NIGHT VISION CAMERA SYSTEM FOR INTRUDER DETECTION IN INDOOR AND OUTDOOR ENVIRONMENT

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NIGHT VISION CAMERA SYSTEM FOR INTRUDER DETECTION IN INDOOR AND OUTDOOR ENVIRONMENT

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Thesis submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Mechatronic Engineering (Hons.)

Faculty of Manufacturing Engineering
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ABSTRACT

This project presents the detection of intruder existence by using a night vision camera system in indoor and outdoor environment. The entire project is done by using image processing techniques via OpenCV which run on Linux environment. The challenge of this project focuses on the detection ability of intruder by using a webcam at a fixed distance in low light condition. The histogram is generated to show the tonal variations and distribution of every frame of the images. Intruders can be detected by detecting the changes occur in the foreground image and the changes of histogram from the real-time video streaming through the webcam.

ABSTRAK

Projek ini membentangkan mengesan kewujudan penceroboh dengan menggunakan sistem penglihatan malam kamera dalam persekitaran dalaman dan luaran. Keseluruhan projek ini dilakukan dengan menggunakan teknik pemprosesan imej melalui OpenCV yang berfungsi dalam persekitaran Linux. Cabaran projek ini memberi tumpuan kepada keupayaan pengesanan daripada penceroboh dengan menggunakan kamera web pada jarak yang tetap dalam keadaan cahaya rendah. Histogram ini dijana untuk menunjukkan variasi yang mempergunakan gaya suara dan pengedaran setiap bingkai imej. Penceroboh boleh dikesan dengan mengesan perubahan berlaku dalam imej latar depan dan perubahan histogram daripada video masa sebenar streaming melalui webcam.

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LIST OF ABBREVIATIONS

OpenCV	Open Source Computer Vision
CCTV	Closed-circuit television
PC	Personal computer
USB	Universal Serial Bus
RAM	Random Access Memory
LED	Light-emitting diode

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter is to have a brief overview on the project background, problem statement, objectives of this project and scopes of the project.

1.2 PROJECT BACKGROUND

Over the years of continued evolution in our world, house breaking at both residential area and industrial area have been a serious problem in every each of the corners in the world. This problem had brought a creation of device named security system to detect intruders for either private housing areas or industrial areas. There are more and more users are trying to apply security system at their own private estate including the most advanced night vision infrared camera for intruder detection. There are quite a lot of security monitoring devices in the market such as CCTV camera, and fingerprint access identification system and face recognition system, but most of the house breaking cases happened in the night time and we are not able to see anything in the dark with our bare eyes and we are not able to give any respond right after the intruders broke in. This had caused a lot of losses to the properties due to poor detection of intruders in the night time. To avoid this kind of problems, we install night vision camera system in our own properties so that if there is an intruder appear or break in, we are able to detect their existence in advance to recognise them and capture their looks in the dark. In this project, we are going to detect the existence of intruders through the webcam connected to PC which mounted at static position in the low light condition. The webcam used is a normal USB webcam which can be easily obtained. The camera allows us to capture image in the dark or low light condition and finally the image or video captured can be used for further analysis from time to time.

1.3 PROBLEM STATEMENT

Everyone of us has our own properties such as cars, land and houses. As we know, we are just not able to protect and monitor our properties all the time. Sometimes, we are not around in our house or when we went for travelling, nobody is staying in the house for few days. This has brought the chances for intruders to break into our house especially in the night time. Poor detection of intruders inside and outside of building in the night time has caused a great loss of the properties and also life-threatening to the human. Somehow, the cost of one full set of CCTV system is considered as high cost due to the combination of devices cost and installation cost while this is the price that not everyone can afford to own it.

1.4 PROJECT OBJECTIVES

1) To investigate the intruder detection system with a USB camera as night vision camera that can be used in indoor and outdoor of buildings.
2) To analyse the light intensity required to capture a picture by the USB camera to detect intruders.
3) To determine the distance required to capture the shadow of intruders in the dark environment.

1.5 PROJECT SCOPE

1) Interfacing the USB night vision camera with the program.
2) Analysing the quantity of light required to detect intruders.
3) Conduct tests on the ground by using the USB camera to determine the possible distance between intruders and the camera to capture the image of the intruders.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will briefly explain about the working principle of a night vision camera, system design and software approach for this project. All the information and sources regarding night vision camera are summarized from the internet sources, articles, journals, and related academic text book. Literature review gives a help in providing important theories and information and essential concept regarding previous research which related to projects of night vision camera. These information and theories are considered important in order to proceed to analysis and further study about the topic.

2.2 NIGHT VISION

Night vision is a technology that allowing one to see more clearly in the dark environment. Human have poor night vision compared to many other animals especially for those animals which hunt their prey in the dark environment. The reason why those animals can see in the dark is that they have a layer of tissue called as tapetum lucidum in their eyes. The tapetum lucidum tissues allow the visible light to reflect back along the light path through the retina in their eyes, yet maintaining the sharpness and contrast of the image on their retina, providing higher light intensity to be received by the photoreceptors and transfer the nerve signal to their brain, result them to see more clearly in the dark environments. That is why those animals have glowing eyes when the light flash into their eyes during the night time, creating creepy and scary looks.

Those animals have the ability to see in the dark where human does not have. That is because human can only see the world when the electromagnetic radiation with wavelength in the range of 380 nm and 750 nm where the frequency is between 400 THz to 789 THz, normally called as visible light. The visible spectrum is provided as below (figure and table taken from Wikipedia):

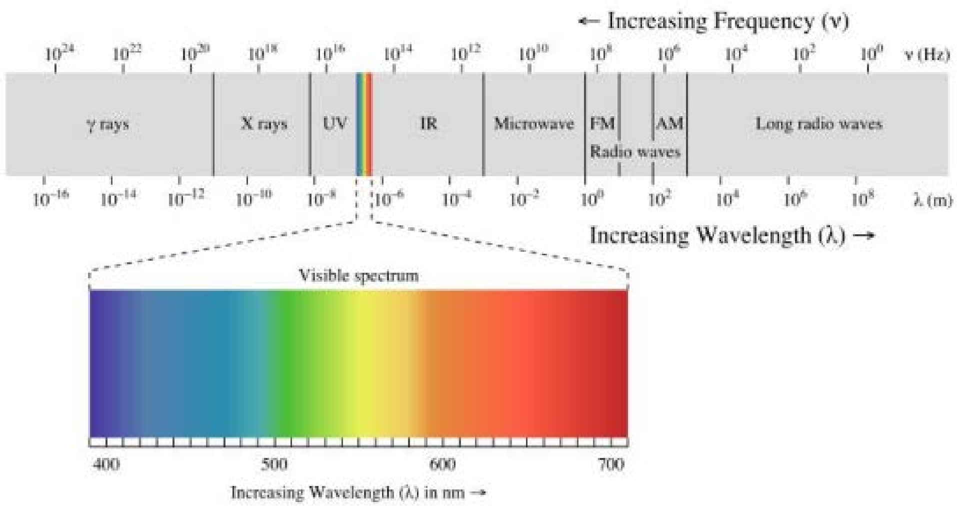
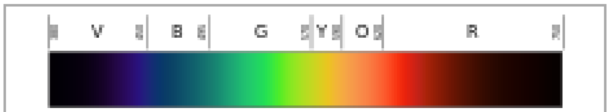


Figure 2.1: Electromagnetic Spectrum with details.



Color	Frequency	Wavelength
violet	668–789 THz	380–450 nm
blue	606–668 THz	450–495 nm
green	526–606 THz	495–570 nm
yellow	508–526 THz	570–590 nm
orange	484–508 THz	590–620 nm
red	400–484 THz	620–750 nm

Figure 2.2: Frequency and Wavelength of Visible Light.

There are a lot of applications of night vision, including military, security, surveillance, wildlife observations and navigation. Military force use night vision goggles to see and locate their enemy in order to complete their mission in the dark environment while a lot of buildings are mounted with night vision devices to monitor the surroundings and for surveillance purpose. On the other hand, many ecologist use night vision technology to observe the ecological changes and wildlife animals in the dark.

2.3 NIGHT VISION DEVICES

Figure 2.3: Example of night vision devices.

The night vision technologies have been widely used in surveillance devices especially night time pedestrian detection system and intruder detection system. When it comes to this topic, there are two approaches, which are image intensification, also known as light amplification and thermal imaging.

2.4 LIGHT AMPLIFICATION

2.4.1 Working principle of Light Amplification

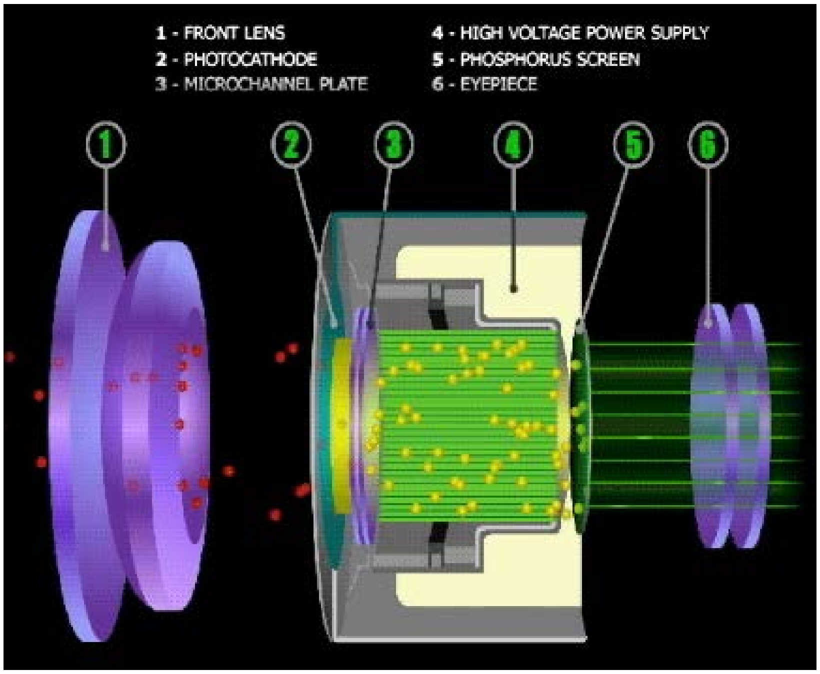


Figure 2.4: Working principle of Light Amplification.

Most of the night vision devices use light amplification technology to achieve better vision in the dark environment is because light amplification is less expensive than thermal imaging. For light amplification, it can be done by collecting and gathering tiny of existing light such as moonlight, starlight and low portion of infrared light that exist in surrounding area through the front lens, also known as objective lens. Then, the light goes into the image-intensifier tube, also known as photocathode tube, to convert the light energy (photons), into electrical energy which called as electrons. When the electrons are passing through the tube, much of electrons are released from atoms and amplified thousand times to much greater of the original number through the microchannel plate and accelerated by an electrical voltage to increase their speed in the tube. Then, the electrons are projected to a screen coated with phosphorus, in order to let the amplified electrons to stay in same alignment and change the electrons back into original photon which provides a perfect image that can be seen through the eyepiece. The electrons cause the phosphorus to reach excited state which produces an amazing green glowing output image and impressive nighttime view even in a very dark environment.

Figure 2.5: Example of output image after light amplification.

2.4.2 The advantages and disadvantages of Light Amplification

Advantages	**Disadvantages**
Excellent sensitivity towards low light level.	It requires at least a little bit of light source and it is not useful in no light condition.
Enhanced visible image into best quality for recognition and identification purposed.	Weak performance during daytime compared to daylight-only method.
Lower cost required.	Damage might occur when observing at bright sources under low light environment.
High resolution.	

Table 2.1: Advantages and disadvantages of light amplification

2.5 THERMAL IMAGING

2.5.1 Characteristic of electromagnetic spectrum

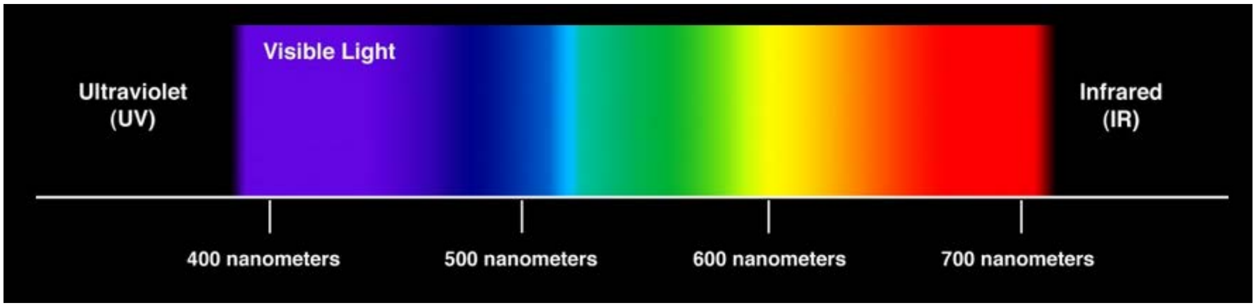


Figure 2.6: Electromagnetic spectrum.

All the natural or artificial objects in this world emit infrared as a function of heat energy. In order to understand how thermal imaging works, there is something which is more important to know first, that is light spectrum. A light wave contains some amount of energy which refers to light energy. The amount of the energy exist in the light wave are depends on the wavelength of the light wave. Shorter wavelength will consist of higher energy. From **Figure 2.2**, we know that in visible light, violet has the shortest wavelength which means that it has the highest energy amount in it while red has the longest wavelength which consist the least amount of energy. Human eyes are capable to see the objects in visible light only when objects emit the visible light at very high temperature. All the objects emit infrared energy at ordinary temperature. If the object is hotter, means that it emits higher infrared energy. Infrared has longer wavelength than visible light and human eyes cannot see it but thermal imaging devices can. Infrared can be catagorised into three:

1) Near Infrared (NIR) - Closest to visible light, NIR has a range of wavelengths from 0.7 to 1.3 microns.
2) Mid Infrared (Mid IR) -Mid IR has a range of wavelengths from 1.3 to 3 microns.
3) Thermal Infrared (Thermal IR) – Has the largest range of the infrared spectrum, it has a range of wavelengths from 3 microns to more than 30 microns.

Both near-IR and mid-IR are used by a variety of electronic devices, including remote controls and the difference between Thermal IR and the other two IR is infrared light is emitted by an object but not reflected off.

2.5.2 Working principle of Thermal Imaging

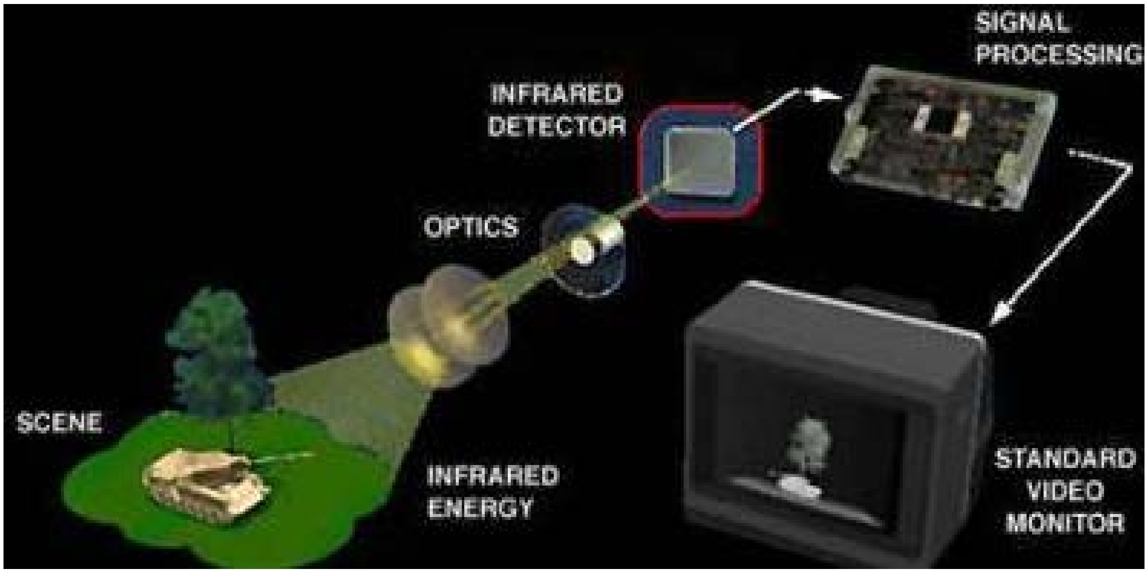


Figure 2.7: Working principle of Thermal Imaging.

Different from light amplification method, thermal imaging do not require any existing light at surrounding at all. It means that it is totally light level independent and also it can penetrate smokes, haze, and fog when focusing on the objects. A special optic lens on the infrared detector is used to focus the infrared light emitted by all of the objects in the scene. The focused light is then scanned by a phased array of infrared-detector elements and a very detailed and informative representing temperature information will be created and it is called as thermogram. Then, the thermogram will be translated into electrical impulses and send to image processing unit to produce output image that can be viewed on displaying unit of a thermal imaging device or other electronic display. The image produced by thermal imaging devices are normally appears in black and white colours, depending on the intensity of the infrared emission by the objects, where black colour objects are cold in temperature while white colour objects are in hot temperature. If there is a temperature difference between two objects that the thermal imaging devices detected in a scene, then a contrast of black and white image will be shown on the display clearly that the human eyes cannot detect when the surrounding has no light at all.

Figure 2.8: Example of output image using Thermal Imaging.

Figure 2.9: Comparison between visible light image and Thermal Imaging output image.

2.5.3 The advantages and disadvantages of Thermal Imaging

Advantages	**Disadvantages**
High sensitivity towards thermal responses.	Lower resolution compared to light amplification method.
Easy to detect people and vehicles.	Devices are heavy and bulky.
Do not being affected by any bright light sources.	Expensive to purchase and to operate for Cooled-detector Thermal Imaging Cameras
High contrast in dark environment	Cannot be used for multispectral or high-speed infrared applications for Uncooled-detector Thermal Imaging Cameras

Table 2.2: Advantages and disadvantages of thermal imaging

2.6 SYSTEM DESIGN PROBLEM

The fundamental problem of night vision camera system for intruder detection is important and crucial and should be understood and identified. This is to ensure that the night vision camera system can achieve optimum performance in all aspects continuously. Design problem can be solved by following steps:

1) Determine the basic characteristics and specifications of the night vision camera used.
2) Determine how much of light intensity required to monitor the condition at indoor and outdoor environment.
3) Identify the distance required to capture the shadow of intruders in the dark environment.
4) Decide the location to mount the night vision camera to monitor the indoor and outdoor environment.
5) Identify the design and maintenance cost required.
6) Investigate the flexibility and durability of the night vision camera, whether the night vision camera system can sustain in such hot weather in Malaysia.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The aim of this chapter is to presents the fundamental frameworks of method which used to investigate the light intensity needed to capture a picture by night vision camera to detect intruders. This chapter will also outline how the project will be conducted and how it will develop according to the methods available.

3.2 FLOWCHART

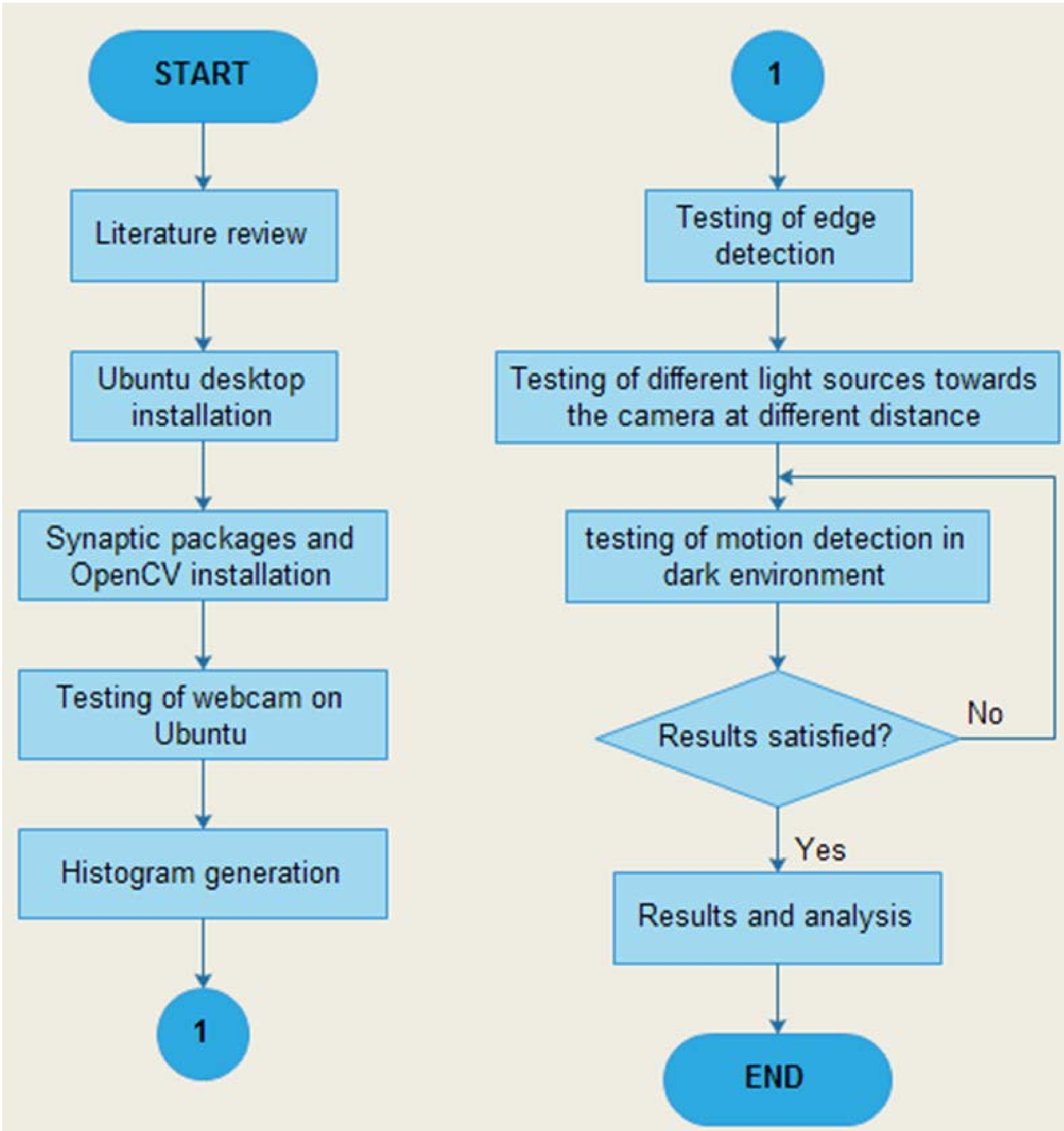


Figure 3.1: Project flowchart

3.3 EQUIPMENT

3.3.1 Personal Computer

The workstation in this project requires a personal computer equipped with at least 2GHz of processor as core, 2 Gb of RAM, and 30 Gb of storage in Ubuntu operating system.

Figure 3.2: Asus A55V notebook

3.3.2 Night Vision Camera

The camera that used in this project for all the experiment is built –in webcam of 0.3M pixels while the frame rate requirement is 15Hz. If the frame rate is too slow, the image of intruder cannot be recorded down.

Figure 3.3: Logitech C300 webcam.

3.4 SOFTWARE

The software part is an important part for night vision camera system to detect intruder. There are variety of freeware in the market or websites which provide programs and coding to drive the whole system of night vision infrared camera system.

3.4.1 Ubuntu desktop 14.04

Ubuntu desktop 14.04 is a free software that can be found on internet that provide users with Linux kernel operating system. Ubuntu provides an open source development culture to encourage users to study how it works and how to improve the whole system. It provides users with wide range of default software such as Firefox, LibreOffice and other software packages like Evolution and Synaptic which can be found in Ubuntu Software Center. The Ubuntu terminal will be used to access the software part of the night vision camera system. The analysis of this project will be done based on the histogram graph produced by terminal.

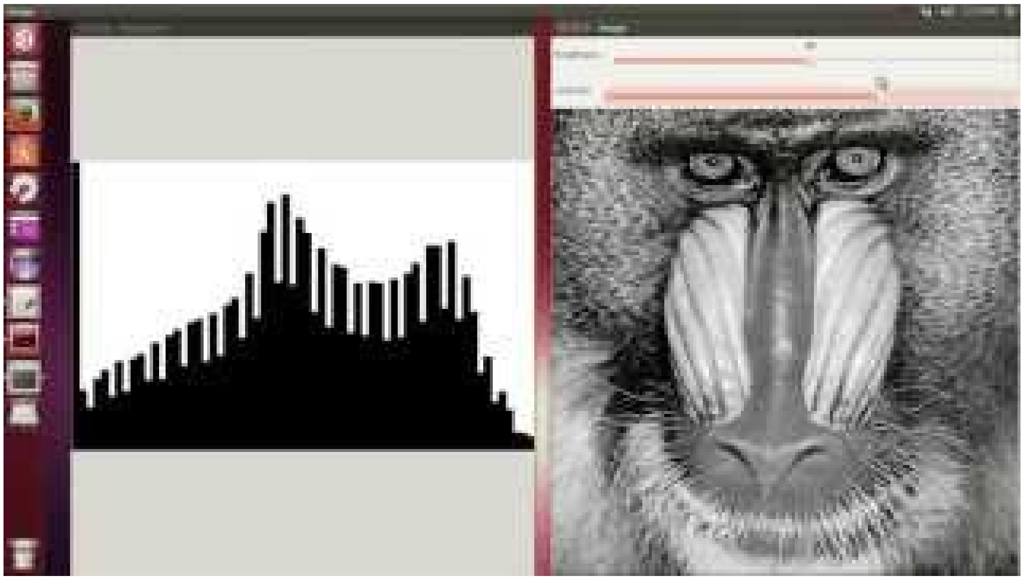


Figure 3.4: Ubuntu desktop used for image processing.

3.4.2 OpenCV

OpenCV (Open-source Computer Vision) is an open source of programming function library that used in real time computer vision. It has a free software licenses that provide cross-platforms of programming languages such as C, C++, Python and Java. There are thousands of algorithms inside the library that can interface and support Windows, Linux, Android, IOS and Mac OS. The applications of OpenCV include facial recognition system, gesture recognition, object identification, and motion tracking.

By putting the camera in indoor or outdoor environment, the images collected from the camera are sent to ground based processor unit to analyses the existence of intruder.

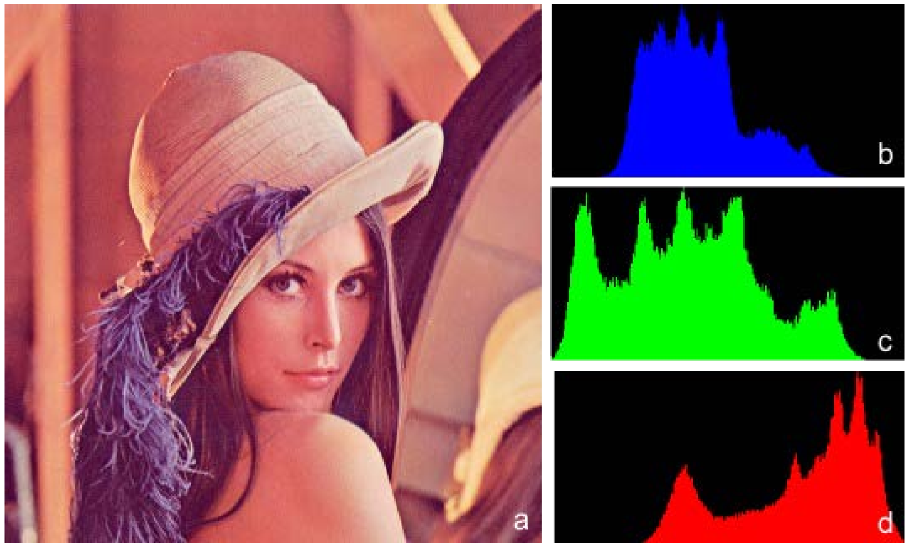


Figure 3.5: Histogram of an image generated by OpenCV.

3.5 HISTOGRAM OF ORIENTED GRADIENTS

Histogram of Oriented Gradients (HOG) is one of the object recognition technique used in computer vision and image processing. The use of edge orientation histogram has been applied to detect the sharp changes in digital image at which the image brightness has discontinuities at every point in the image. The points that change brightness sharply is then restructured into a set of curved line segments or edges. Edge detection is one of the fundamental image processing steps to analyse the image pattern so that the important event can be shown in the result of image processing.

Figure 3.6: Edge detection of an image.

3.6 LIGHT SOURCE MODELING

As we know that different light sources will give different amount of light. In the experiments, the tests include of testing the camera with car light, street light, corridor light and LED light. The edge detection technique is applied to test the camera to detect the sharp changes of image in different environment with different intensity of light. The test has determined the range of distance for detection in the environments provided and amount of light required.

CHAPTER 4

RESULTS AND ANALYSIS

4.1 INTRODUCTION

This chapter is to show the results obtained from the research, by carrying out few types of testing and experiments related to histogram generation, edge detection of object, and motion detection by using Open CV.

4.2 HISTOGRAM GENERATION

Histogram of an image can be generated by running the program codes using OpenCV libraries and then upload a picture together with the program codes. When the program read the image, results as below:

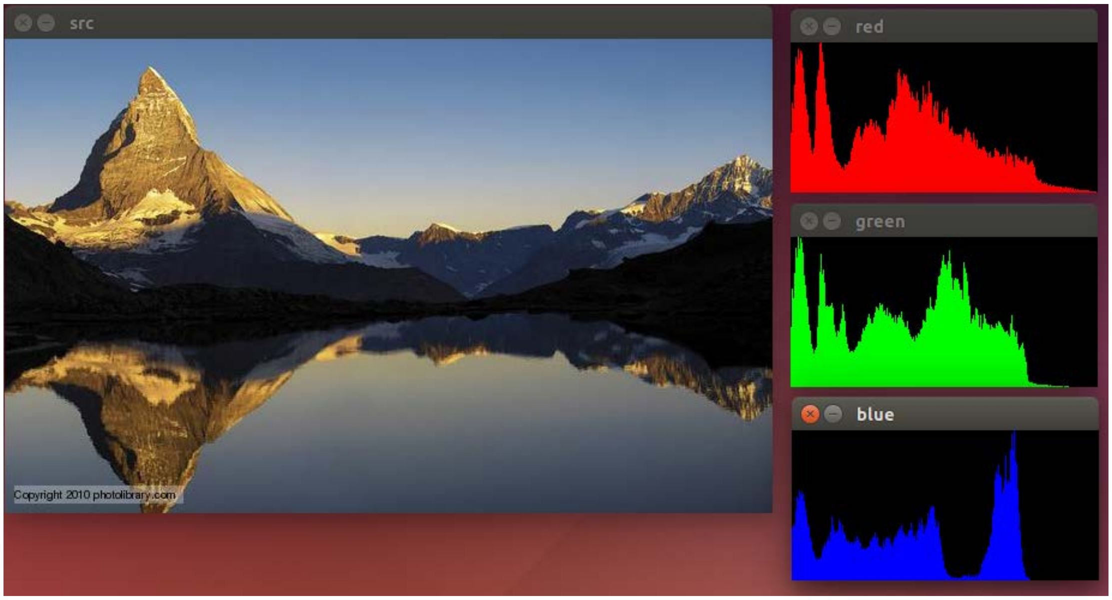


Figure 4.1: An image source with output histogram graph.

Every image will give different histogram graph based on the brightness and the RGB planes. The image above has shown that the dark colours pixels are slightly more than the bright colours pixels.

4.3 HISTOGRAM CALCULATION

Any random image can be divided into its correspondent planes. Histogram can be calculated by calling the function using Open CV.

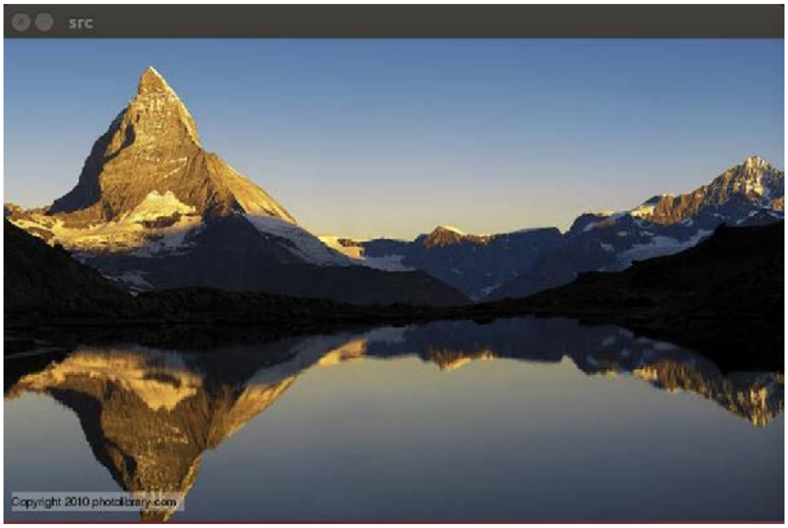


Figure 4.2: Image input.

Figure 4.3: Output histogram calculation.

This function is to separate the source image in its three R,G and B planes and then configure the histograms for each plane. The intensity of light of each image is ranged from 0 to 255 for every pixel in the image, means that 0 is the darkest intensity value while 255 is the brightest one.

4.4 EDGE DETECTION AND HISTOGRAM

4.4.1 Indoor detection

The histogram graph will be changing continuously from time to time if the source video input received from camera has different intensity of light.

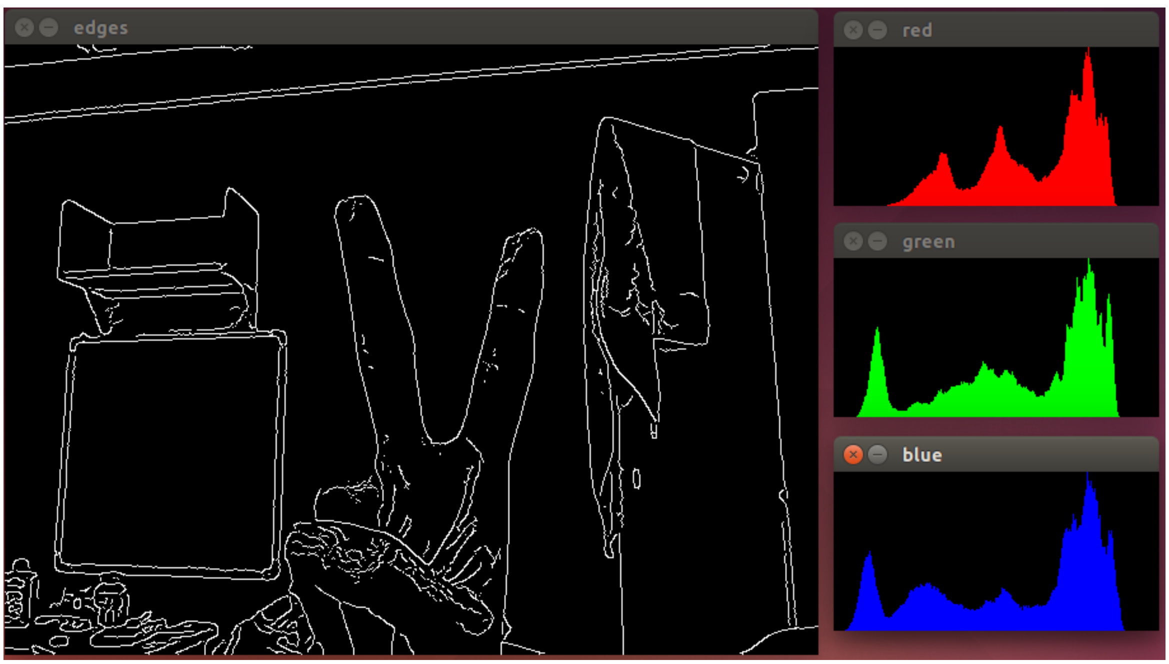


Figure 4.4: Indoor environment with lamp as light source.

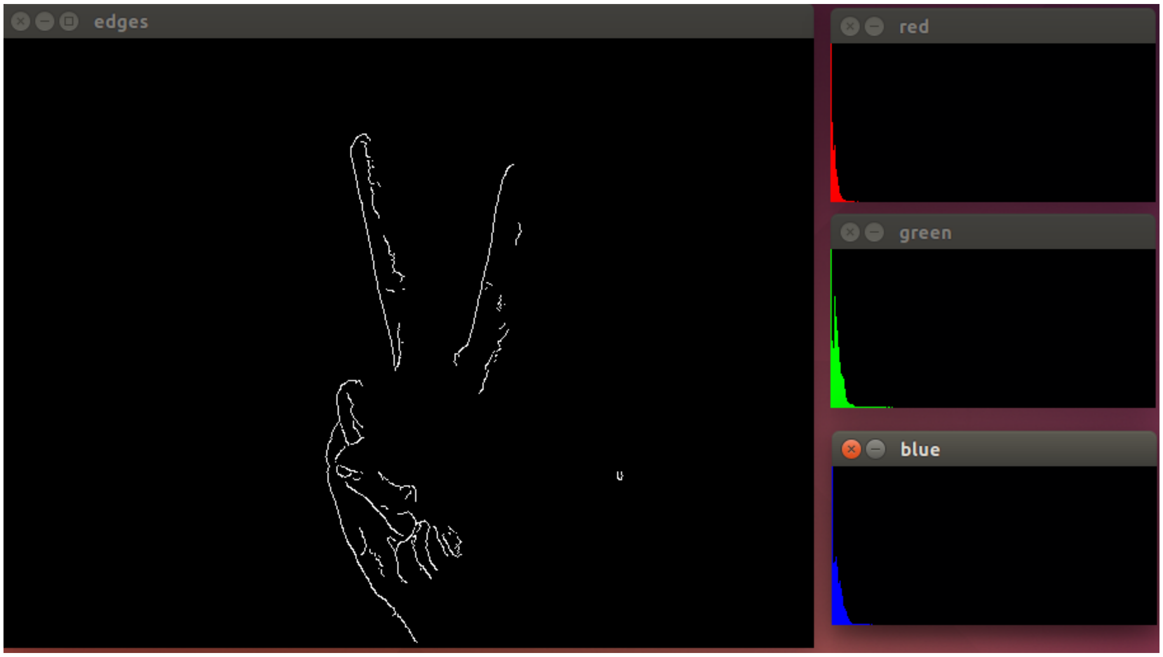


Figure 4.5: Indoor environment with a little of light source.

Both figures above show that the image is taken from the same place and same position but the light source is different. The histogram will change when the light intensity of the environment change. The test has shown that the Edge Detection function needs the minimum of light to be effective.

4.4.2 Outdoor with corridor light

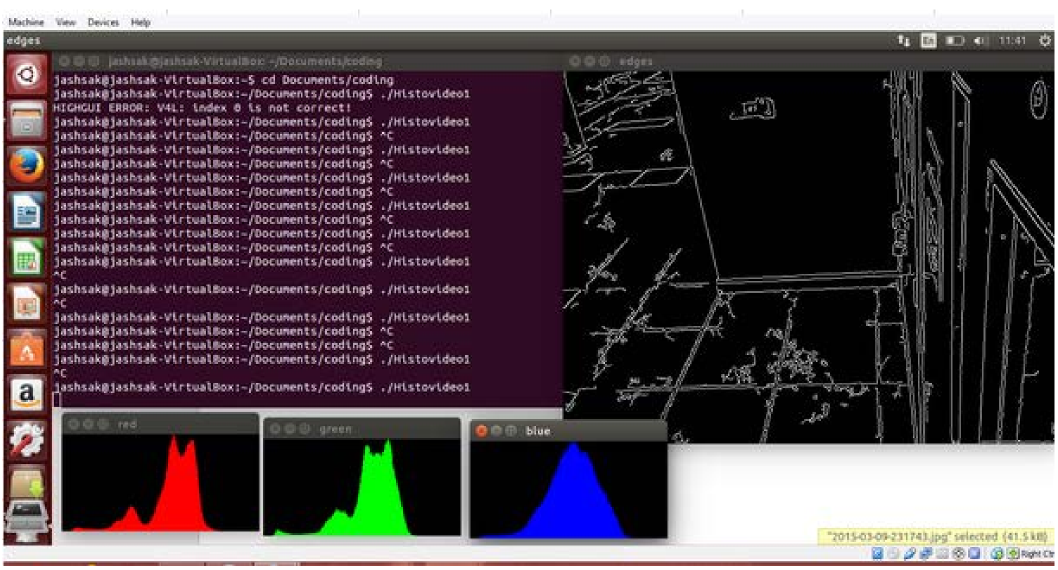


Figure 4.6: Without intruder.

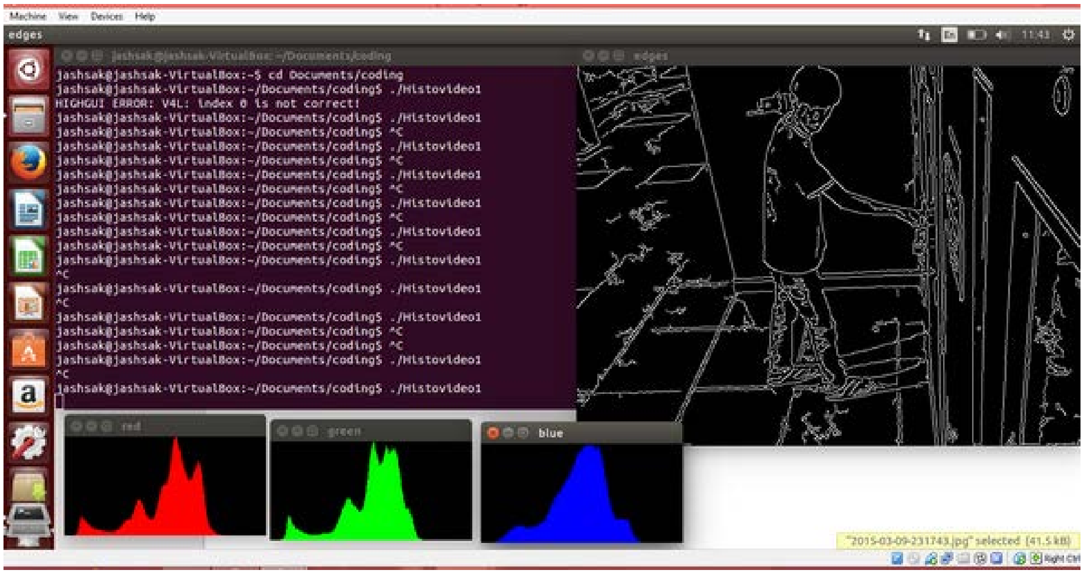


Figure 4.7: With intruder.

This experiment is done at the corridor that full with corridor light at night. The camera is mounted on the top of the wall and pointing at the entrance of the building. The edge detection image and the histogram has obviously changed when an intruder is in front of the camera.

4.4.3 Outdoor with car light

Figure 4.8: The view with car light.

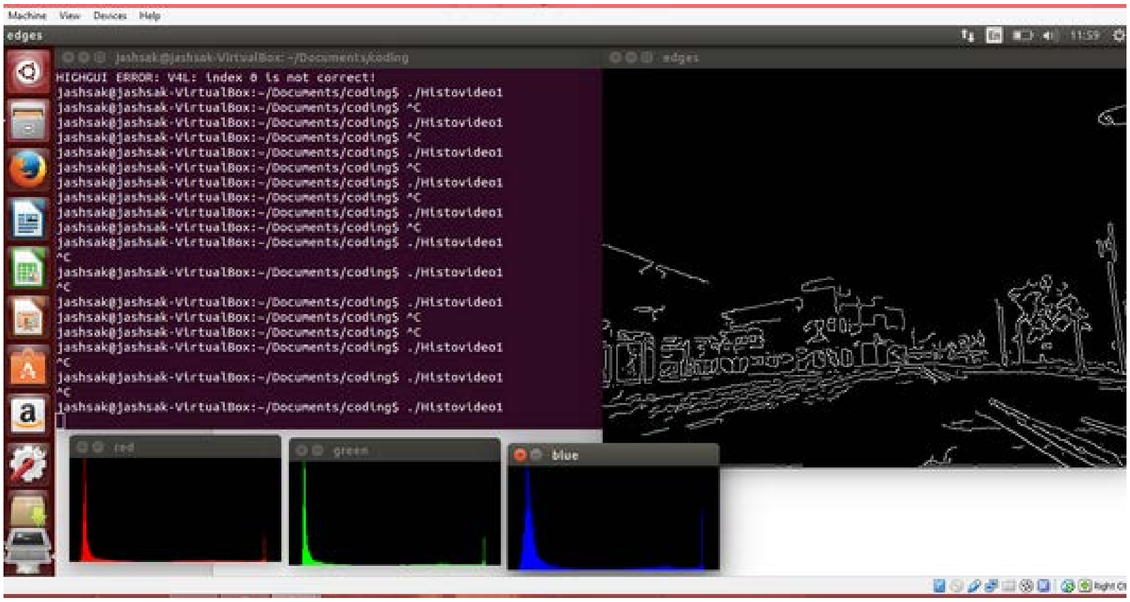


Figure 4.9: Edge detection view with histogram.

This experiment is done by using car light while the camera is mounted in front of the car and the object is going to stand in front of the camera. The histogram shows the image has more on dark pixels than the bright one even when the car light is switched on.

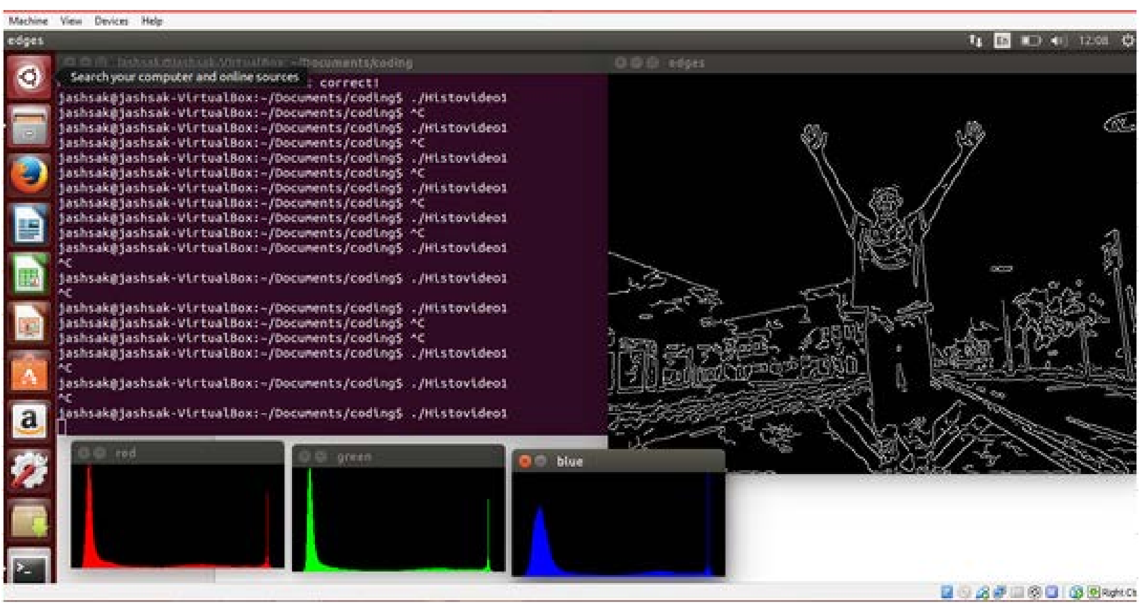


Figure 4.10: Object is 5m away from camera.

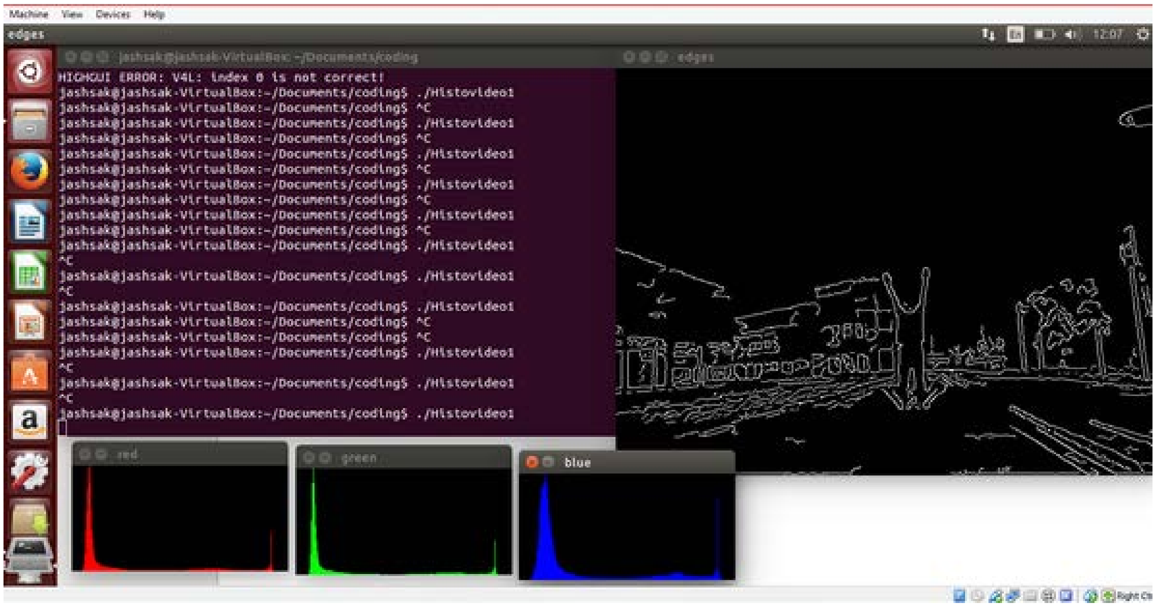


Figure 4.11: Object is 10m away from camera.

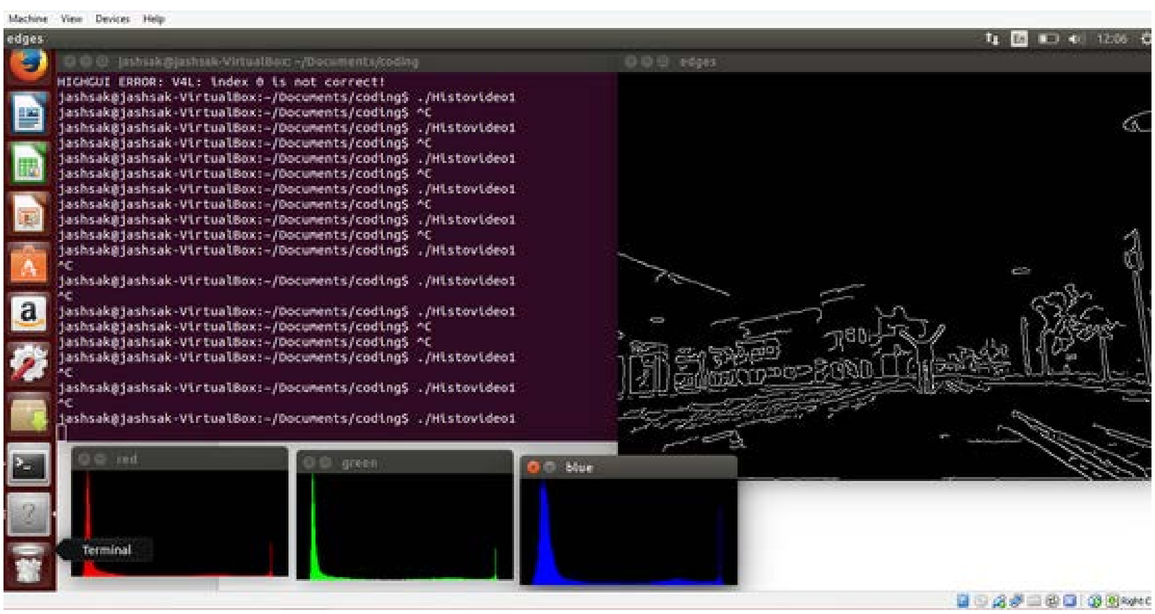


Figure 4.12: Object is 15m away from camera.

When the object is 5m away, the edge of the object can be clearly seen. The object’s edge started to become smaller when the distance is 10m away. When the object reached 15m long from the camera, the edges of the object is smaller and the image mixed into the environment and cannot be easily detected.

4.5 MOTION DETECTION WITH HISTOGRAM

4.5.1 Pre-recorded video

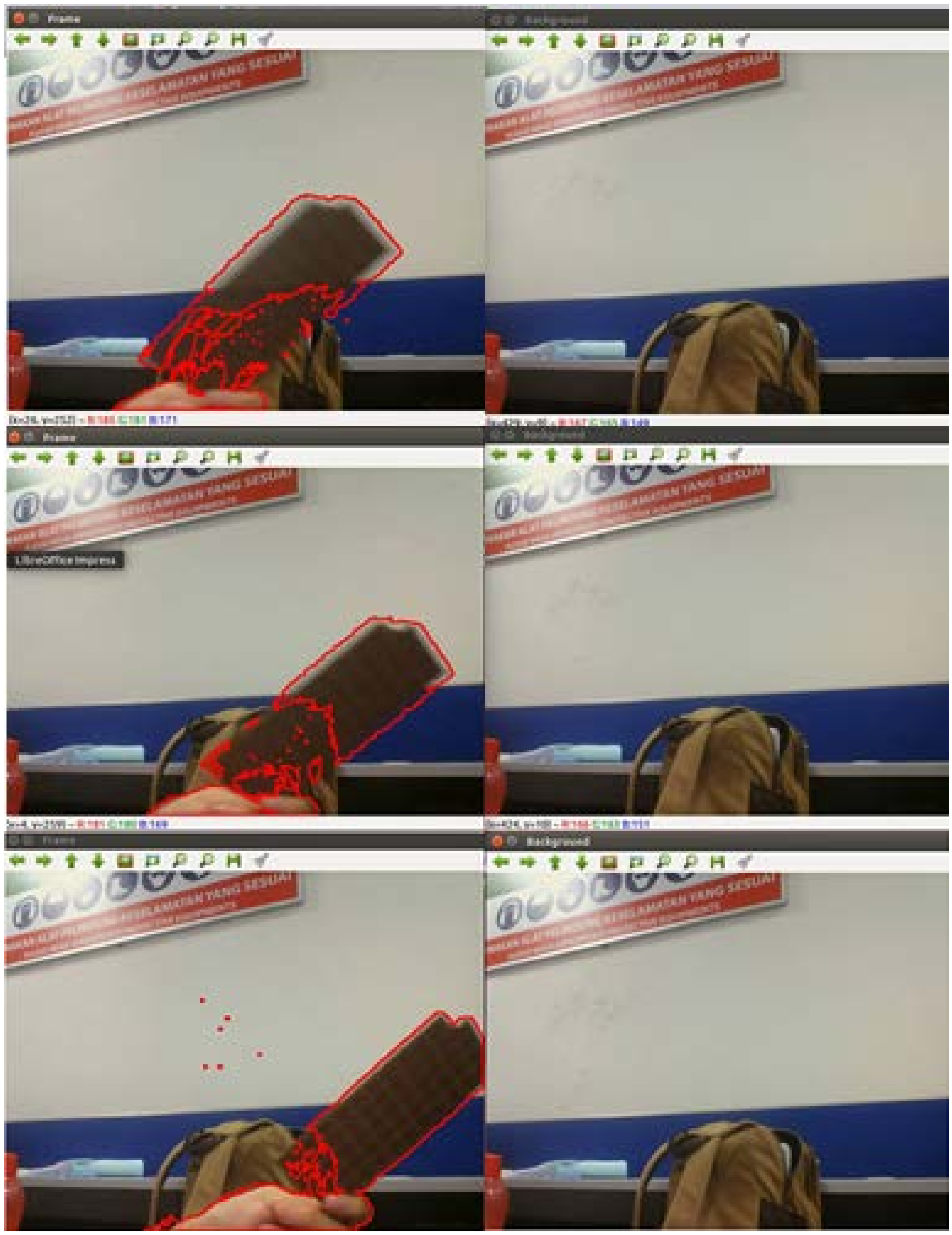


Figure 4.13: Right columns of image are foreground images while the left columns of image are background images.

The motion detection function is to detect the moving object in the pre-recorded source video. In this function, the background subtraction method is used detect the background frame which are the right column of pictures. The background frame will keep updating with foreground frame. The background image created is used to compare with foreground image. If there are different in light intensity, the red contour will be drawn out. It means that after the foreground frames subtract the background frames, the differences will be retrieved as a matrix containing points of coordinates and the coordinates will be drawn out using a red colour function. The background image might be very blurry, as it contains the average background statistics. In order to produce a clear background, the camera should be mounted or put at static condition.

4.5.2 Live stream video

The concept used is same as above but the video source input is different which is from live stream video.

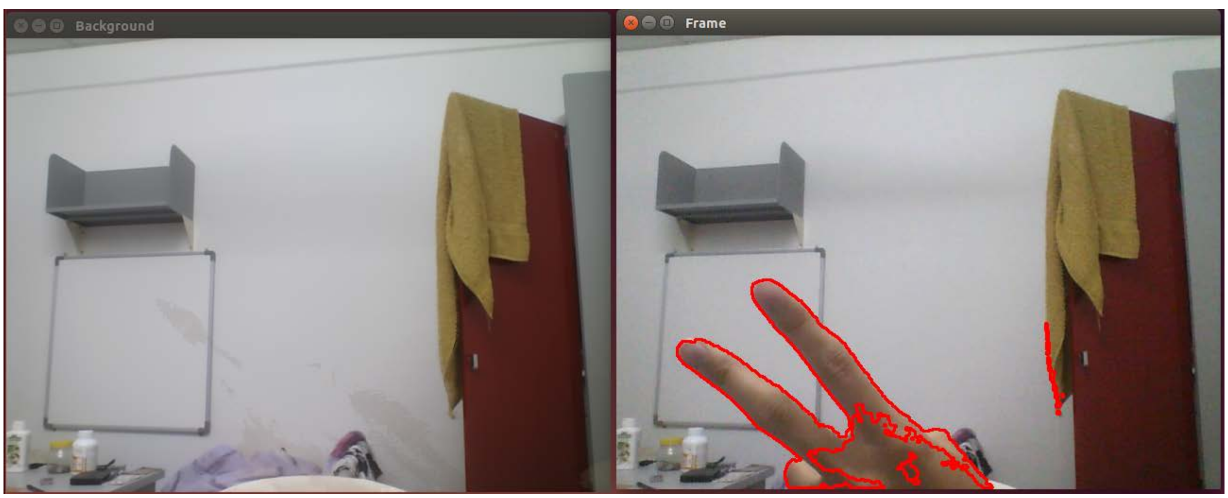


Figure 4.14: Motion detection from a live stream video.

If the hand is not moving for a while, the red contour around the hand will disappear as the background frame is updated. The red contour at the towel has shown that a little movement is detected when the fan is blowing down and make the towel is moving.

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

In this thesis, the research aim at using a USB connected camera to detect intruders at indoor and outdoor condition is presented by implementing the use of image processing technique which is OpenCV motion detection technique. Firstly, the histogram of picture input is generated by OpenCV. Secondly, the edge detection technique is used to determine the parameters which are minimum light source needed and the maximum detection range of the camera for the moving objects through the designed experiments.

The three objectives stated in the introduction are achieved and the results are considered as successful. The motion detection module is introduced as it is simple to understand and easy to implement in the development of the surveillance system at night.

5.2 FUTURE WORK

The device has its limits that restricted by few factors such as environment and user's set up. Although the current system can detect the moving objects, but the development of the system is needed in order to optimize the device parameters or recognise the unusual behaviour of human such as fighting, vandalism or violence action. The system might be upgraded as wireless intruder detection system which use a wireless camera attached to an Unmanned Aerial Vehicle (UAV) as it transfers the image from the camera to database through wireless connection.

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APPENDIX A1

PROGRAM CODE

```
#include "opencv2/core/core.hpp"
#include "opencv2/imgproc/imgproc.hpp"
#include "opencv2/video/background_segm.hpp"
#include "opencv2/highgui/highgui.hpp"
#include <stdio.h>

#include <iostream>
#include <vector>

using namespace std;
using namespace cv;

void showHistogram(Mat& img)
{
	int bins = 256;		// number of bins
	int nc = img.channels();	// number of channels

	vector<Mat> hist(nc);	// histogram arrays

	// Initalize histogram arrays
	for (int i = 0; i < hist.size(); i++)
		hist[i] = Mat::zeros(1, bins, CV_32SC1);

	// Calculate the histogram of the image
	for (int i = 0; i < img.rows; i++)
	{
		for (int j = 0; j < img.cols; j++)
		{
```

```
                for (int k = 0; k < nc; k++)
                {
                    uchar val = nc == 1 ? img.at<uchar>(i,j) :
img.at<Vec3b>(i,j)[k];
                    hist[k].at<int>(val) += 1;
                }
            }
        }

        // For each histogram arrays, obtain the maximum (peak) value
        // Needed to normalize the display later
        int hmax[3] = {0,0,0};
        for (int i = 0; i < nc; i++)
        {
            for (int j = 0; j < bins-1; j++)
                hmax[i] = hist[i].at<int>(j) > hmax[i] ? hist[i].at<int>(j) :
hmax[i];
        }

        const char* wname[3] = { "blue", "green", "red" };
        Scalar colors[3] = { Scalar(255,0,0), Scalar(0,255,0), Scalar(0,0,255) };

        vector<Mat> canvas(nc);

        // Display each histogram in a canvas
        for (int i = 0; i < nc; i++)
        {
            canvas[i] = Mat::ones(125, bins, CV_8UC3);

            for (int j = 0, rows = canvas[i].rows; j < bins-1; j++)
            {
```

```
                line(
                    canvas[i],
                    Point(j, rows),
                    Point(j, rows - (hist[i].at<int>(j) * rows/hmax[i])),
                    nc == 1 ? Scalar(200,200,200) : colors[i],
                    1, 8, 0
                );
            }

            imshow(nc == 1 ? "value" : wname[i], canvas[i]);
        }
}

int main(int, char**)
{

    VideoCapture cap;
    bool update_bg_model = true;

    cap.open(0);
    cv::BackgroundSubtractorMOG2 bg;//(100, 3, 0.3, 5);
    bg.set ("nmixtures", 3);
    std::vector < std::vector < cv::Point > >contours;

    cv::namedWindow ("Frame");
    cv::namedWindow ("Background");
    cv::namedWindow ("edges");



    Mat frame, fgmask, fgimg, backgroundImage, edges;
```

```
    for(;;)
    {
       cap >> frame;

       bg.operator()(frame, fgimg);
       bg.getBackgroundImage (backgroundImage);
       cv::erode (fgimg, fgimg, cv::Mat ());
       cv::dilate (fgimg, fgimg, cv::Mat ());

       cvtColor(frame, edges, CV_BGR2GRAY);
       GaussianBlur(edges, edges, Size(7,7), 1.5, 1.5);
       Canny(edges, edges, 0, 30, 3);

       //cv::findContours (fgimg, contours, CV_RETR_EXTERNAL,
CV_CHAIN_APPROX_NONE);
       //cv::drawContours (fgimg, contours, -1, cv::Scalar (0, 0, 255), 2);



       cv::imshow ("Frame", fgimg);
       cv::imshow ("Background", backgroundImage);
       cv::imshow ("edges",edges);

       showHistogram(frame);

       char k = (char)waitKey(30);
       if( k == 27 ) break;

    }

    return 0;
  }
```

APPENDIX B1

FINAL YEAR PROJECT 1 GANTT CHART

SEM 1 2014/2015

Task/Week	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Meeting Supervisor to Register title Brain storming	1														
Installation of Linux (Ubuntu) Adding OpenCV software	2														
Do basic OpenCV example	3														
Chapter 1: Introduction submission	4														
Study about histrogram in OpenCV and generate some example	5 & 6														
Chapter 2 : Literature Review submission	7 & 8														
Do video capturing coding in Ubuntu	9 & 10														
Chapter 3 : Methodology submission Car light testing with webcam	11 & 12														
Presentation of FYP	13														
Final Exam	14														

APPENDIX B2

FINAL YEAR PROJECT 2 GANTT CHART

SEM2 2014/2015

Task/Week	Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hardware assembly (testing camera in virtual box	1														
Interfacing with software and hardware (Install Ubuntu and camera driver)	2														
Conduct experiment 1 (dark room)	3														
Conduct experiment 2 (outdoor, corridor)	4														
Conduct experiment 3 (car light)	5 & 6														
Thesis writing (chapter 4)	7 & 8														
Completion of the project and thesis writing (chapter 5)	9 & 10														
Completion of thesis and draft poster	11 & 12														
Presentation of FYP	13														
FYP report	14														