COIN CURRENCY VALUE DETECTOR

By

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Dissertation submitted in partial fulfilment of

the requirements for the

Bachelor of Engineering (Hons)

(Electrical & Electronics Engineering)

DECEMBER 2007

Universiti Teknologi PETRONAS
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Electrical & Electronics Engineering Programme
Universiti Teknologi PETRONAS
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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Nur Fariza Bt. Ramli

ABSTRACT

Malaysian's coin consists of four-currency values that are 5, 10, 20 and 50 cents. Coins are normally recognized using features such as value, symbols, weight, size and colour. This project, which is named as 'Coin Currency Value Detector' is mainly proposed to make a software development of total currency value by the taken image with the aid of image processing. The methodology used in this project is to compare the image of coins taken with the stored database. The features being evaluated in this report are the diameter of coins, the white pixels percentage of image and total area of binary image. The identification result will be based on the probability. The theories, concept, proposed methodology as well as coding are represented in this report.

ACKNOWLEDGEMENTS

First and foremost, I give thanks and praise to God for His guidance and blessings throughout the entire course of this project.

My warm gratitude and appreciation is extended to the Prof. Dr. P. A. Venkatachalam as project supervisor and Ms Lila Iznita Bt. Izhar as project co-supervisor for his excellent care and guidance throughout the course of this project. Thanks for you time, guidance and patience.

Also, thanks to all the lecturers and technicians from Electrical and Electronic Engineering Department of UTP for their assistance in small and big ways.

Next, thanks and full pleasure to my beloved family members and my fellow colleagues for their continuous support and encouragement

Last but not least, million thanks to all personal, which had been involved directly or indirectly upon the completion of this project

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LIST OF ABBREVIATIONS

GUI	Graphical User Interface
JPEG	Joint Photographic Experts group
SVD	Singular Value Decomposition
ROI	Region of Interest
BW	Black and white (binary 0/1)

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Computer vision is a process of recognizing objects of interest in an image by automatic logical deduction of properties, while digital image processing refers to processing digital images by means of digital computer [1].

Digital image processing concerns the transformation of an image to a digital format and its processing by digital computers. Both the input and output of digital image processing systems are digital images. Digital image analysis is related to the description and recognition of the digital image content [2]. Human vision is very complex neurophysiological process. Therefore, its simulation by digital image is a very difficult task.

Vision is the most advance in human sense. However, unlike humans, who are limited to the visual band of electromagnetic (EM) spectrum, imaging machine cover almost the entire EM spectrum ranging from gamma to radio waves [1]. In computer vision, there are unlimited ways of manipulating the image including ultrasound, electron microscopy and computer generated images. Besides, computer vision also can explore into areas where human vision cannot even imagine such as CT SCAN and MRI. Thus, digital imaging processing encompasses a wide and varied field of applications

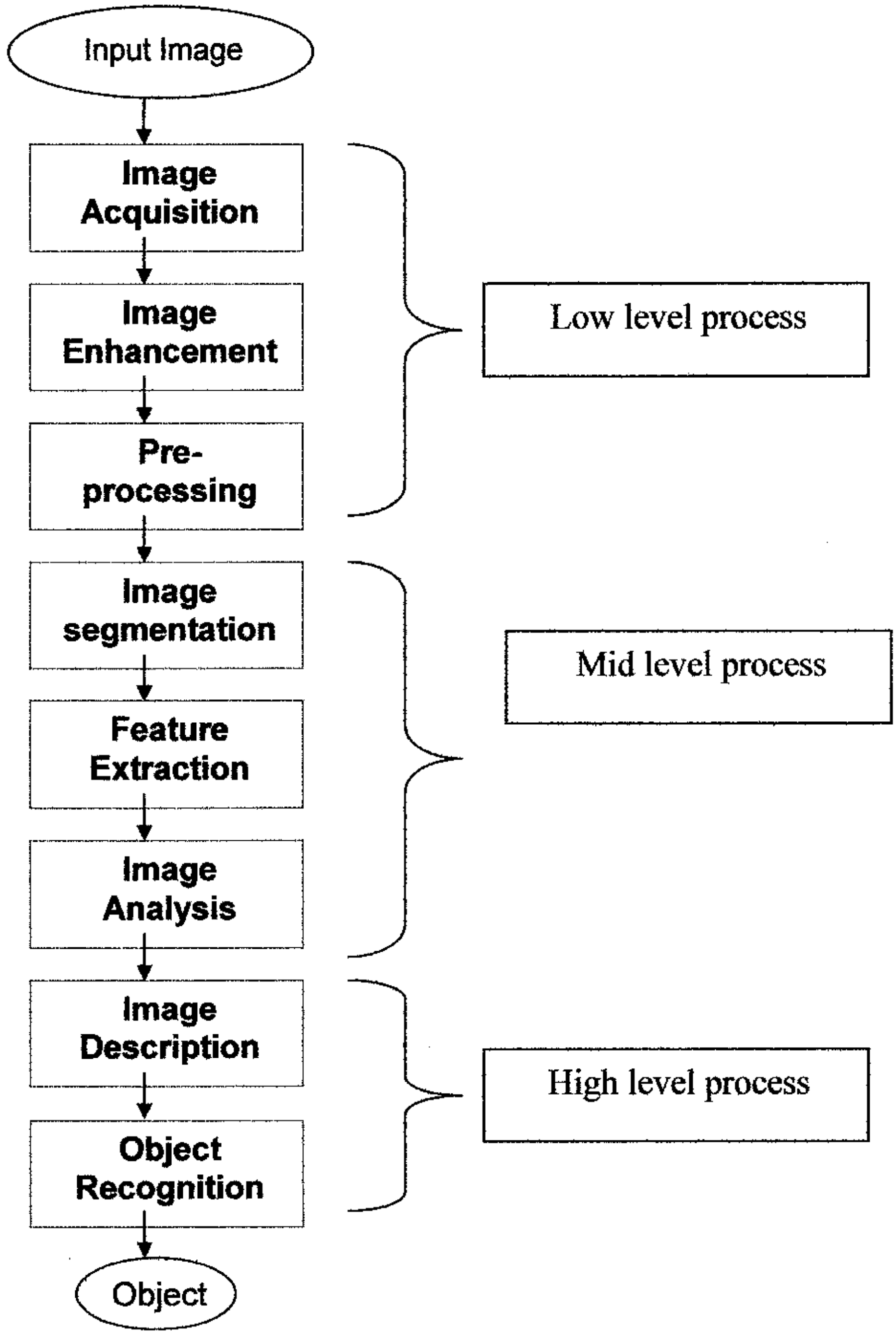


Figure 1.1 Histogram of BW image Computer Vision Systems with 3 Level Process Level

The objectives of computer vision and image digitalization are for classification of images and outcome based on the recognition result. Computer vision and image digitalization in general can be divided into three levels: low -, mid-, and high-level processes. Low level process involved in image processing to reduce noise, contrast enhancement and image sharpening. In this level, both input and output are images. Mid-level process involve task such as segmentation (portioning image into regions or object), description of those object to reduce them to form suitable for computer processing and classification (recognition) of individual objects. In this level, inputs are images but the output is attributes extracted from those images. Finally, high-level process involves 'making sense' of all together of recognized objects as in image analysis [1]. High level process is closely related to artificial intelligent and pattern recognition. It tries to stimulate the high level of human visual perception like image understanding [2].

Image processing is where an image is digitized to convert it to a form which can be stored in a computer's memory or on some form of storage media such as a hard disk or CD-ROM. This digitization procedure can be done by a scanner, or by a video camera connected to a frame grabber board in a computer. Once the image has been digitized, it can be operated upon by various image processing operations [2].

1.2 Problem statement

In commercial world, every task is to be carried very fast with high efficiency. Bank and other financial business concerns need high speed currency inspection and value system. For that matter, mechanical coin currency detector is developed and the currency can be inspected.

As an issue, can that objectives can be achieved by computer system? At present computer vision has much used for object recognition in several range of field such as military, hospital and industry. This is because computer vision and system have advantages than human vision especially in accuracy and speed in data calculation and classification. Besides, computer also can be work fast with high accuracy in long term without getting bored.

Therefore, with those characteristic of computer vision and system, this project is developed. Thus, with this image vision and image digitalization system hopefully can be used for Malaysian image currency detector.

CHAPTER 2

OBJECTIVES

This project aims to achieve the following objectives:

- To develop a system using image processing and computer vision concept, to identify the Malaysian's currency (coins) and find the total value of identified coins.
- To apply few levels of image processing functions such as segmentation, pattern recognition, shape analysis and feature extraction.
- To implement it as a working model.

CHAPTER 3
LITERATURE REVIEW

In order to obtain relevant and beneficial information regarding this project, the author carried out an extensive literature review such as books, journals, magazine and website. The information is very important for the development of the system as it provides theories, concepts and as well as techniques that will be utilized throughout this project.

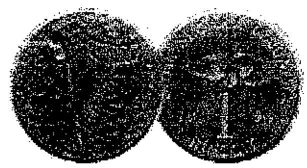
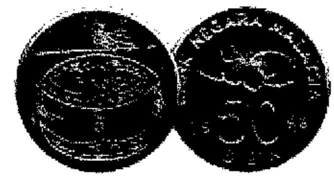
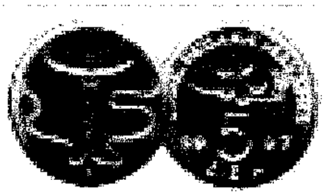
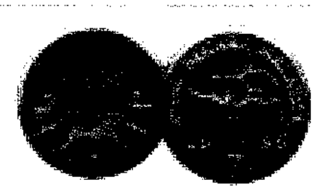
3.1 Malaysian currency secure system

Malaysians coins are consisting of 1cent, 10 cents, 20 cents and 50 cents. Each of the coins have own unique criterion to differ from the others. 50 cents has the biggest diameter followed by 20 cents, 10 cents, 5 cents and 1 cent. All the coins have different image in the back of the coins that show the traditional culture items. For example 50 cents have wau (like s big kite) image , 20 cents have traditional item called 'tepak sireh' image, 10 cents with 'congkak' image, 5 cents with 'gasing' image and 1cent with 'rebana' image.

Those coins also have differed in weight. In term of colour, 1 cent the only one with brown color and else with silver colour. This special identity for each coin will help to detect the exact currency value of the coins. Some of the security systems in the Malaysian coins are the rise of design picture, jagged surface in the boundary of the coins and the character on back and front surface on the coins. If the coins fall on the hard plane, it will give some ring tone. It also can be recognized by its colour and smoothness of the entire surface.

Table 3.1 Malaysian circulation coin and data

Table from View 1967-1988 Series View Straits Settlements Series [9]

RM 1	**50 sen**
	
Standard weight: 9.300 g *Metal:* Copper-Zinc-Tin *Composition:* Cu:84 Zn:12 Sn:4 *Diameter:* 24.50 mm *Thickness:* 2.55 mm *Type of edge:* Reeded edge * No longer issued	*Standard weight:* 9.331 g *Metal:* Copper-Nickel *Composition:* Cu:75 Ni:25 *Diameter:* 27.76 mm *Thickness:* 2.18 mm *Type of edge:* Incused lettered edge
20 sen	**10 sen**
	
Standard weight: 5.655 g *Metal:* Copper-Nickel *Composition:* Cu:75 Ni:25 *Diameter:* 23.60 mm *Thickness:* 1.75 mm *Type of edge:* Reeded edge	*Standard weight:* 2.828 g *Metal:* Copper-Nickel *Composition:* Cu:75 Ni:25 *Diameter:* 19.40 mm *Thickness:* 1.37 mm *Type of edge:* Reeded edge
5 sen	**1 sen**
	
Standard weight: 1.414 g *Metal:* Copper-Nickel *Composition:* Cu:75 Ni:25 *Diameter:* 16.26 mm *Thickness:* 1.04 mm *Type of edge:* Reeded edge	*Standard weight:* 1.744 g *Metal:* Copper-Clad Steel *Diameter:* 17.78 mm *Thickness:* 1.17 mm *Type of edge:* Plain edge

3.2 Pattern recognition

Pattern recognition is used for region and object classification. These techniques are used to automatically classify a variety of physical objects (2D or 3D) or abstract multidimensional patterns. A number of commercial pattern recognition systems exist which can automatically classify printed or handwritten text, blood cells, fingerprints, speech, face, and cursive hand writing[3].

Most vision systems employ pattern recognition techniques to identify objects for sorting, inspection, and assembly. The design of a pattern recognition system requires development of following modules such as sensing, feature extraction and selection, decision making, and system performance evaluation. The availability of powerful personal computers and affordable and high resolution sensors (e.g., CCD cameras, microphones and scanners) has fostered the development of pattern recognition algorithms in new application domains (e.g., text, image, video retrieval, and face recognition) [3].

Pattern recognition systems can be designed using the following main approaches those are template matching, statistical methods, syntactic methods and neural networks.

CHAPTER 4
METHODOLOGY

4.1 General process flow

The coin detector will be developed using a set of defined procedure. The initial stage of the project is involved extensive literature research on the topic of the project and its entire related subject. This involves performing research on the subject by various means such as books, journals, magazine and website. Digital image processing is the most important area that needs a firm and comprehensive knowledge from the author.

Then the project proceeds with development of image database. These images is gathered using web camera for each coin in different setting such as lighting, angle, area of captured image and environments. Form this image database, the core features that can be extracted is been analyzed. This features is include the diameter, value, color and to name a few. Then, suitable algorithm and software is developed. The algorithms then be tested and the result is gathered and stored. If the system is not working, the new algoritm need to redone. If the system is working and reliable, then the system is accepted. The system development procedure is shown in figure 4.1 below.

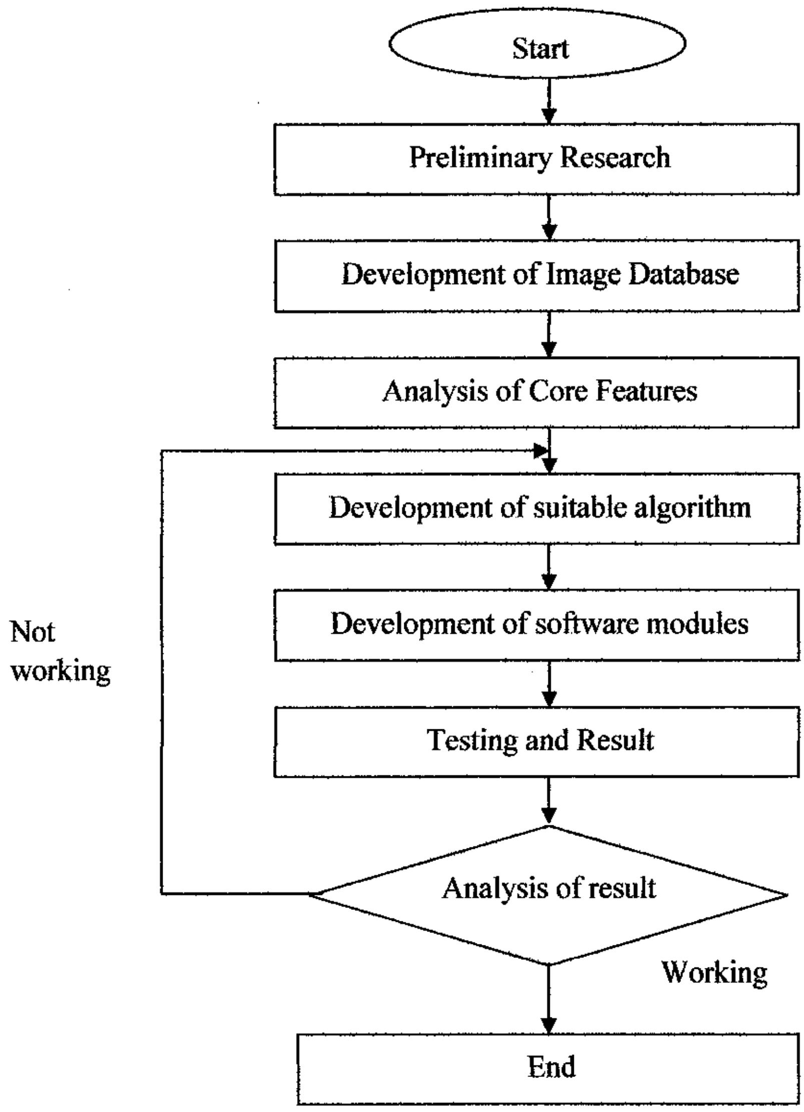
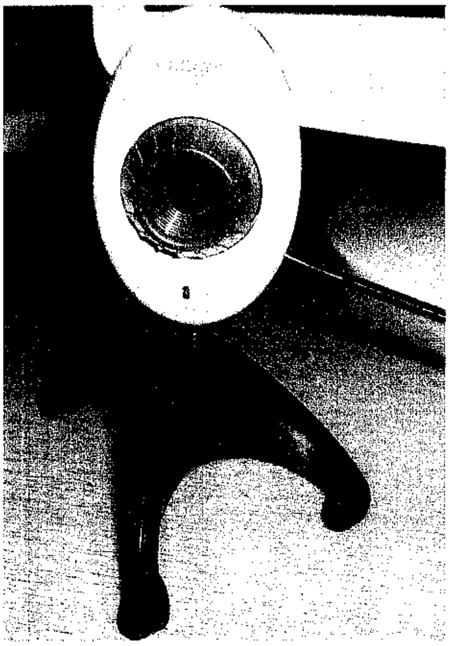


Figure 4.1 Block diagram of system development procedure

4.2 Tool and equipment used

MATLAB has been identified as the main driver for this project as the entire algorithms developed are processed by MATLAB. MATLAB software is very powerful tool for mathematical calculation, visualization and programming. In addition, there are several *toolboxes* available to expand the capabilities of MATLAB. The image processing toolbox is one of that is used. This toolbox consists of a set of functions and structures that handle image processing.

The most important equipment is the web camera for image acquisitions. This web camera does not have automatic focusing image. Therefore, object focus must be set manually at the beginning. Specifications of the web camera that has been used are:



Model : Creative Live! Cam Vista Im
Video Capture : 800x600 pixels
Photo Capture : 800x600 pixels
Frame rate : 30fps

Figure 4.2 Web cam used and it specifications

A USB LED light like in figure 4.3 is used to supply the light to get sharp and clean image. This lighting is important since the features white pixels calculation is depend on the lighting condition.

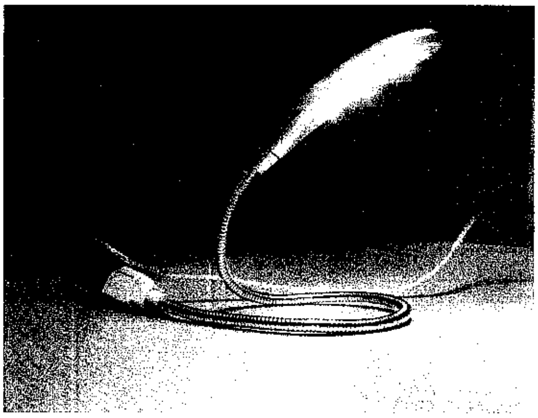


Figure 4.3 USB light for coin detector system

A sensor is used to detect the present of coin object. This sensor will be place near to the camera and show a signal when a coin present so camera will capture the image.

4.3 Database developing

The database is develop base on the features extracted fro image captured. For this database, there are four different angles for each coin is captured. This entire image then is process as shown in the figure 4.4 below.

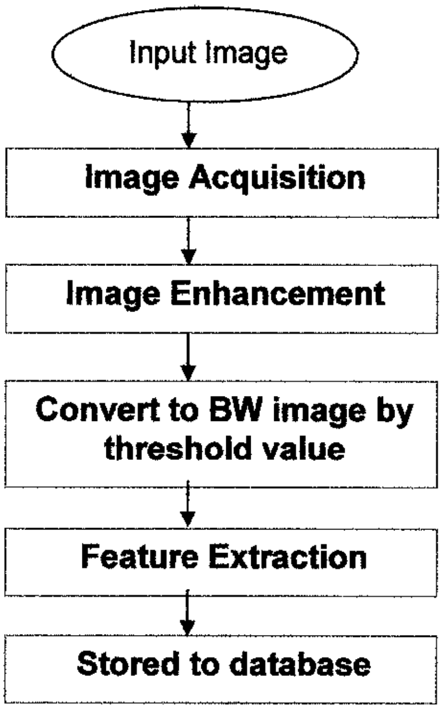


Figure 4.4 Flow Chart of database system

Before the system start, there are several things that need to prepare first. First, the image is captured in the close area. In this project, a box is used as the closed area to maintain the lighting effect to the image captured. Next is the distance between the web camera and to the object. This is to ensure the same area will be cover for every image captured. If the distance mix or different, the calculation might not accurate as required. As mention before, lightning also be fixed with the distance and angle to give brightness to the image captured.

Based on figure 4.3, the first step in developing the database algorithms is the acquisition of the image. The entire coin image is captured by using a web camera. If the camera is using an analogue signal, the image needs to be converted to digital signal first. Captured coin images then converted to grayscale image. This grayscale image is easier to process and use less capacity of system storage. This image then stored for image enhancement and pre-processing level. For this system, Gaussian filter is chose to filtered noise as well as maintain the desired edge image. Noises are filtered in order to produce a good result. The noises might be produce due various reasons:

- Improper focusing
- Background
- Bad lighting
- Low resolution camera
- Improper digitization

Next, the image is converted to BW image by the threshold value. This threshold value is can be found in the abrupt change in quantity of pixels in grayscale image.

Features extraction method is an important stage in the development of the coding. Features extraction will utilize to process segmented area of the input image. In this system, there are three features extracted that are white pixels percentage, BW image area value and the diameter value. All the value obtains is state at the table 5.1 until table 5.6.

4.4 Coin currency detector system

The first stage of this work involved the acquisition and pre-processing of dataset using a digital camera. In this project, the author is using a measurement method for coins classification system that identifies the currency of the coins.

Coins classification can be considered as currency recognition in loose sense and it is done by comparing input image against a database. The image captured is in the box provided to controlled environments parameter such as constant lightning, background and static model like in figure 4.5.

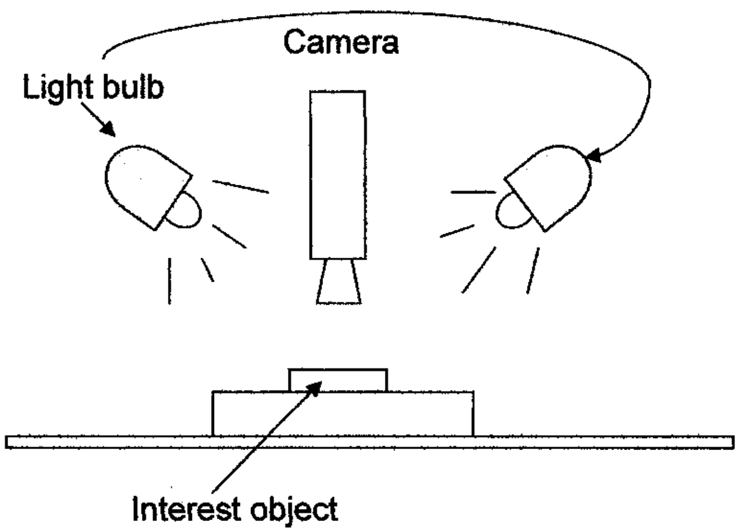


Figure 4.5 Interest object taken

The width and height used for all images must be standards and the system proposed employs a 400x 300 pixels size format. The angle and the high of the web camera is been fixed to control the hue, saturation and intensity of each image acquired. The background of the image is white in color. Once the proper background is set, there are several type of pattern image could be captured by the web camera such as lying flat and isolated, lying flat and touching, overlapping, and being completely overlapping. To ease the project, only first type is accept in this project by assuming the coins are already separate before lying in the plain paper.

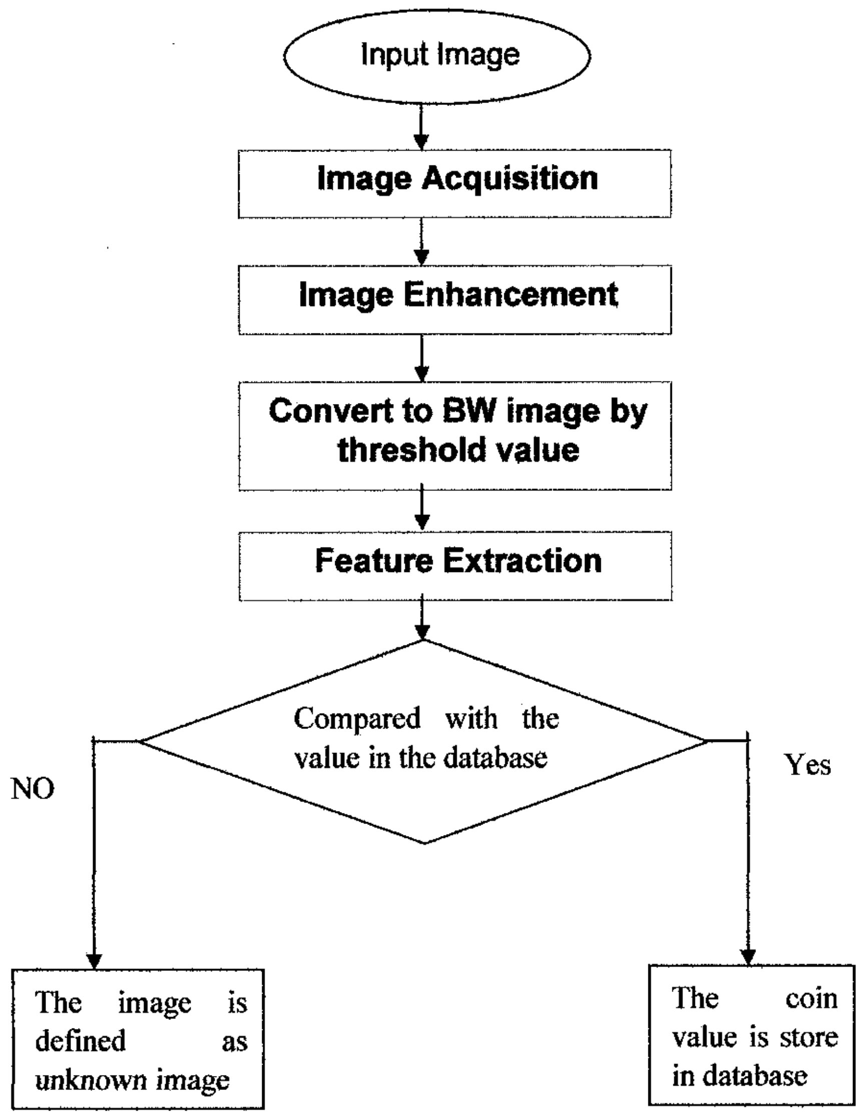


Figure 4.6 Coin recognition systems

The coin will be place on the white paper and will be pulling slowly to web camera direction. A sensor will tell a present of coin before it reaches the camera. The camera will captured an image, and then stored the image and all the processing stage for recognizing image carried like in the figure 4.6. The program will be detecting the currency value of the coins and count number of coins captured by the camera. The program will calculate and display the total value of the coins. This counter is developing like the figure 4.7 below.

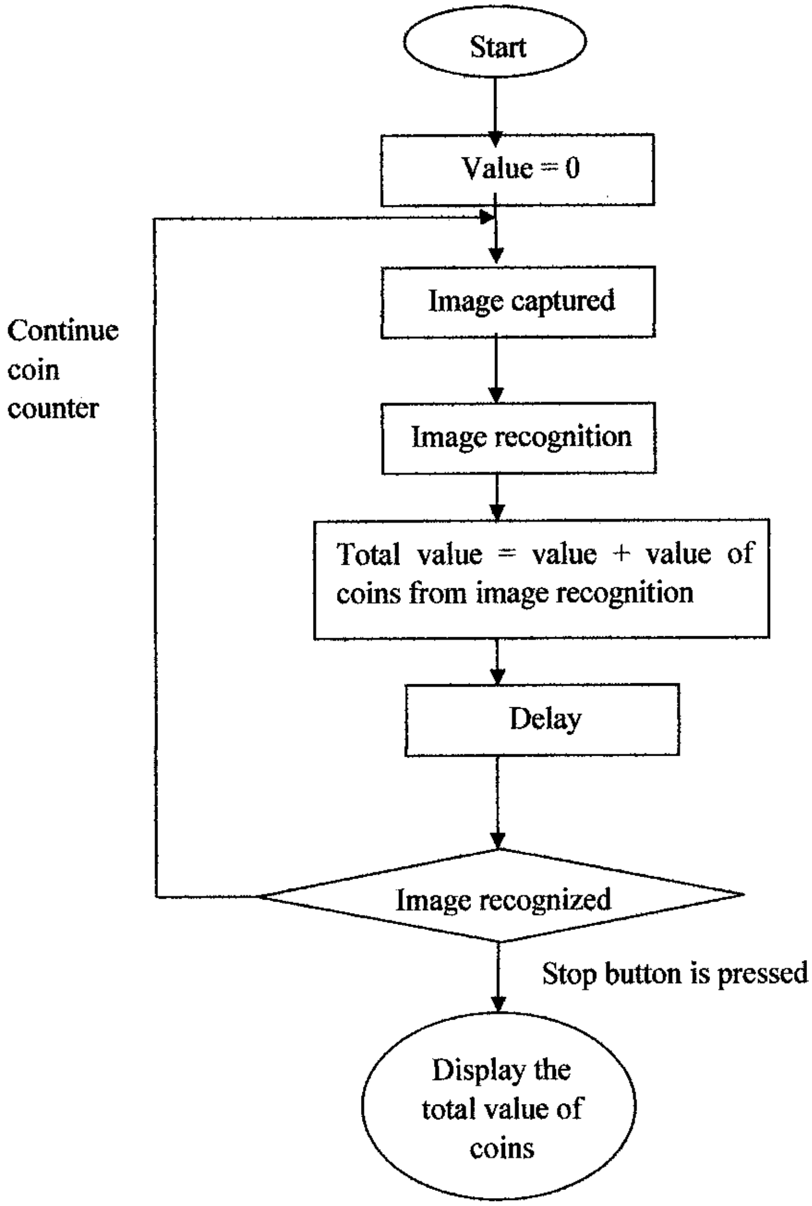


Figure 4.7 Flow Chart of counter function in the system

All the images that are used in the software are captured using a standard web camera with a controlled environment. The system will be recount the total value of coins until stop button is pressed as shown in figure 4.6. The output will be pop-up in window, for ease of displaying and for reading the result. The overall view of the hardware system is shown in figure 4.8 and the inside view is shown in figure 4.9

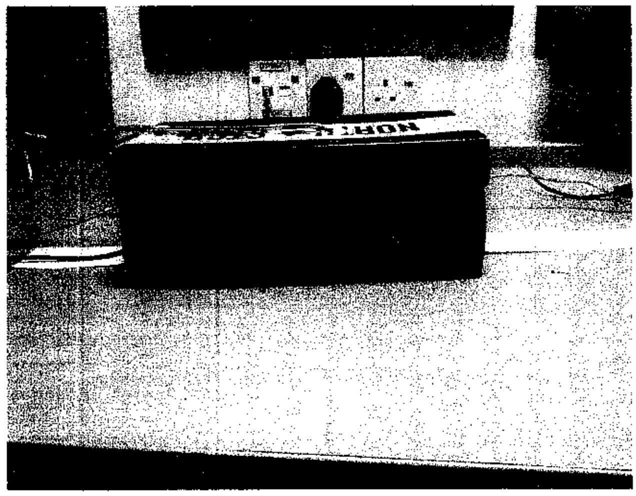


Figure 4.8 The outside view of sheltered box

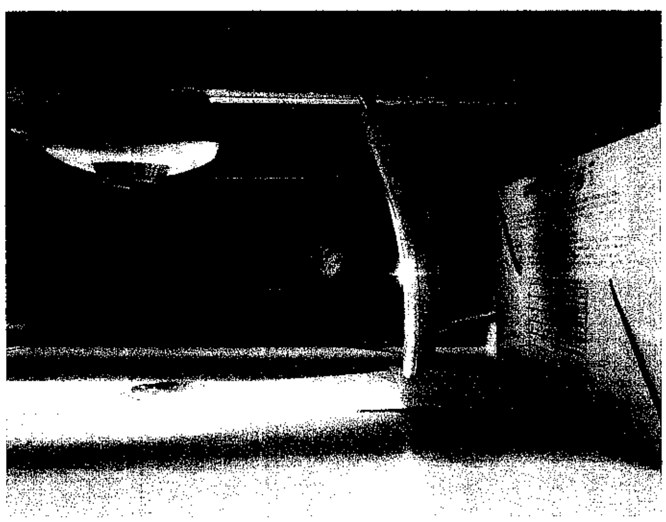


Figure 4.9 The inside view of lighting system in the box

CHAPTER 5
RESULT AND DISCUSSION

During the research there are terms such as filtering, segmentation, edge detection to name a few that existing in the image processing. These terms are use in the process to get better quality picture.

5.1 Propose coin currency detector system

5.1.1 Early stage preprocessing

For the early stage preprocessing, the image taken is experimentally clean by several type of filter in the Matlab tool. This is to get the best filter for acquired sharp, clean and smooth coin image. Below is the output image that passes through by different filter:

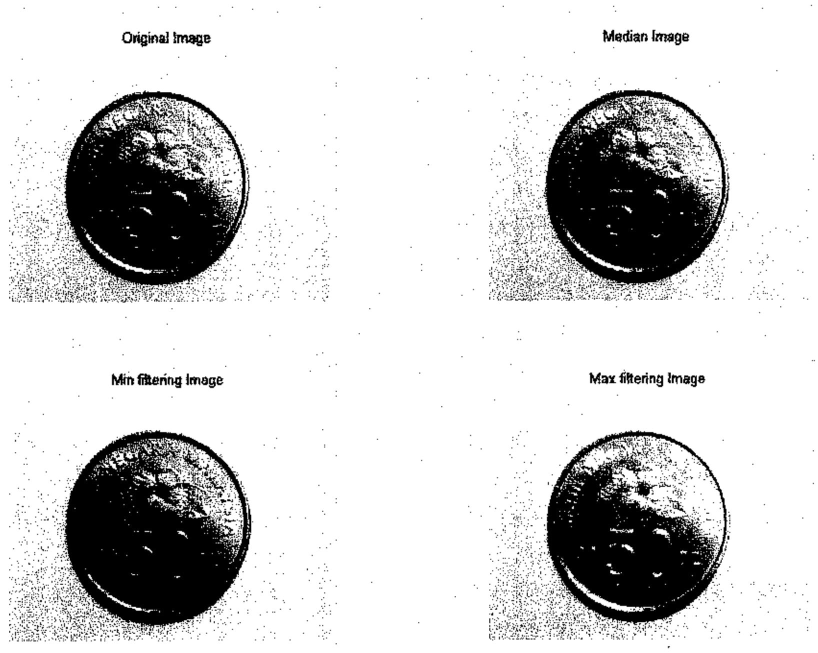


Figure 5.1 Minimum, maximum and median filters

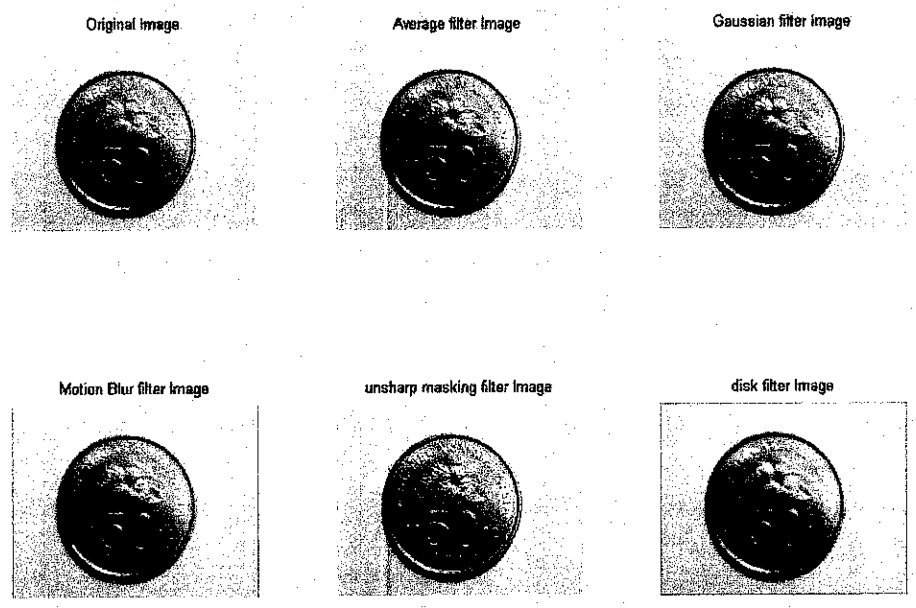


Figure 5.2 Average Gaussian, motion blur, unsharp masking and disk filter

From the obtained output image, Gaussian filter gives the best smooth, clear and clean image. Therefore the Gaussian filter will be including in the program software.

5.2 Features extraction

5.2.1 White pixel percentage

One of the features that are including in the programming part is white pixels percentage content.

Procedure:

1. image acquisition
2. image filtering
3. convert into grayscale
4. run histogram (check up for data)
5. use threshold function

6. calculate the sum of black pixels of each different currency (for each currency, I use for different image of angle)
7. data tabulated for each currency
8. average calculation and +- of 0.025 % accuracy of black pixels
9. image recognition
10. output value

Threshold calculation

The threshold calculation is made as iteration threshold value. It will calculate the breakpoint of the difference between black region and white region. The value is given after several process of repeating the same thing as the value gets almost similar from initial value.

As example, from the image in figure 5.3 below, figure 5.4 shows the histogram. As we can see, the threshold value might falls in between 0.45 till 0.55. The threshold iteration calculation is repeated to less the error calculated.

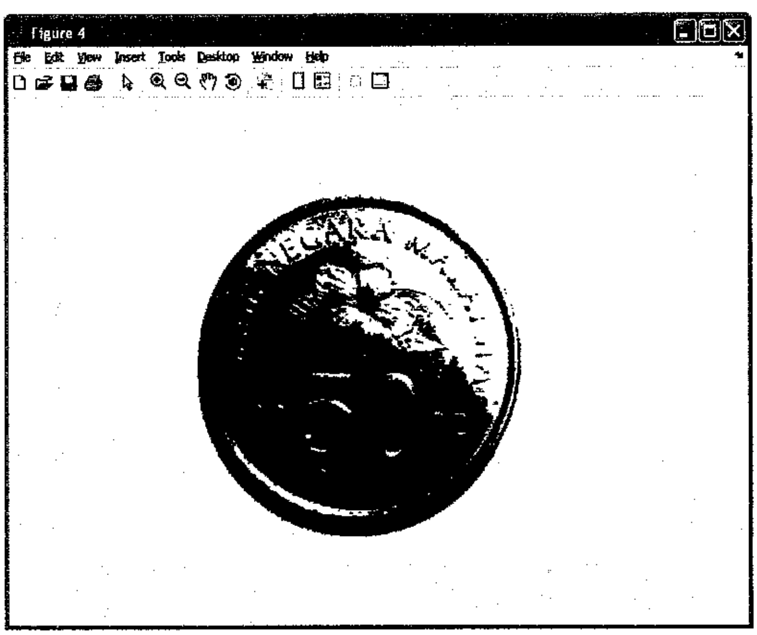


Figure 5.3 BW image

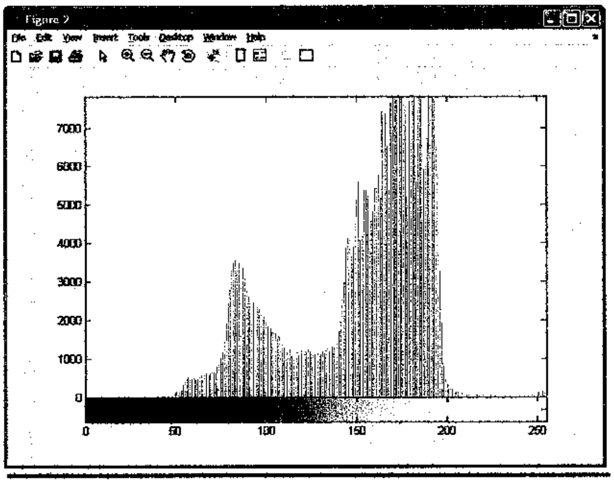


Figure 5.4 Histogram of BW image

Below is the data obtain from the program

Table 5.1 White pixel percentage by using obtained threshold value

Image	Threshold value	Black pixels	White pixels	Black pixels %	White pixels %
50senA	0.5216	122154	357846	0.2545	0.7455
50senB	0.5333	114135	365065	0.2378	0.7622
50senC	0.5098	126902	353098	0.2644	0.7356
50senD	0.5294	134641	345359	0.2805	0.7195
20senA	0.4824	100176	379824	0.2087	0.7913
20senB	0.4667	103020	376980	0.2146	0.7854
20senC	0.4627	111560	368440	0.2324	0.7676
20senD	0.4980	105654	374346	0.2201	0.7799
10senA	0.4863	75453	404547	0.1572	0.8424
10senB	0.4941	76618	403382	0.1596	0.8404
10senC	0.4941	76535	403465	0.1594	0.8406
10senD	0.4863	73748	406252	0.1536	0.8464
5senA	0.5098	40125	439875	0.0836	0.9164
5senB	0.4667	51017	428963	0.1663	0.8937
5senC	0.4824	48248	431754	0.1005	0.8995
5senD	0.4745	50534	429466	0.1053	0.8947

Table 5.2 Percentage difference (white pixels) with +_ 0.025%

(Refer table 5.1)

Image	Lower value	average	Upper value
50cent	0.7222	0.7407	0.7592
20cent	0.7615	0.7811	0.8005
10cent	0.8215	0.8425	0.8636
5cent	0.8792	0.9018	0.9243

From the calculated white pixel percentage, an accuracy of +_ 0.025 percent is extract from the average value of coin image. The lower and upper value is the acceptable range of white pixel data for each coin

5.2.2 BW area features

This features is extract by calculate the area of binary image. Below is the table result of BW area calculations

Table 5.3 BW area features extraction

image	White area				AVERAGE	UPPER VALUE	LOWER VALUE
	A	B	C	D			
50SEN	358316.1	366386.6	353632.5	345801.0	356034.0625	363154.7438	348913.3813
20CENT	380180.6	377304.8	368639.3	374674.5	375199.7813	382703.7769	367695.7856
10CENT	404718.6	403543.1	403628.8	406454.1	404586.1563	412677.8794	396494.4331
5CENT	440131.0	429115.8	431920.5	429626.1	432698.3438	441352.3106	424044.3769

5.2.3 Diameter calculation features

The diameter of coin is calculated vertically and horizontally fro the image acquire. From the BW image process, the system will go one by one pixel vertically from [x, y] = [0, 0] and will stop at when the pixel value equal to 0(black). This pixel is denoted as [x1, y1]. Then the system start from [x, y] = [600,800] pixel (the maximum pixel) and go one by one vertically until [x, y] equal to 0(black). This pixel is denoted as [x2, y2]. Then diameter 'a' is calculated taking the difference between x1 and x2 value of pixel like in the figure 5.5 below.

Next, the system is process again but it goes one by one pixel horizontally. The value denoted by [x3, y3] and [x4, y4]. Diameter 'b' is calculated by find the difference between y4 and y3.The value obtain is tabulated in the table 5.7 below.

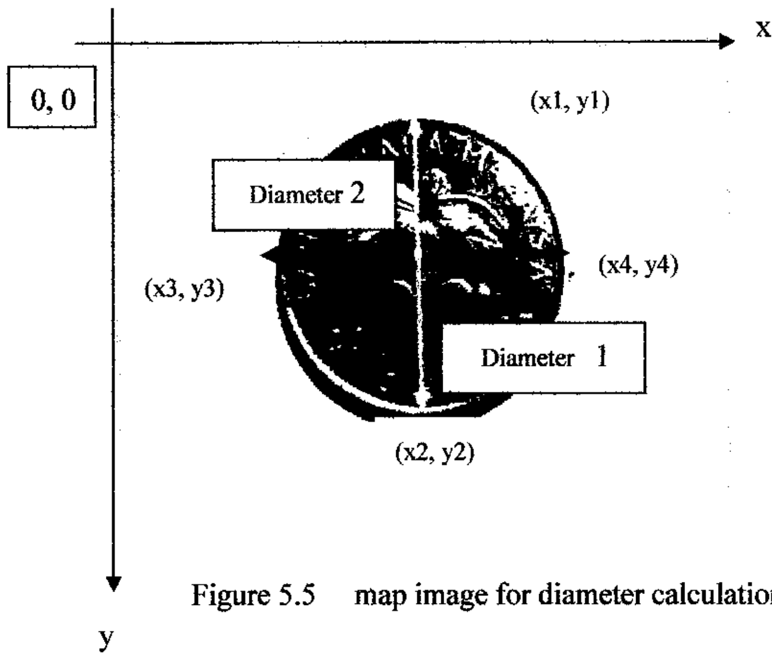


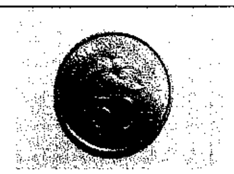
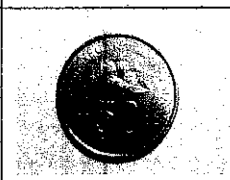
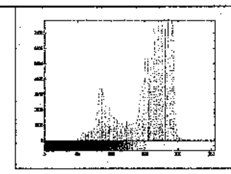
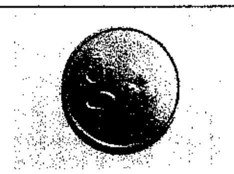
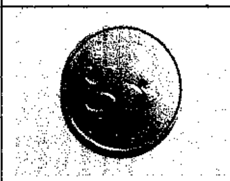
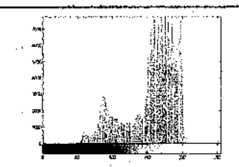
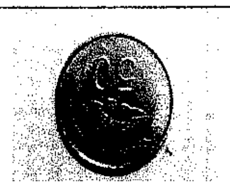
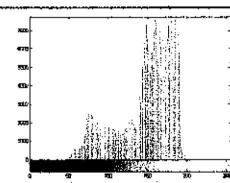
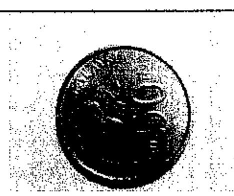
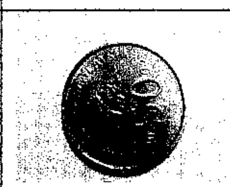
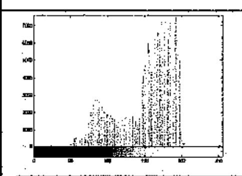
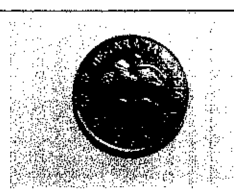
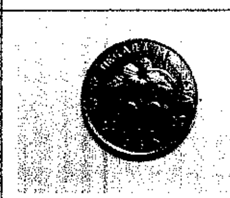
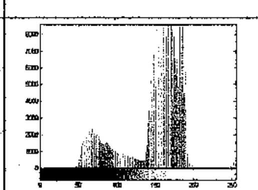
Figure 5.5 map image for diameter calculation

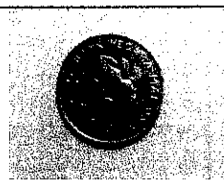
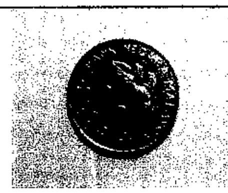
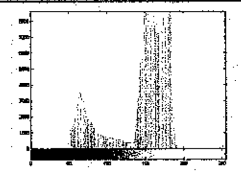
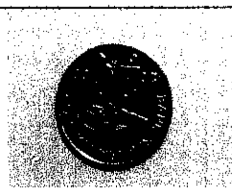
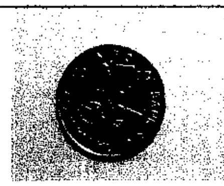
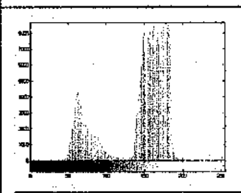
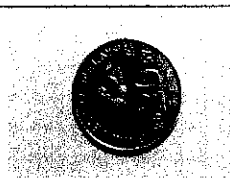
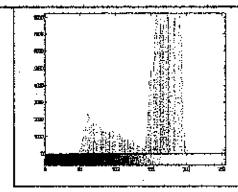
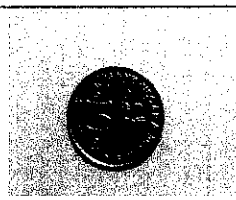
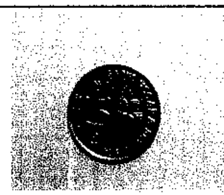
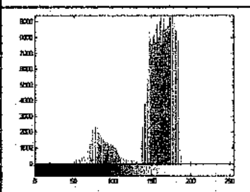
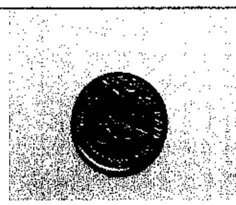
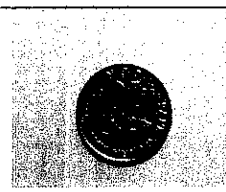
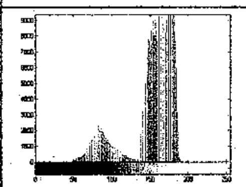
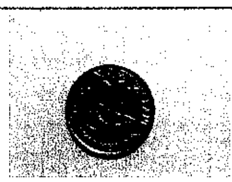
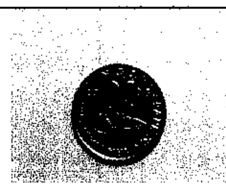
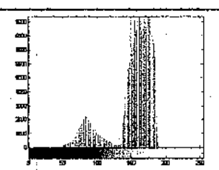
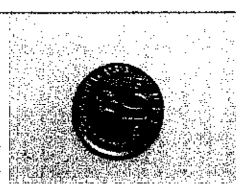
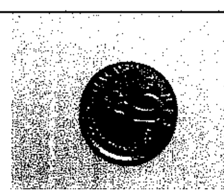
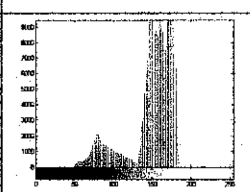
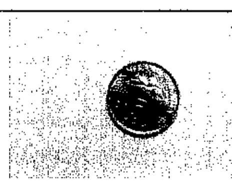
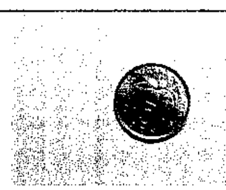
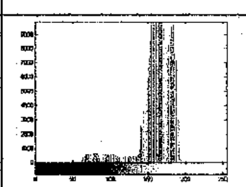
Table 5.4 Result of diameter calculation for several input image

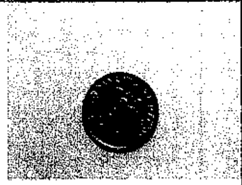
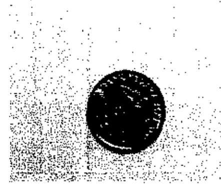
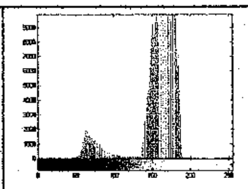
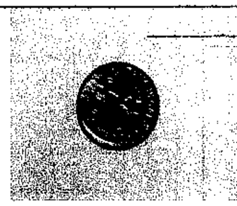
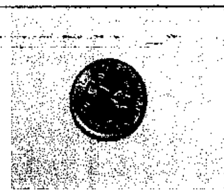
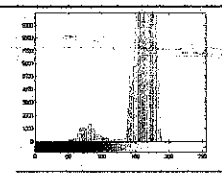
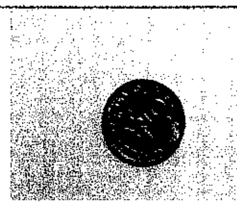
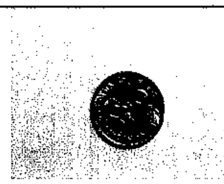
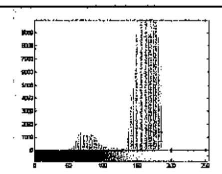
Image	Threshold value	X1	X2	Y3	Y4	Diameter 1 (x2-x1)	Diameter 2 (y4-y3)
50centA	0.5216	89	560	145	601	471	456
50centB	0.5333	72	451	179	635	469	456
50centC	0.5098	91	565	163	616	474	453
50centD	0.5294	104	577	163	617	473	454
20centA	0.4824	92	490	205	598	398	393
20centB	0.4627	124	521	157	540	379	383
20centC	0.4980	109	512	223	605	403	382
20centD	0.4667	101	499	188	568	398	380

10centA	0.4863	188	517	193	510	329	317
10centB	0.4941	195	526	212	531	331	319
10centC	0.4941	195	526	212	531	331	319
10centD	0.4863	173	503	221	538	330	317
5centA	0.5098	175	445	348	610	270	262
5centB	0.4667	239	511	258	522	272	264
5centC	0.4824	168	438	209	470	270	261
5centD	0.4745	220	491	294	558	271	264

Table 5.5 Output image for database calculation

Image	Input image	Grayscale image	Threshold histogram	Binary image
50centA				
50centB				
50centC				
50centD				
20centA				

20centB				
20centC				
20centD				
10centA				
10centB				
10centC				
10centD				
5centA				

5centB				
5centC				
5centD				

5.3 Limitation

Currently, the proposed currency value detector system still has a number of limitations that have to be overcome. Limitations of the system are as below:

- The system is able to recognize image of coin from the fixed orientation only. The ability of the system to recognize other orientation is due to the fact that the author has not yet developed the algorithm to perform such operation.
- System is unable to handle variable parameters of the camera and the surrounding environments. Currently, the test image must be taken in the similar lighting condition and same area backgrounds with no extra details.
- Only one coin per image can be process through the system. If there are more coins the system will recognize as unknown image.

5.4 Analysis of result

From the features extracted, the value then use for the recognition process. All three features is being put together to increase the accuracy of the system. There are 50 samples for each coin from difference coin has been experimented. From the table 5.9 result, the system has the acceptable accuracy for the coin detector. This process can be understood by looking at the coding in the appendix E.

Table 5.6 Result percentage accuracy

Currency value (50 samples)	Number of coin detected	Percentage (%)
50 cents	42	84.0
20 cents	40	80.0
10 cents	39	78.0
5 cents	37	74.0

5.5 Discussion

All the experiments are done in try and error methods. A lot of time has been use for understanding the theory of image processing and for try different method for image recognition.

In the beginning, the image captured for database is usually gives different value and then give bad result for the experiment. Therefore, the lightning and angle is fixed for the camera and also the lamp. A closed area from a box is been used to place the web camera and LED light so only the required situation will be present.

For improvement, the system then include with the sensor to inform the present of coins and also automatically image captured. The system then calculates the number of coins has been captured by the camera.

CHAPTER 6
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This project is created based on the information gained and studies through numerous of books about image processing. The output result shows that this system can be used by the acceptable percentage of accuracy. It also can be used in other image processing in computer vision by the correct alteration.

However, the equipment setting must be accurate so the coins will be recognize in the within the acceptable value features extracted in database. The system also cannot be used for coins counterfeit like if the coin has the same image but made from the different material.

6.2 Recommendation

The accuracy of the system can be improved by increasing the number of features extracted from the coin image.

Some of initial equipment setting can be improved by built in the equipment for the whole set of system. Therefore, setting equipment error can be reducing.

The automatic conveyer belt with constant speed can be improved the system. It will make the system more intelligent and give better accuracy.

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APPENDIX A

GANNT CHART FOR FINAL YEAR PROJECT 1

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic	■													
	-Propose Topic														
	-Topic assigned to students														
2	Preliminary Research Work		■	■											
	-Introduction														
	-Objective														
	-List of references/literature														
	-Project planning														
3	Submission of Preliminary Report			●											
4	Project Work				■	■	■	■							
	-Reference/Literature														
	-Practical/Laboratory Work														
5	Submission of Progress Report								●						
6	Project work continue								■	■	■	■			
	-Practical/Laboratory Work														
7	Submission of Interim Report Final Draft												●		
8	Oral Presentation													●	
9	Submission of Interim Report														●

● Suggested milestone

■ Process

APPENDIX B

GANNT CHART FOR FINAL YEAR PROJECT 2

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Work Continue		■	■											
	-Practical/Laboratory Work														
2	Submission of Progress Report 1			●											
3	Project Work Continue				■	■	■	■							
	-Practical/Laboratory Work														
4	Submission of Progress Report 2								●						
5	Project work continue								■	■	■	■			
	-Practical/Laboratory Work														
6	Submission of Dissertation Final Draft												●		
7	Oral Presentation													●	
8	Submission of Project Dissertation														●

● Suggested milestone

■ Process

APPENDIX C

MATLAB CODE FOR FEATURES EXTRACTION OF BW AREA

```
clear all;
clc;
clf;

I1=imread('5senA.jpg');
M1=rgb2gray(I1);

threshold_value = graythresh(M1)
binary_image1 = im2bw(M1,threshold_value);
BW1=bwarea(binary_image1)
a=BW1

if (348913.3813<a & a<363154.7438);
    msgbox('coin = 50 cents','Result of coins')

    elseif (367695.7856<a& a <382703.7769);
    msgbox('coin = 20 cents','Result of coins')

    elseif (396494.4331<a & a<412677.8794);
    msgbox('coin = 10 cents','Result of coins')

    elseif (424044.3769<a & a<441352.3106);
    msgbox('coin = 5 cents','Result of coins')

else
    msgbox('coin is not detected','Result of coins'
```

APPENDIX D

MATLAB CODE FOR FUNCTION PF WHITE PIXEL PERCENTAGE

```
clear all;
clc;
%clf;
I=imread('10senA.jpg');
M=rgb2gray(I);
figure,imshow (M);
threshold_value = graythresh(M)
binary_image = im2bw(M,threshold_value);
imhist(M);
%figure,imhist(threshold_value);
figure,imhist(binary_image);
figure,imshow(binary_image);

%A=max(max(max(I)))
%B=min(min(min(I)))
%C=mean(mean(mean(I)))
[m,n]=size(binary_image)
white=sum(sum(binary_image))
black= m*n-white
percent_black= black/(m*n)
percent_white=white/(m*n)

if (0.8792<=percent_white & percent_white <0.9243);
    msgbox('coin = 5 cents','Result of coins')

 elseif (0.8215<=percent_white & percent_white<0.8636);
```

```
    msgbox('coin = 10 cents','Result of coins')


 elseif (0.7615<=percent_white & percent_white<0.8006);
    msgbox('coin = 20 cents','Result of coins')


    elseif (0.7222<=percent_white & percent_white<0.7592);
    msgbox('coin = 50 cents','Result of coins')


else
    msgbox('coin is not detected','Result of coins')
end
```

APPENDIX E

MATLAB CODE FOR FUNCTION OF DIAMETER CALCULATION

```
clear all;
clc;
%clf;
I=imread('20senA.jpg');

imshow(I);
M=rgb2gray(I);
figure,imshow(M);

threshold_value = graythresh(M)
binary_image = im2bw(M,threshold_value);
figure,imhist(M);
%figure,imhist(threshold_value);
%figure,imhist(binary_image);
figure,imshow(binary_image);

%A=max(max(max(I)))
%B=min(min(min(I)))
%C=mean(mean(mean(I)))
[x,y]=size(binary_image)

for x1=1:1:x
    for y1=1:1:y
        if binary_image(x1,y1)==0
            break
        end
    end
```

```
    if binary_image(x1,y1)==0
        break
    end;
end;


fprintf('\n x1=%d',x1)
for x2=x:-1:1
    for y2=y:-1:1
        if binary_image(x2,y2)==0
            break
        end
    end
    if binary_image(x2,y2)==0
        break
    end;
end;

fprintf('\n x2=%d',x2)
a=x2-x1



for y3=1:1:y
    for x3=1:1:x
        if binary_image(x3,y3)==0
            break
        end
    end
    if binary_image(x3,y3)==0
        break
    end;
end;
```

```
fprintf('\n y3=%d',y3)

for y4=y:-1:1
    for x4=x:-1:1
        if binary_image(x4,y4)==0
            break
        end
    end
    if binary_image(x4,y4)==0
        break
    end;
end;

fprintf('\n y4=%d',y4)
b=y4-y3



if (270<=a & a<273 || 262<=b & b<265);
    msgbox('coin = 5 cents','Result of coins')

 elseif (329<=a & a<322 || 317<=b & b<320);
    msgbox('coin = 10 cents','Result of coins')

 elseif (379<=a & a<404 || 380<=b & b<394);
    msgbox('coin = 20 cents','Result of coins')

    elseif (469<=a & a<472 || 453<=b & b<457);
    msgbox('coin = 50 cents','Result of coins')

else
    msgbox('coin is not detected','Result of coins')
end
```

APPENDIX F

FULL MATLAB CODE FOR COIN CURRENCY DETECTOR

% this system is combining of three different features extraction

```
z=vcapg;
imwrite(z,'image1.jpg');


I=imread('image1.jpg');
imshow(I);
M=rgb2gray(I);
figure,imshow(M);

threshold_value = graythresh(M)
binary_image = im2bw(M,threshold_value);
%figure,imhist(M);
%figure,imhist(threshold_value);
%figure,imhist(binary_image);
figure,imshow(binary_image);


%A=max(max(max(I)))
%B=min(min(min(I)))
%C=mean(mean(mean(I)))


binary_image=detect;

[m,n]=size(binary_image)
white=sum(sum(binary_image))
black= m*n-white
percent_black= black/(m*n)
percent_white=white/(m*n)
BW1=bwarea(binary_image);
c=BW1
```

```
[x,y]=size(binary_image)

for x1=1:1:x
    for y1=1:1:y
        if binary_image(x1,y1)==0
            break
        end
    end
    if binary_image(x1,y1)==0
        break
    end;
end;


fprintf('\n x1=%d',x1)
for x2=x:-1:1
    for y2=y:-1:1
        if binary_image(x2,y2)==0
            break
        end
    end
    if binary_image(x2,y2)==0
        break
    end;
end;

fprintf('\n x2=%d',x2)
a=x2-x1



for y3=1:1:y
    for x3=1:1:x
        if binary_image(x3,y3)==0
            break
        end
    end
    if binary_image(x3,y3)==0
        break
    end;
```

```
end;


fprintf('\n y3=%d',y3)

for y4=y:-1:1
    for x4=x:-1:1
        if binary_image(x4,y4)==0
            break
        end
    end
    if binary_image(x4,y4)==0
        break
    end;
end;

fprintf('\n y4=%d',y4)
b=y4-y3


total=0;



countfifty=0;
counttwenty=0;
countten=0;
countfifth=0;
notdetected=0;

if  (350<=a  &  a<358   ||  424044.3769<c  &  c<441352.3106||
0.8422<=percent_white & percent_white <0.8822);
    msgbox('coin = 5 cents','Result of coins')
  countfifth=countfifth+1;


elseif  (410<=a  &  a<418  ||   396494.4331<c  &  c<412677.8794
||7972<=percent_white & percent_white<0.8372);
   % msgbox('coin = 10 cents','Result of coins')
    countten=countten+1;


elseif  (400<=a  &  a<409  ||   367695.7856<c  &  c <382703.7769
```

```
||0.6757<=percent_white & percent_white<0.7157);
    %msgbox('coin = 20 cents','Result of coins')
    counttwenty=counttwenty+1;

elseif  (414<=a  &  a<423  ||   348913.3813<c  &  c<363154.7438  ||
0.5702<=percent_white & percent_white<0.6102);
   % msgbox('coin = 50 cents','Result of coins')
     countfifty=countfifty+1;

    else
        notdetected=notdetected+1;

end

countfifty
counttwenty
countten
countfifth

fifty=countfifty*0.5;
tweenty=counttwenty*0.2;
ten=countten*0.1;
fifth=countfifth*.05;

total= fifty + tweenty + ten + fifth;

button = questdlg('Ready to quit?', ...
                              'Exit
Dialog','Yes','Continue','Continue');
switch button
            case 'Yes',

              clear vcapg
              fprintf('\n Sum of coins are= RM% 3.2f',total)
              fprintf('\n   Number   of   coins   not   detected
=%d',notdetected)

            case 'No',
             quit cancel;


end
```