, it still show that the system may not be perfect as the camera can still detect shadows inside the object.

5 CONCLUSION

In this paper, the maturity of the Carabao Mango was collected by gathering the data of the RGB value through color image segmentation algorithm. The results showed that Red mean value less than or equal to 155 are acceptable. The paper also includes size detection using boundary tracing and spot detection using the regionprops function.

Mamdani-type Fuzzy Inference System was used to determine the quality of the Carabao Mango from the data gathered by the aforementioned image processing techniques.

Although the parameters can be easily adjusted by manipulating the values in the Fuzzy Inference System, with the given references and data, the program is successful in grading the mango whether it is acceptable enough for export through three different parameters.

ACKNOWLEDGEMENT

UNIVERSITY OF PERPETUAL HELP SYSTEM DATA

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