5.0 Penutup

Dalam bidang kejuruteraan, penggunaan bahan bantu mengajar adalah sangat penting dalam proses pengajaran dan pembelajaran yang melibatkan komponen teori dan amali. Bagi kerja amali, pendekatan yang bersesuaian perlu digunakan bagi meningkatkan pemahaman pelajar dalam teori yang telah dipelajari. Justeru itu penghasilan *DC-DC Converter Set* ini dilihat sebagai alternatif bahan bantu mengajar yang mampu memberi pemahaman yang lebih jelas kepada para pelajar tentang tentang operasi *Buck Chopper* dan *Boost Chopper*. Penggunaan kit ini juga boleh memberikan pengetahuan tentang operasi litar PWM sebagai litar kawalan kepada kebanyakan aplikasi sebenar elektronik kuasa.

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COLOR RECOGNITION SYSTEM BY USING LABVIEW

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Abstract

This project is about the development of vision system by using USB Camera. The process for development of vision system have been design with LabVIEW as a platform. This system have been developed with the purpose to perform color recognition by using image processing algorithm. The image processing algorithm will be described in this paper for the purpose of analyzing the interested color either dark or bright by extracting from their surroundings. Different image processing algorithms such as Thresholding, Morphology and Particle Analysis are implemented to obtain the X and Y center location of image particles. The simulation results show that this method is achieves its objectives

Keywords: LabVIEW, image processing, threshold, morphology, particles analysis

1.0 Introduction

During the production process, many unwanted defects are also produced. These types of defect are unsuitable for use and thereby need to be sorted out. Color recognition is one of the methods to sort out the defect and many factories invest a lot of money, time and effort to have a reliable system that can recognize colors or sort products. (Szabo, Gontean, & Lie, 2011). Traditionally, visual inspection and quality control has been done by human expert to sort a defect on object surface. The manual activity of sorting is subjective and highly reliant on the experience and capability of human inspectors, which cannot provide a guarantee of quality. In certain cases, maybe human can do inspection task better than machines, but sometimes they are slower than the machines and get fatigued quickly. Sometimes, the quantity of items increases, inconsistency in sorting happens due to worker fatigue. Therefore, the performance manual activity is mainly depends on the attention, physical strength, experiences and work attitude of the workers (Ibrahim, Mohd Zin, Nadzri, Shamsuddin, & Zainudin, 2012).

To upgrade the traditional system, algorithm based on machine vision is develop and realized to replace the human eye. Machine vision supply innovative solutions to generate imaging based automatic inspection in industrial automation. Machine vision is also called as computer vision, which simulates human or reappears some intelligent functions related to human vision. The applications of machine vision in industries have been typically seen in measurements, counting, quality control, object sorting, and robotic guidance. It has become a yielding tool in product inspection and analysis, because it reduces cost, effort, and time with a significant level of accuracy and reliability (Bikarna, 2013).

Figure 1.1 shows an industrial vision system structure. Main processor or computer with image processing software functioning for processing the acquired images. Besides, usually one or more cameras with the aid of illumination will be located at the fixed location under inspection. This is because, in most cases, industrial automation systems are designed to inspect the object interest at fixed position. When this system exceeds the capabilities of the main processor, they face the problem of processing speed which is can solve by using specific hardware, application specific integrated circuits (ASICs), or field programmable gate arrays (FPGAs).

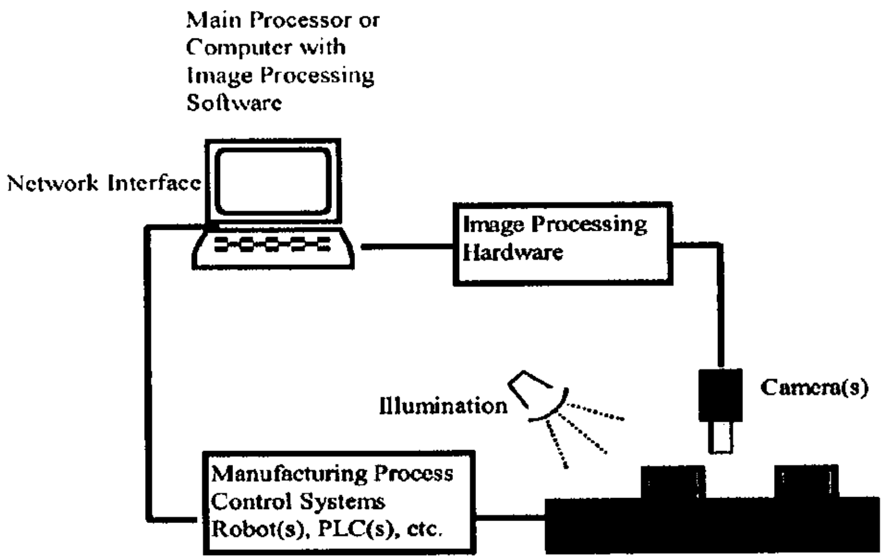


Figure 1.1: A model of Industrial Vision System (Malamas, Petrakis , Zervakis, Petit, & Legat, 2003)

2. 0 Literature Review

Roland Szabo published a research on cheap live color recognition with webcam. The paper presents method to recognize color with simple webcam. The application is made in LabVIEW v8.6 with NI Vision Development Module v8.6 and NI IMAQ for USB. The color recognition is done by using USB webcam driver block, the main color spectrum block and the threshold block. The advantages of this system is it works with any webcam. (Szabo, Gontean, & Lie, 2011)

In a paper wrote by Kargar B, they studied an automatic weed detection system and smart herbicide sprayer robot for corn fields. The goal of this paper is to develop a new weed detection and classification method that can be applied for autonomous weed control robots. In order to achieve this goal, plants must be classified into crops and weeds according to their properties which is done by a machine vision algorithm. Accordingly in the initial step, plants pixels were segmented from background with an adaptive method which is robust against variable light conditions as well as plant species. After that, crops and weeds were classified according to features extracted from wavelet analysis of the image. Finally, based on positions of weeds, herbicide sprayers are told to spray right on desired spots. With the proposed image processing algorithm 95.89% classification accuracy has been reached (Kargar B & Shirzadifar, 2013).

Wan Mohd Syahir published a research on egg's bloodspot detection using image processing in 2007. In the production of the commercial eggs, The quality of eggs is very important to make sure that only first quality of eggs are sold. To detect the abnormalities in eggs, image processing method was applied and the image of eggs has been collected in form of RGB color images. There are two main method to improve the quality of acquired image which is color enhancement and image filtering. The horizontal scanning process is apply to obtain the information from the interested area. The system meets its objectives when the result shows that 83% of the eggs with bloodspot images is being detected correctly. (Syahrir, Suryanti, & Nurul Ain, 2007).

In 2014, a work on vision inspection system for pharmaceuticals was performed by Duong. The work presents a low cost automatic inspection system aimed at monitoring of the quality of pharmaceutical products on a production line. Quality control and monitoring is of paramount importance in the pharmaceutical industry thus requiring deployment of accurate and effective

inspection systems. Unfortunately such systems are often of a high cost thus making them unaffordable for small and medium size companies in particular in developing countries. With the aim to address this shortcoming a low-cost machine vision automated system has been developed employing National Instruments (NI) tools – the smart camera 1772C and custom designed software using LabVIEW graphical programming. The system capable of detecting multiple defects of various type by using threshold method for binarization and segmentation of an image (Duong, Chew, Demidenko, Pham, & Pham, 2014).

Ana Ferraz published a work on automatic system for determination of blood types using image processing technique. This work aims to develop an automatic system to perform blood tests in a short period of time, adapting to emergency situations. To do so, it uses the slide test and image processing techniques using the IMAQ Vision from National Instruments. The results of slide test is captured by a CCD camera (Sony Cyber-shot DSC-S750) consisting of a color image from four samples of blood and reagent. This image then will be processed using image processing techniques which is image buffer, color plane extraction, auto threshold, local threshold and advanced morphology (Ferraz, 2013).

In 2014, Chaitali Raje, proposed the detection Leukemia in microscopic images using image processing. The aim of this paper is nucleus segmentation followed by feature extraction to detect leukemia. In the algorithm of nucleus segmentation, the image is enhanced using histogram equalization method and nucleus segmentation of enhanced image is done using statistical parameter such as mean and standard deviation. The proposed method is successfully applied to a large number of images, showing promising results for varying image quality. Different image processing algorithms such as Image Enhancement, Thresholding, Mathematical morphology and Labelling are implemented using LabVIEW (Raje & Rangole, 2014).

In 2013, research on the image acquisition and camera control of machine vision camera based on LabVIEW have been published by Yupeng and Feihong. In this paper, a method for the image acquisition and camera control of machine vision camera is proposed. Experiments are conducted in a machine vision camera which is designed and manufactured by researcher group. Results indicate that this method has a better performance and support in camera attributes compare to the conventional used NI-IMAQdx approach. And as far as VI performance is concerned, this method has a distinct advantage over NI-IMAQdx method. (Xu & YU, 2013).

Several researcher from India purpose method for counting of silkworm eggs using image processing algorithm. Conventional method of counting silkworm eggs relied on manual counting, which is time consuming and labor-intensive. Egg counting has to be done to generate statistics such as fecundity and hatching percentage. The algorithm is realized in LabVIEW graphical programming environment that shortens the development cycle. The algorithm realizes high precision and accuracy of counting (Amruta, Jyoti, Rajveer, & Shankar, 2014).

On the basis of previous studies, development of algorithms for color recognition is proposed based on LabVIEW.

3.0 Methodology

A flow chart in Figure 3.1 describe the procedure have been implemented in order to achieve desired result and completing this project. It can be classified into three categorized as follows; image acquisition, image processing and output.

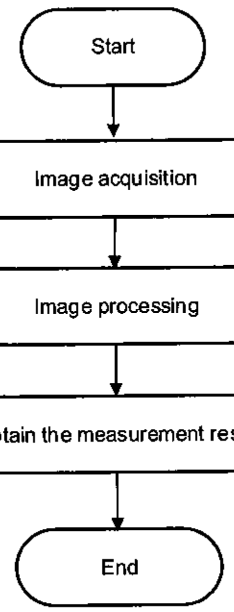


Figure 3.1: Measurement Procedure

3.1 Image Acquisition

Image acquisition is the process of getting image from an image acquiring device, a USB camera to the processing and storage units. Setting up the camera in right position is a key to generate a vision application. The camera should be positioned perpendicular (90° angle) as shown in Figure 3.2 to obtain better result.

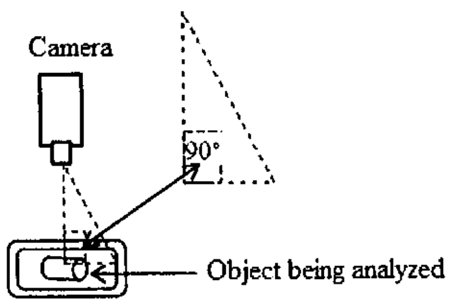


Figure 3.2: Camera installation position

In Figure 3.3 are pictured of blocks which responsible with control of the USB video camera and image acquisition. NI Vision Acquisition Express have been setting in LabVIEW block diagram to acquire image from a camera. Located in Vision/Vision Express toolbox, NI Vision Acquisition Express is a fastest way to configure all camera characteristic.

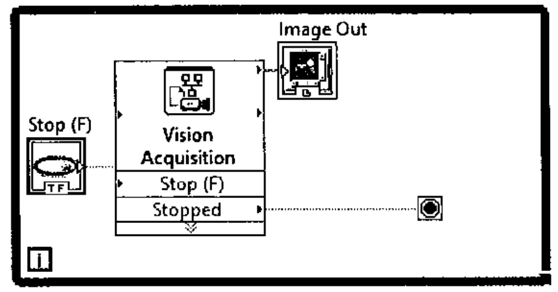


Figure 3.3: IMAQ Vision Acquisition Express

Inside this block, there are three important section of camera parameter to be fulfilled. Firstly, "acquisition source" selection which shows the cameras that connected with computer. The next selection, called "acquisition type" which determines the mode to display the image and the third selection refer to the "configure acquisition setting" which represents the video mode. In our implementation, Cisco USB Webcam was used with resolution setting of 320x240 pixels sensor array and a maximum of 30 frames per second. Meanwhile, continuous acquisition with inline processing have been selected to display the acquired image in continuous mode until the stop button was pressed.

3.2 Image Processing

The acquired image needs to be further processed by using image processing tools based on IMAQ vision which was a built-in development toolkit in LabVIEW. Figure 3.4 showed the algorithm steps of image processing after acquiring image from USB camera.

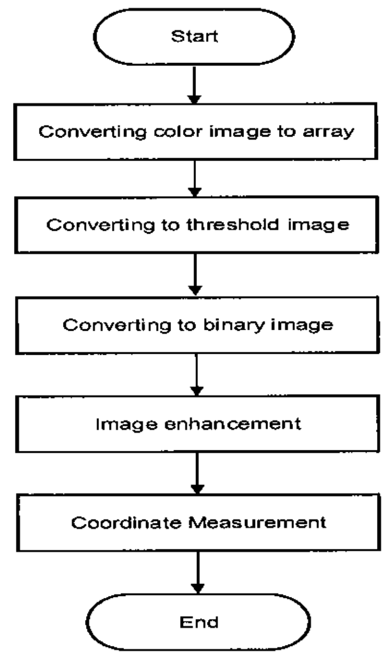


Figure 3.4: Flowchart of Image Processing

LabVIEW application for image processing algorithm operates in while loop and controlled by 'STOP" button. In general, each function plays a key role in the various steps as shown in Figure 3.5.

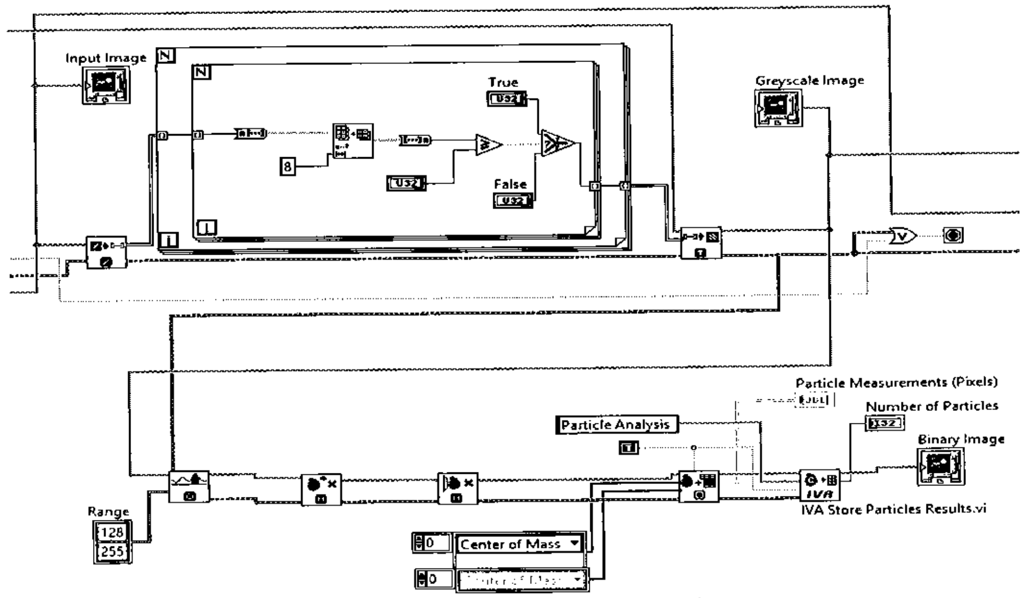


Figure 3.5: Image Processing Block Diagram

The acquired image from cameras is digital color image which is refer to three color values. Combination of R(red), G(green) and B(blue) represent the brightness and color of the pixels in an image. The digital color image consists of 32 bit image corresponds to a RGB (U32) image type. Each of the R, G and B color values in pixel has an 8 bit values which refer to integer range from 0 to 255 and the other 8 bit is not used.

3.2.1 Converting Image to Array

The first step to start the image processing process, an image was converted from digital color image to a pixel array by using Color Image To Array function. The digital image represented in 2D array as eq. 3.1. Each element in image array has a pixel value of 32 bit in X and Y location which represent to the brightness of the image. In this research, the digital color image was formed to be array of size 320 x 240 where the matrix indices start with 0; the maximum row and column indices therefore have the values 319x239. The size of array depends on the resolution value that was setting up during image acquisition process.

$$Image = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{pmatrix} \qquad (3.1)$$

3.2.2 Converting to Thresholding Image

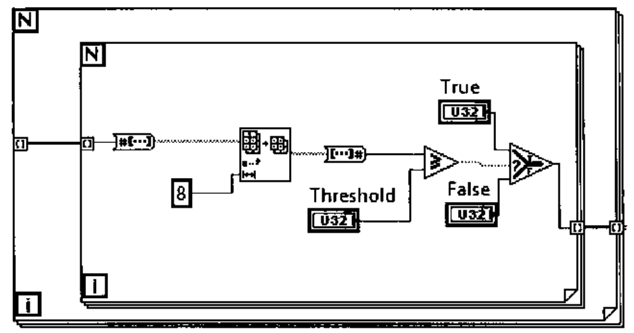


Figure 3.6: Block Diagram of Converting to Threshold Image

Figure 3.6 shows the block diagram that used to converted image array to threshold image. The conversion process to threshold image can be observed by adjusting the range slide bar at front panel between 0-255. Each value of pixel from Boolean array will be compared by adjusting threshold value. If the pixel is greater than the selected threshold, the output become the true value at select block which has been selected at front panel and vice versa. The threshold value also need to be altered due to a change in lighting conditions.

3.2.3 Converting to Binary Image

Next, a threshold function as shown in Figure 3.7, was applied to generate a binary image from a threshold input image. A threshold image has 8 bits per pixel (U8) which consist of 256 values (2^8). Each image pixel values represent the brightness of pixel in range from black to white.

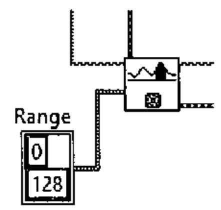


Figure 3.7: Threshold Function

The way to extract object of interest from the background is by adjusting a value of threshold, t. The threshold image, p is define as eq. 3.2. (Hengdi, Yang, Sier, Erdong, & Yong, 2011). If the threshold image is 0, then it is refer to the most dark (black) image pixel, whereas a value of 255 refer to the bright (white) image pixel.

$$p = \begin{cases} 255 & if\ q > t \\ 0 & if\ q \leq t \end{cases} \qquad (3.2)$$

When threshold function was apply in image processing process, the threshold range was adjusted according to the object interest by using value range of an 8 bit gray image (0-255). The binary image pixel has only two digit values, where object of interest has the value of 1 and background has the value of 0 or vice versa. In this research, there are two option either object of interest in an image is dark against a bright background or the bright part of an image represent the object interest against a dark background. In the case when the option for dark objects was selected as object interest, the threshold range is adjusted from 0 to 128. While, when the option for bright object is selected as object interest, the threshold range is adjusted from 128 to 255.

3.2.4 Image Enhancement

After the threshold process successfully converted the threshold image to binary image, morphology function was apply before continue to particles analysis process. Morphology functions have been used at this process to modify image for obtain better result. In this research, IMAQ Remove Particles as shown in Figure 3.8 is used to remove unwanted particles or noise from 8 bit image. While if there are any particles intersects with the border of the image, IMAQ Reject Border as seen in Figure 3.9 will exclude it. This helps to avoid noise which caused by different lighting.

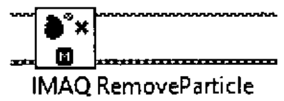


Figure 3.8: IMAQ Remove Particles Function

Figure 3.9: IMAQ Reject Border Function

3.2.5 Coordinate Measurement

After through an image conversion using threshold and morphology function, particle analysis have been applied to analyze the object in an image. Particles analysis operates to measuring a binary images which have a pixel value of 1 or 0. The particle analysis function as seen in Figure 3.10 was analyzed the object of interest that identified with pixel values of 1. It is an easy and fastest method to analyze the object by differentiating the objects from the image background.

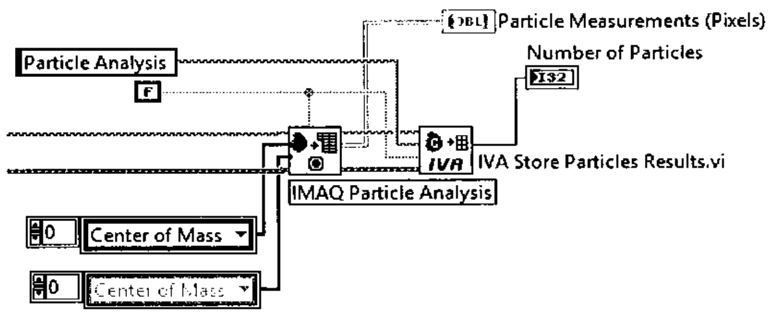


Figure 3.10: Particle Analysis Measurement

The number object of interest and measurement result from the particle analysis are used as output of the SubVI so that they can be display to the main VI. The measurement results are in the form of 2D array, as seen in Figure 3.11 The number of columns represent of measurement item; the particles X and Y center coordinates, whereas the number of rows refer to the number of particles found in the image.

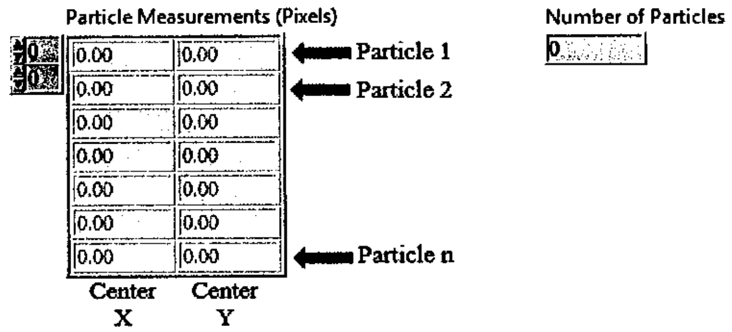


Figure 3.11: Particle Analysis Result at Main VI

4.0 Discussion

This chapter presents the experimental results of proposed algorithm applied to this project. Figure 4.1 shows the front panel of LabVIEW that consist of three different image display which is input image, threshold image and binary image. The results was captured by a USB camera and there are three different cases that have been used as a sample for testing.

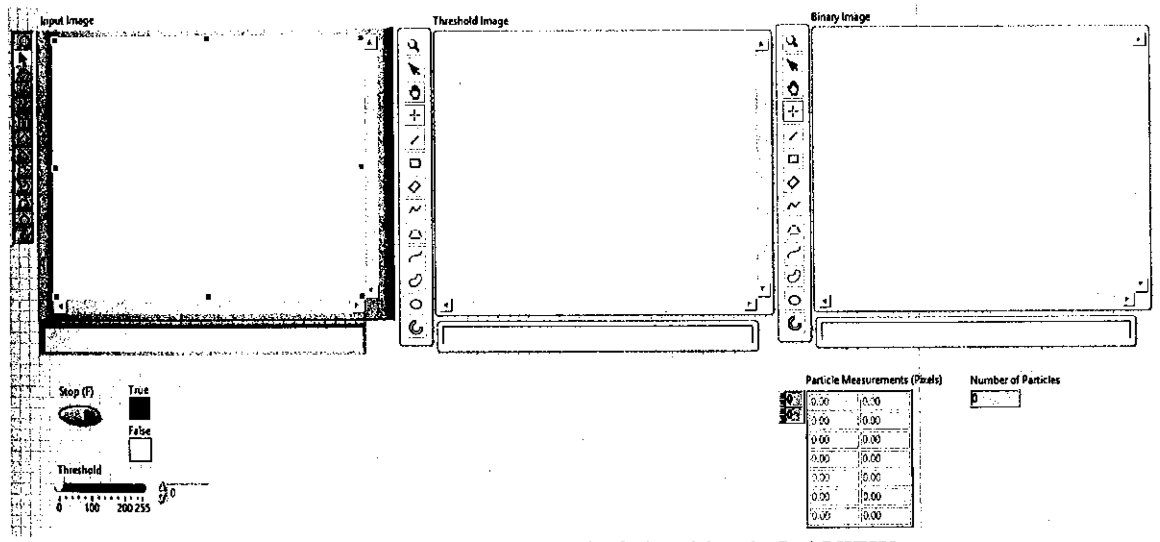
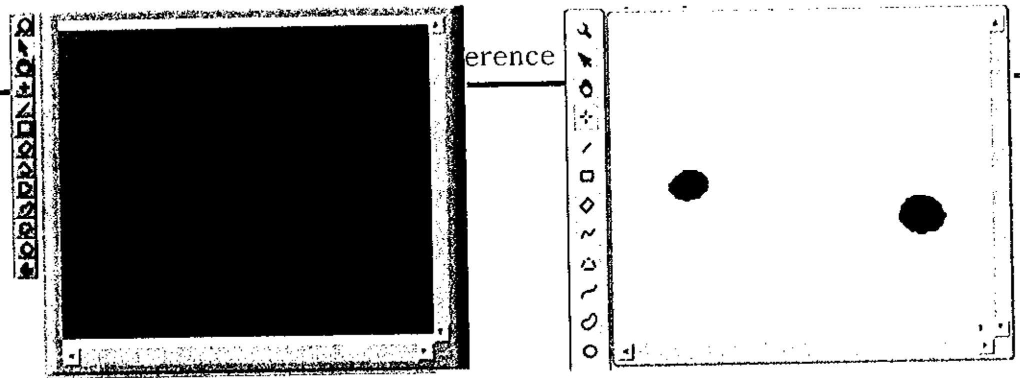


Figure 4.1: The Front Panel of algorithm in LabVIEW

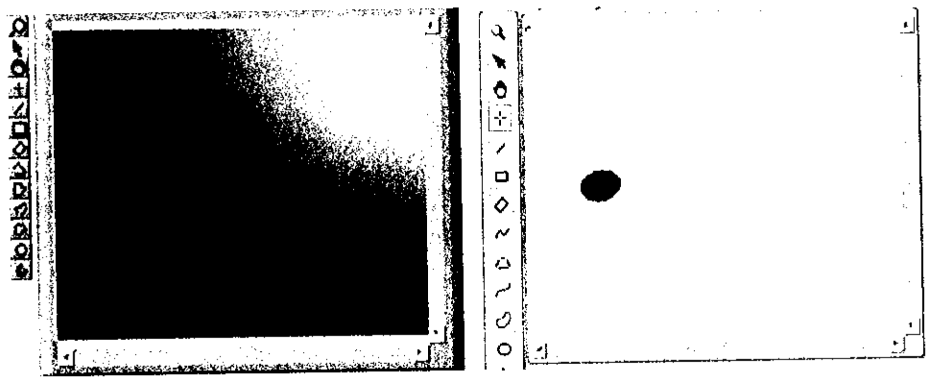
A. Case I

Case I is referring to a different illumination situation when acquiring image from USB camera. Figure 4.2 and Figure 4.3 shows a different input image with same threshold value. In this situation, dark image nearest the illumination location is not converted to threshold image due to higher pixel value. As a solution, to obtain a better result, a threshold value has to be increase so that the result be as in Figure 4.3(c).

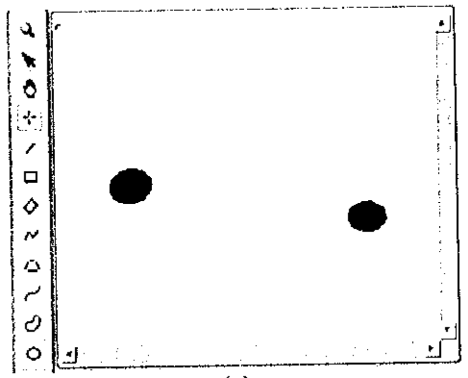


(a) (b)

Figure 4.2: (a) Input Image with Less Illumination (b) Threshold image, Threshold = 23



(a) (b)

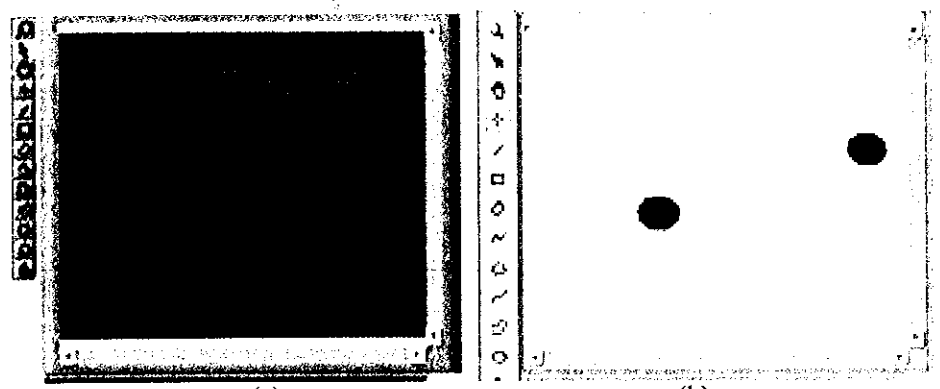


(c)

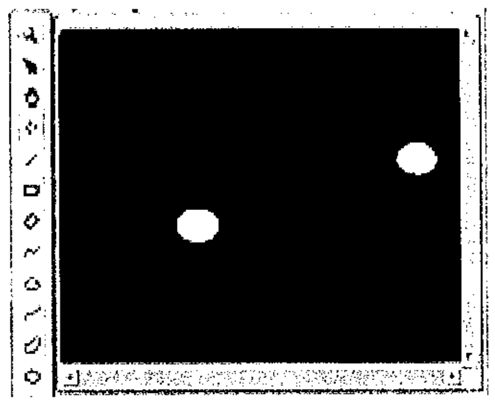
Figure 4.3: (a) Input Image with High Illumination (b) Threshold image, Threshold = 23, (c) Threshold image, Threshold = 49

B. Case II

Case II based on the output binary after particle analysis process. There are 2 situation in case II. When dark or bright object from threshold image have been selected as object of interest as in Figure 4.4, value of threshold range must be adjusted in LabVIEW block diagram. The value of threshold range is referring to object of interest. If it is not chosen correctly, the converted binary image will not accurately represent the object of interest and particle analysis also can't detect the correct number of particles and pixel coordinates. Figure 4.5 represent the measurement from particle analysis process.



(a) (b)



(c)

Figure 4.4: (a) Input Image (b) Color of Interest = Dark, Threshold Range = 0-128 (c) Color of Interest = White, Threshold Range = 128-255

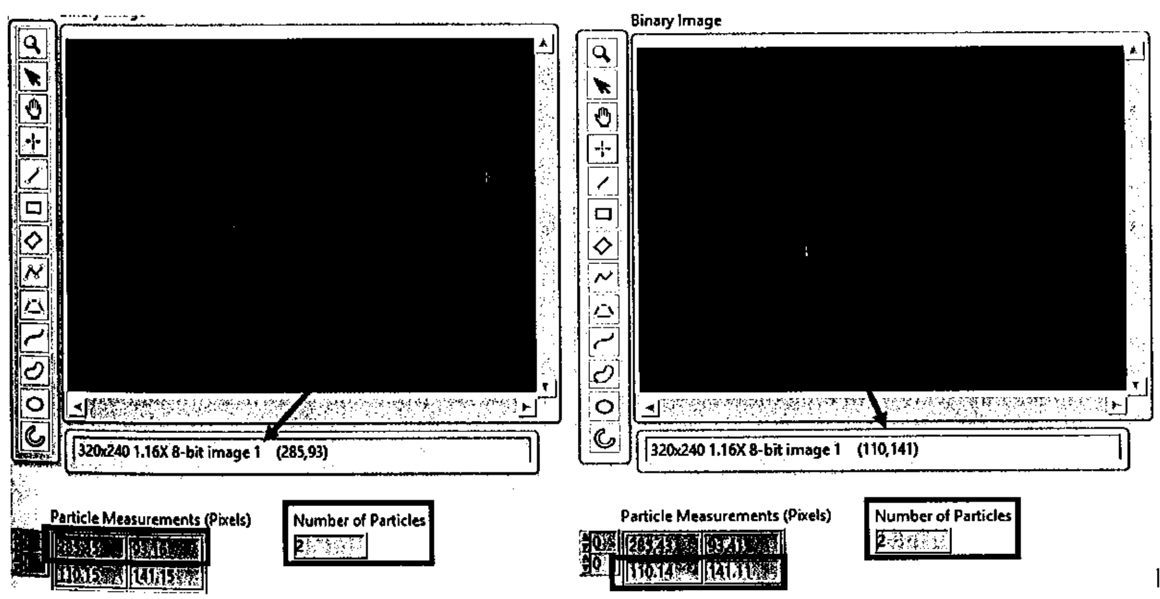
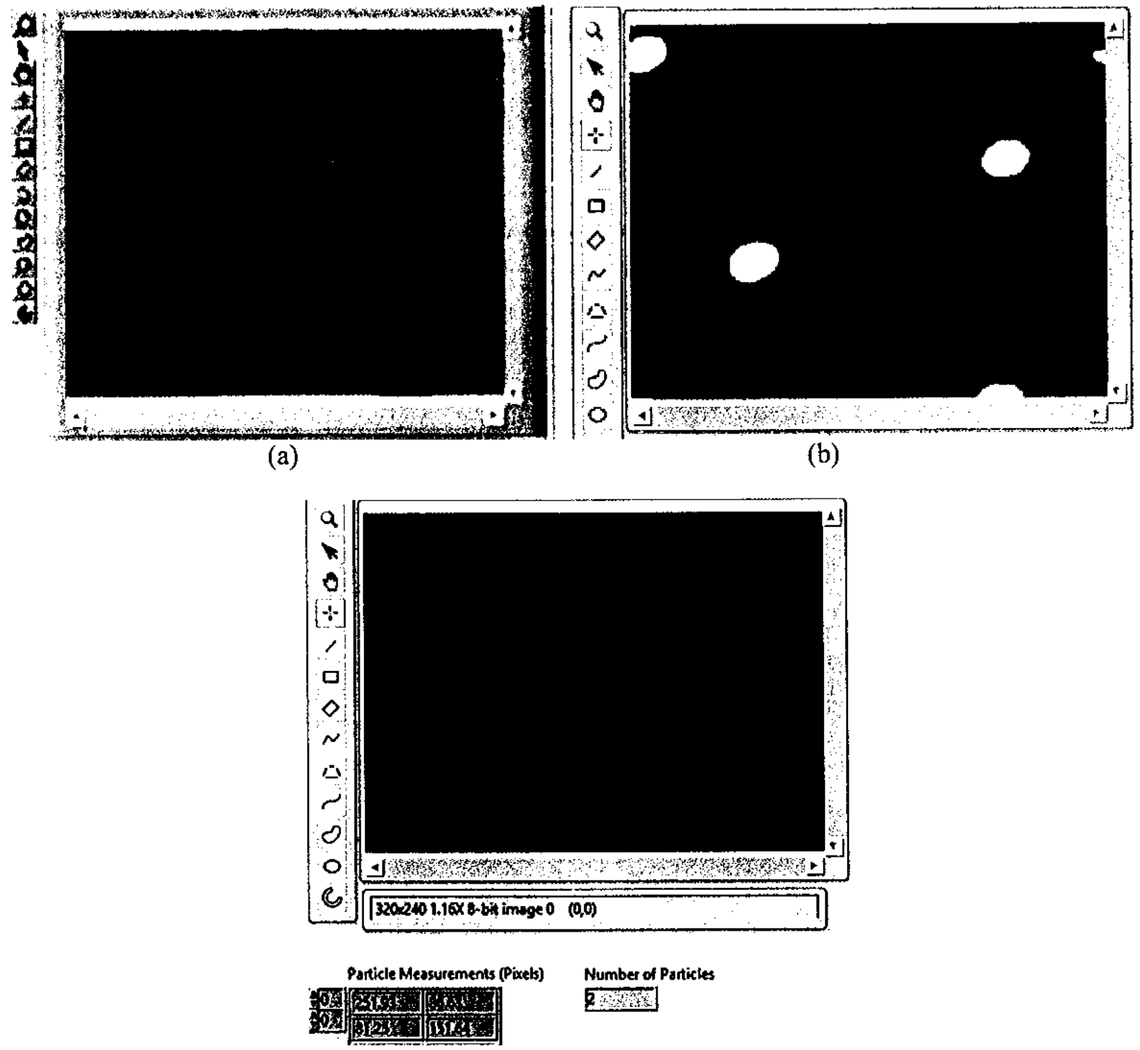


Figure 4.5: Particles Analysis Result

C. Case III

Case III is referring to input image with particles intersects with the border. In this situation, a particle analysis only measured the object of interest which not intersects with the image border as shown in Figure 4.6. This happen due to IMAQ reject border located after threshold function and remove any particle which intersects with the image border.



(c)

Figure 4.6: (a) Input Image with particles intersects with the border, (b) Threshold Image with particles intersects with the border, (c) Binary Image with particles intersects with the border.

5.0 Conclusion

This project presented an image processing algorithm for color recognition by using USB camera. LabVIEW Vision Development software from National Instrument has been successfully used as a platform to complete the process of image processing. The combination of camera vision and LabVIEW produce a powerful tool for applications that require image processing with minimum programming. Image processing algorithm such as Thresholding function, Morphology function and Particle Analysis have been used to improve the quality of the image and also to perform measurement of X and Y center coordinates of detected image particles.

Some recommendations for future work can be performed from the existing work. In future it is recommended to improve the capturing image by using digital CCD camera to obtain a better image acquired. Besides, the output coordinate from NI LabVIEW can be extended to Programmable Logic Controller application such as pick and place robot.

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