ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

PROTOTYPE OF MANGO INSPECTION AND LABELING USING IMAGE PROCESSING TECHNIQUE

Nursabillilah Mohd Ali[1,2], Mohd Safirin Karis[1,2], Mohd Bazli Bahar[1,2], Oh Kok Ken[1,2], Masrullizam Mat Ibrahim[3], Marizan Sulaiman[1,2] and Amar Faiz Zainal Abidin[4]
[1]Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia
[2]Robotics and Industrial Application Automation Research Laboratory, Durian Tunggal, Melaka, Malaysia
[3]Faculty of Electronics and Computer Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Melaka, Malaysia
[4]Faculty of Electrical Engineering, Universiti Teknologi Mara, Pasir Gudang, Johor, Malaysia
E-Mail: nursabillilah@utem.edu.my

ABSTRACT

This paper describes about practical design and analysis of mango inspection and monitoring using machine vision approach. Simulation and outdoor experiment shows that the project able to detect mango with adjustable lighting and proposed suitable design of quadcopter as the hardware part. The captured image of mango tree's leaf has approximately 87.35 % similarity with the actual one. In addition, image of mango recorded as 95.56 % similarity with the actual one. The practical design shows the view of the quadcopter and raspberry Pi can be attached together in a single case.

Keywords: mango monitoring, RGB colour based technique, quadcopter, and machine vision.

INTRODUCTION

Sustainable agricultural concept requires an adequate and optimum level of modern technology to yield a good quality crop. There were numerous obstacles encounter by mango's grower to nurture a standardized product. One of the issues troubling agriculture's entrepreneur is heavy loss due to damaged and spoilt mangoes. The common reasons were inadequate knowledge in technical and management wise. For instance, manual plucking and vibrator's assistance method to harvest goods is a leading factor. Machine vision technique based on shape analysis will be applied to tackle the issues arises.

Nevertheless, a compatible colour detection algorithm will be complement for the former method to further improve the system's efficiency. Relevant experiments will be conducted throughout the project to offer a judgment that applied machine vision technique is capable to replace human workforce [1].

Generally, this work utilizes many resources from previous works of researchers. The first part consists of research papers on application of small and embedded computer unit in completing an image processing task. In these papers, more discussion is made over the benefit of using Raspberry Pi in conducting image processing task and the practical design using SolidWork. This paper is organized as follows. Section 2 consists of various machine vision techniques used in agricultural field in order to enhance mango labelling and detection [2]. These papers mainly dealt with fruit crops such as mangoes. It covers comparison and synthesizes made over the algorithm used in the previous projects.

In Section 3, the versatile application of drone is discussed. It elaborates the technical section of controlling a drone and possibility of venturing a drone into agricultural applications. Advancement in mango harvesting and farming technology would be discussed in the final part. It shows the real implementation of the current project which resembles the experimental done in the past. In every part, used algorithm and approximate results obtained from all research paper is compared and synthesized for benchmarking purpose. Finally, our work of this paper is summarized in the last section.

IMAGE PROCESSING USING RASBERRY PI

Object recognition and placing it to a correct location is a tiring work particularly in an industry where sorting process on numerous objects has to be done in a quick manner. Thus, automation system approaches with Raspberry Pi could be used to enhance the process and its efficiency in robotic system.

Raspberry Pi is described to have found its way be useful and versatile in object sorting on a robotic arm in [3]. The construction done is by attaching the Raspberry Pi with sensor on the robotic arm. In order to complete the task, Raspberry Pi uses GNU Octave which is an open source language resembles MATLAB.

Figure-1. Raspberry Pi with Pi camera module 3.

Figure-1 illustrated Raspberry Pi and Pi camera module. The mentioned algorithm is divided into two major parts which are algorithm for colour and shape detection as well as design of quadcopter for the hardware development.

ALGORITHM FOR COLOR AND SHAPE DETECTION

The input image colour captured image was converted from RGB colour space into L*a*b colour space for the coarse detection of the fruit region. Other than that, L*a*b colour space also resembles the human vision perception. Since the fruit well distinguishable, L*a*b colour space would be used to segment it with its perceptually uniform property. Comparison of colour based technique has been performed with different lighting for road sign detection [4-5]. Besides that, the robust technique on how the colour based technique is done also discussed but the technique still open for discussing [6-7].

However, for shape detection, an automatic segmentation and yield calculation of fruit based on shape analysis. In pre-processing stage, input image was applied to Gaussian low pass filter for averaging the variation in lighting conditions.

AERIAL MONITORING ON MANGO

Advancement in unmanned aerial vehicle with high speed image processing algorithms contributes much to the process of transforming agricultural scenario to modernity. Aerial vehicle is chosen for this task because it does not affected by uneven terrain and thus reduces the hindrance of motion. In addition, aerial vehicle has its bird's eye view that can enhance robot's visual system for a range of agricultural routine. In contrast to mobile robot which moves on ground, it has the ability to cut mango which normally lies on upper part of the tree. Quadcopter is a class of unmanned aerial vehicle that is relatively agile and reliable. It has six degrees of freedom, three translational and three rotational as in Figure-2.

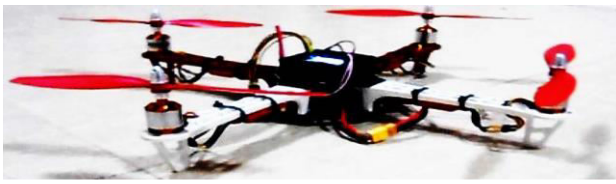

Figure-2. AAM prototype [1].

In the image processing part, the experiment done is quite similar to [1] where it involved outdoor or field test. As a result, the experimental outcome might be affected by the uneven significant change of stated parameters.

Figure-3. Input image [1].

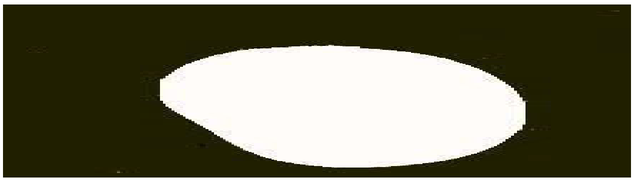

Figure-4. Binary image [1].

PROJECT DEVELOPMENTS

The process flow diagram describes the overview done to ensure the objective achieved. The process flow in the diagram below shows the test to be conducted as shown in Figure-5.

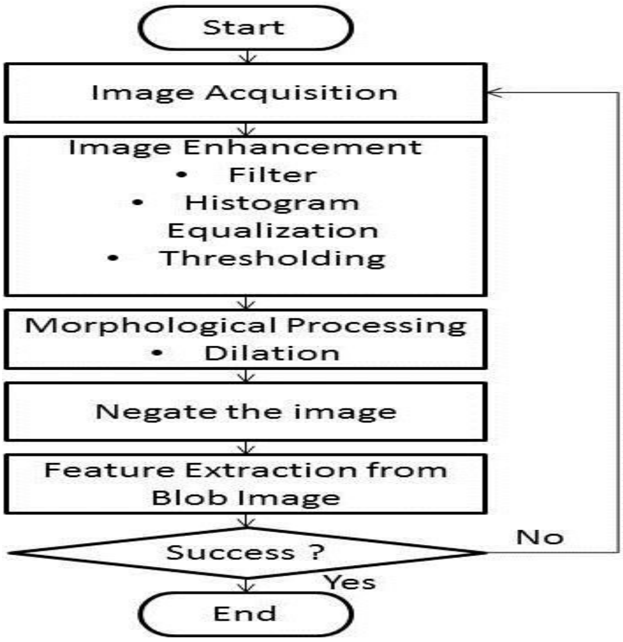

Figure-5. Process flow of the proposed project.

TYPES OF QUADCOPTER

Mango's farming inspection technique used in the overall project is aerial monitoring with a drone. Specifically, the flying drone used would be a medium-sized quadcopter with an attachable processor board. A good quality quadcopter would be able to maintain its flight direction cruise in a high wind movement environment. The models undergone comparisons are WLToys V333N, Syma X5C Explorer and Syma X8C Venture. The parameters within consideration are dimensions, weight, flight time, battery charging time, voltage supplied, battery capacity, presence of camera and distance covered [1].

Based on the compared criteria, all three models have almost similar dimensions and flight time. All of these models have an attachable camera for image capturing purpose. Syma X5C Explorer is the lightest followed by Syma X8C Venture and WLToys V333N. In this criterion, a moderate weight model should be chosen as the heavier model would restrict its motion while the lighter model could sway due to wind movement. Syma X8C Venture has relatively longer charging hour which

VOL. 12, NO. 10, MAY 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

traded off with its huge battery capacity in comparison to its opponents. The last criterion would be the controllable distance covered. Syma X8C Venture has the furthest distance compared to other two models. In conclusion, the selected model would be Syma X8C venture.

Figure-6. Quadcopter: Syma X8C venture.

TYPES OF SENSORS

The commonly sensor used in conducting most of the digital image processing experiments is a digital camera. An image sensor in machine vision field captures a model of the real world and recovers useful information from it. When sufficient light source shone over the image sensor, the chip within would generate a small electrical charge. Next, each charge induced is expected to perform conversion to voltage one pixel at once. Lastly, the digital acquisition maps the retrieved voltage value into appropriate digital information. Coupled Charged Device (CCD) and Complementary Metal Oxide Semiconductor (CMOS) were the type of image sensor used in various applications. However, the difference between CCD and CMOS is very significant in a many criteria. Table-1 shows comparison between CCD and CMOS sensor.

Table-1. Comparison between types of sensors used.

Sensors	CCD	CMOS
Power Consumption	High	Low
Quality of Image	More resolute	Less resolute
Less sensitivity	High	Moderate
Capturing Speed	Moderate	High
Dynamic Range	High	Moderate
Presence of Noise	Low	Moderate

Based on the comparison, CMOS consumes lesser power than CCD which shows that more images could be capture within the same power cell. CCD offers a higher resolution and more sensitive image than CMOS could do. As a result, CMOS also has a lower dynamic range and noise saturation compared to CCD.

TYPE OF CAMERA

The camera model undergone consideration and in-depth selection is Logitech Webcam model C310 and Pi camera manufactured by Raspberry Pi Foundation. Both of the camera models has their similarities and differences which contributes to the selection factor.

DESIGN THE CASE OF RESPBERRY PI 2 MODEL B

Raspberry Pi 2 would be used to capture and save important images in the overall project. In digital image processing technique, Raspberry Pi 2 acts as the initiator or the image acquisition device under proper lighting condition. The design is developed using SolidWorks software. This section described about the design of hardware development.

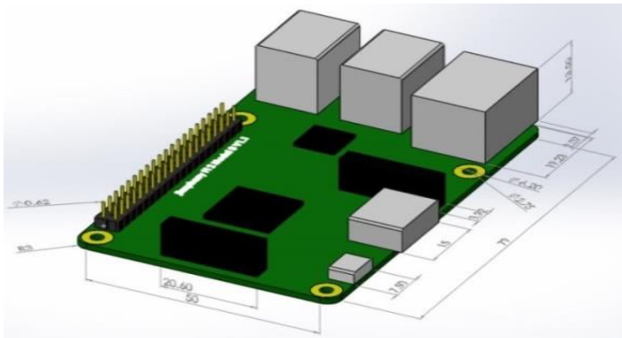

Figure-7. Isometric view of Raspberry Pi 2.

RASPBERRY PI 2 WITH PROTOTYPE CASE I

Raspberry Pi 2 is a sensitive element in the project. Nonetheless, it has a very fragile and static electronic part. A hard and rigid bodied casing is required to protect the board from any cracking effect and short circuit. The first prototype case is made from two Medium Density Fibre (MDF) board with Raspberry Pi 2 sandwiched in between by light-weighted bronze connector.

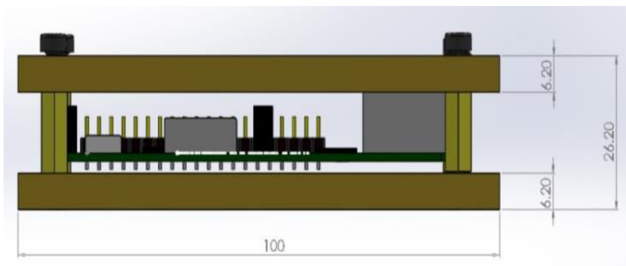

Figure-8. Front view of Raspberry Pi 2 with wooden case.

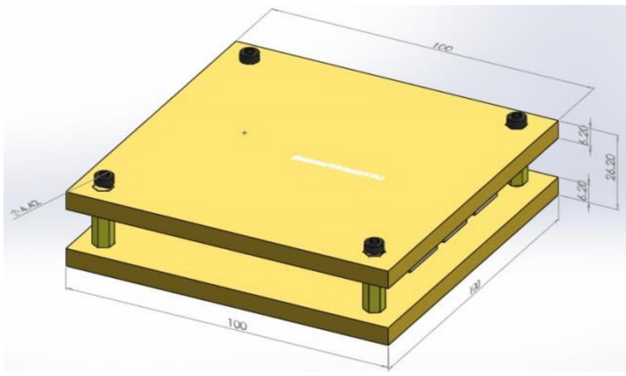

Figure-9. Isometric view of Raspberry Pi 2 with case no.1.

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

RASPBERRY PI 2 WITH PROTOTYPE CASE II

With the consideration of implementing the hardware component on a flying drone, the prototype case's weight has to be studied thoroughly. Hence, the second design is done with the usage of a round shaped plastic box without downsizing the quality of protection to the board.

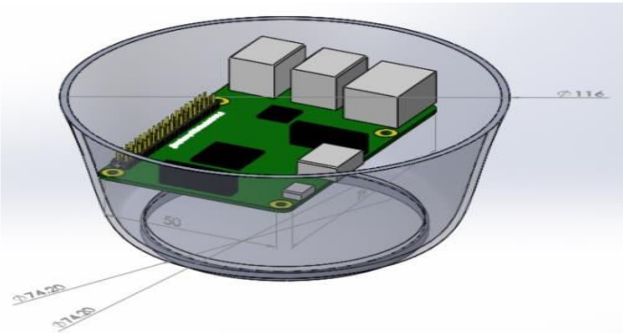

Figure-10. Isometric view of Raspberry Pi 2 with plastic case.

DESIGN OF QUADCOPTER USING SOLID WORK

The illustrated view of quadcopter used in the project is firstly measured and next transfer into several design sketches.

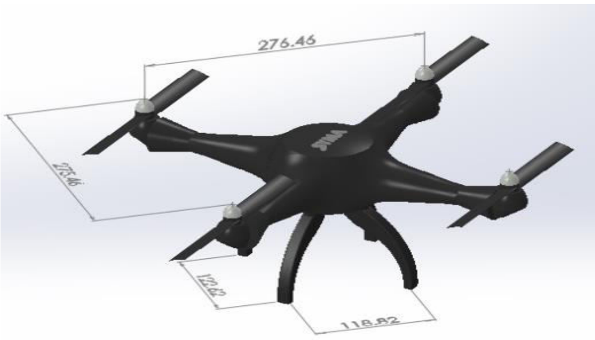

Figure-11. Isometric view of quadcopter.

EXPERIMENTAL RESULTS USING IMAGE PROCESSING TECHNIQUE

Image conversion function allows the manipulation of an image from RGB into another format. For instance, rgb2gray() function is used to convert an image with true colour into a gray scale image. The mapping of rgb2gray() would produce a gray scale image with 8-bit environment or 256 entries value. Value of '0' represents the darkest point (black) while '255 represent the brightest point (white) [8-9].

Image segmentation is the process of subdivides an image into its constituent regions or objects. The segmentation would halt whenever the feature object is isolated from noise or unwanted region.

Thresholding an image could be defined with the usage of the Equation. (1):

$$g(x,y) = \begin{cases} 1\ , \text{if } f(x,y) > T \\ 0\ , \text{if } f(x,y) \leq T \end{cases} \quad (1)$$

where T is the thresholding value. The pixel value in gray scale image which exceeds T would appear to be '1' (white), while the lesser ones would appear to be '0' (black).

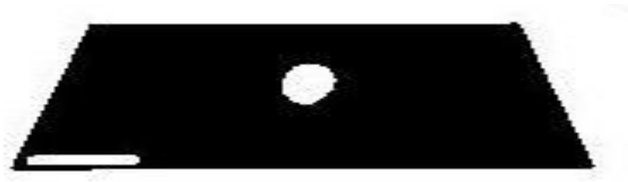

Figure-12. Binarized an image.

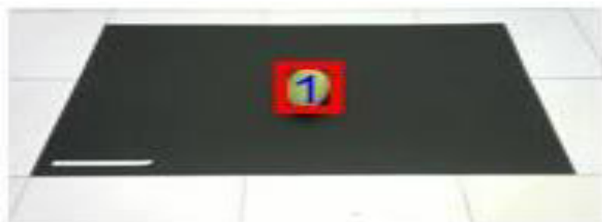

Figure-13. Object labelling result.

In this experiment, few mangoes with different sizes would be chosen to study the shape's parameter appropriately. The main purpose is to conduct shape analysis and detection on mango under fixed light intensity environment.

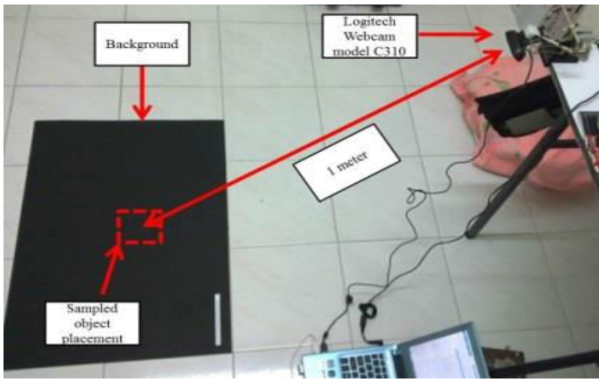

Figure-14. Indoor experimental setup (top view).

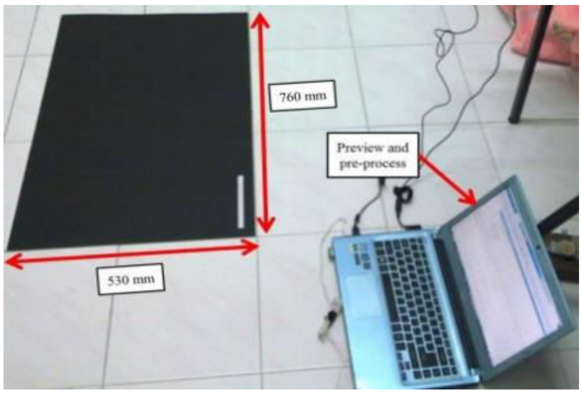

Figure-15. Indoor experimental setup.

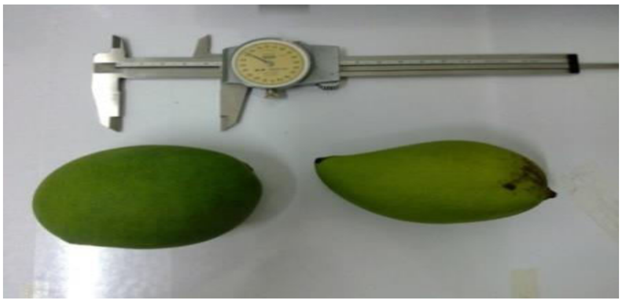

Figure-16. Tested samples of mango with vernier callipers used.

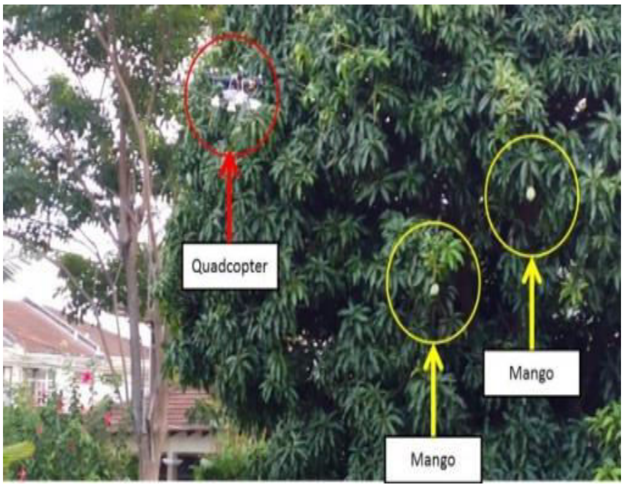

Figure-17. The quadcopter hovers under mid-level light intensity condition.

CONCLUSIONS

This proposed method discussed about design and analysis of mango using machine vision technique. One of the most obvious advantages of conducting technical research over the sampled object is capable to understand its feature properly before making comparison with upcoming experiment. With the usage of MATLAB and Solidworks, the Image Processing Toolbox assists in the feature extraction and classification wise. In indoor test, the light intensity does not vary much and hence the obtained result is rather consistent. The captured image of mango tree's leaf has approximately 87.35 % similarity with the actual one. In addition, image of mango recorded a 95.56 % similarity with the actual one. Future research is considered to be applied for invariant lighting and robust navigation.

ACKNOWLEDGEMENT

The authors would like to thank to the Robotics and Industrial Automation (RIA) research group under Center of Robotics & Industrial Automation (CeRIA) and Centre for Research and Innovation Management (CRIM) of Universiti Teknikal Malaysia for providing tools to complete this project. This work was funded by RAGS/1/2014/TK03/FKE/B00054.

REFERENCES

[1] Konam S. 2014. Agricultural aid for mango cutting (AAM). In: International Conference on Advances in Computing, Communications and Informatics. pp. 1520-1524.

[2] H. N. Patel, R. K. Jain and M. V. Joshi. 2012. Automatic segmentation and yield measurement of fruit using shape analysis. International Journal of Computer Applications. 45(7): 19-24.

[3] Pereira V., Fernandes V. A. and Sequeira J. 2014. Low cost object sorting robotic arm using Raspberry Pi. In: IEEE Global Humanitarian Technology Conference-South Asia Satellite. pp. 1-4.

[4] N. M. Ali, M. S. Karis, A. F. Z. Abidin, B. Bakri and N. R. A. Razif, 2015. Traffic sign detection and recognition: Review and analysis. Jurnal Teknologi. 77(20): 107-113.

[5] N. M. Ali, Y. M. Mustafah and N. K. A. M. Rashid. 2013. Performance analysis of robust road sign identification. IOP Conference Series: Materials Science and Engineering. 53(1): 1-6.

[6] Ali N. M., Karis M. S. and Safei J. 2014. Hidden nodes of neural network: useful application in traffic sign recognition. In: IEEE Conference on Smart Instrumentation, Measurement and Applications. pp. 1-4.

[7] N. M. Ali, N. K. A. Md Rashid and Y. M. Mustafah. 2013. Performance comparison between RGB and HSV color segmentations for road sign detection. Applied Mechanics and Materials. 393: 550-555.

[8] Ali N. M., Jun S. W., Karis M. S., Ghazaly M. M. and Aras M. S. M. 2016. Object classification and recognition using bag-of-words (BOW) model. In: IEEE 12th International Colloquium on Signal Processing and Its Applications. pp. 216-220.

[9] Karis M. S., Razif N. R. A., Ali N. M., Rosli MA., Aras M. S. M. and Ghazaly M. M. 2016. Local binary pattern (LBP) with application to variant object detection: A survey and method. In: IEEE 12thInternational Colloquium on Signal Processing and Its Applications. pp. 221-226.