

**WARNING SYSTEM FOR ETHIC OF VISITOR IN HOSPITAL ICU
USING VISION SYSTEM**

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**This thesis is submitted as partial fulfillment of the requirements for the award of
the Bachelor of Electrical Engineering (Hons.) (Electronics)**

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MAY, 2012

ABSTRACT

A warning system using vision system for ethic of visitor in hospital ICU (Intensive Care Unit) is developed. This system will enable the ICU's guard monitors the movement of visitor who entered patient's room at ICU without followed the correct order path. The order path that have been set where: area 1 was a door which the first area this system will detects the moving object, area 2 represented sink area and lastly area 3 represented the patient's room. To overcome this problem, currently this system will be trained to detect and track moving object in the observation scenes using static camera. This is done with the camera as a vision sensor and area of ICU room will be display. Then, it will sent data to the computer for the image processing process. Based on video processing using MATLAB software and applications, it consists of four main stages, namely: moving object detection and tracking, analysis of sum of pixels on the set area, interfacing with GUI (Graphical User Interface) and warning system activation. This system will notifies the ICU's guard in making sure that the visitor will follow the correct path before entering the patient's room.

ABSTRAK

Satu sistem amaran yang menggunakan sistem penglihatan untuk etika pelawat di Unit Rawatan Rapi dibangunkan. Sistem ini membolehkan pengawal keselamatan Unit Rawatan Rapi memantau pergerakan pelawat yang memasuki bilik pesakit di Unit Rawatan Rapi tanpa mengikut susunan laluan yang ditetapkan dimana: kawasan 1 adalah pintu, dimana kawasan pertama sistem ini akan mengesan objek yang bergerak kawasan 2 diwakili kawasan sinki dan akhir sekali adalah kawasan 3 iaitu mewakili bilik pesakit. Untuk mengatasi masalah ini, sistem ini dilatih untuk mengesan dan menjejal objek yang bergerak dalam tabir pemerhatian menggunakan kamera statik iaitu buat masa ini . Ini dilakukan dengan kamera sebagai sensor pemerhati dan kawasan Unit Rawatan Rapi akan menjadi paparan. Kemudian, ia akan menghantar data ke komputer untuk pemprosesan imej digital. Berdasarkan pemprosesan video menggunakan perisian dan aplikasi MATLAB, ia terdiri daripada 4 peringkat utama iaitu: pengesanan dan pengesanan objek yang bergerak, analisis daripada jumlah piksel pada kawasan yang ditetapkan, pengantaramukaan dengan GUI (Graphical User Interface) dan pengaktifan sistem amaran. Sistem ini akan membantu pengawal Unit Rawatan Rapi bagi memastikan bahawa pelawat Unit Rawatan Rapi akan mengikut laluan jalan yang betul sebelum melawat pesakit.

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CHAPTER 1

INTRODUCTION

This chapter explains the overview of project background, the problem of the project, the objectives of the project and project scope.

1.1 Project Background

Nowadays, vision system is commonly being used to enhanced surveillance and security, agriculture, medical imaging and automotive engineering as in field of engineering. As it popularity increasing in application such as vision based surveillance involves many of the core topics in computer vision area such as moving object detection and tracking,

An Intensive Care Unit (ICU) is a specialized department in hospital that provides intensive – care medicine. Usually, the infection that can be related to this unit is Nosocomial Infection. Patients who are hospitalized in ICUs are 5 to 10 times more likely to acquire Nosocomial infection than patients elsewhere in the hospital [5]. Nosocomial Infection can be prevent and control by having a proper handwashing. Hospital have sanitation protocols regarding uniforms, equipment sterilization, washing and other preventive measures. An effective infection control program includes a surveillance system, proper hand washing, appropriate patient isolation, prompt evaluation and intervention when an outbreak occurs, adherence to standard guidelines on disinfection and sterilization, and an occupational health program for health-care

providers [5]. As in all hospital around the world, they practise handwashing in prevention the Nosocomial infection. Although this practice seem to be easy, it is actually can adequately control the spread of Nosocomial infection.

Currently, in this project, the system consists of software development and hardware development. Software development was a construction of coding of image processing on the data acquired and construction of Graphical User Interface (GUI). This system will be trains to detect and track visitor using the application of image processing in MATLAB software which the visitor enters the ICU room presented in the observation scenes using static camera. In this study, in order to make sure that the visitor do their handwashing before visiting, a system with warning was developed to notify the security personnel about the visitor coming in. Basically, this system will detect and track visitor entering the ICU room and then make decision either the visitor follow the appointed area. The appointed areas are area 1 indicates the ICU's door, area 2 indicates the sink area and patient's room as area 3. This study consists of four cases been processed in order to make the system works properly. The decision is based on the 4 cases which in case A, the visitor follow the area 1 to the area 2 and then area 3, while in case B the visitor follow the area 1 and area 2 then go back to area 1. Meanwhile, case C, the visitor follow the area 1 only. Lastly for case D, the visitor follow the area 1 and pass through to area 3. Warning system consists of rotating light warning will be generate if false scene happen. Among the 4 cases, case A,B and C are true cases while case D is false case.

In part of hardware development, a warning system was constructed. It consists of rotating lamp as a warning indicator to the ICU personnel guard, BJT Switching circuit, Arduino UNO board as I/O port and power supply of 12V.

1.2 Problem Statement

In part of medical hand hygiene pertains to the hygiene practise by cleanse the hands of in order to minimize spreading of disease. Nosocomial infection commonly related to this hygiene practise which patients hospitalized in ICUs are highly exposed to this infection. As in all ICU, the visitor need to wash their hand first before visiting the patient. Sometimes, visitor of ICU become complacent and does not follow the correct hygiene by do not go to area 2 which is sink area first and cleans the hands before visiting.

1.3 Objectives of this study

The objectives of this project are :

- i. To detect and track moving object entering the ICU room using vision system which is camera as a vision sensor.
- ii. To develop a warning system which can identify either the false scene or true scene.
- iii. To display the result in Graphical User interface (GUI) system.

1.4 Project Scopes

To achieve the objectives of this project, application of image processing toolbox in MATLAB is used for moving object detection and tracking method as static camera as a vision sensor. The interfacing with hardware which is simple warning system will be the indicator after decision have been make. Therefore, the display result will be representing in Graphical User Interface (GUI) as associate to warning system.

1.5 Thesis Outline

The Warning System for Ethic of Visitor in Hospital ICU using Vision System final thesis is a combination of 5 chapters that contains and elaborates specific topics such as the Introduction, Literature Review, Methodology, Result and Discussion, and Conclusion. The detailed discussion about the thesis outline on each chapter is as below:

- Chapter 1: Introduction of the project. The explanation for the project will be given in a general term. The objectives of the project will be elaborated. It is followed by the explanation in the scope of project.
- Chapter 2: Literature review for this project will be elaborated in this chapter. Explanation will be focused on object detection and tracking technique related past researched and based on theory and conceptual ideas. Focusing on image processing research which is associate to this project.
- Chapter 3: Methodology of the project. This chapter discusses the full methodology of the overall project. Software development involved in image processing technique and development of Graphical User Interface (GUI) development while hardware development involved in warning system construction also be discussed.

Chapter 4: Results and Discussion. This chapter explains the results regarding the performance of the system such as thresholding value testing. Discussion also included in each results to affirmed the results.

Chapter 5: Conclusion. Conclusion of the project and some future recommendation for further development of this project are being discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

Like human eyesight, vision system has ranked its popularity higher in many field of engineering. There are four components of vision system which were: 1) hardware component which basically using a camera as a vision sensor, 2) computer or processors component, 3) image processing software component and 4) display component.

2.1 Hardware component

In application of surveillance and security, a commonly used type of camera was CCTV camera (Close Circuit Television). It is one of the greatest equipments of modern surveillance and security system nowadays. Surveillance place such as malls or stores crucial needed this equipment in monitoring the place so that security personnel can keep an eye on shoplifter, customers and employees. By using this security camera, anti-social activities such as theft, vandalism, shop-lifting, criminal actions and many more can be prevent. Instead being used in the malls or stores, CCTV also widely been installed outside house or office building. It helped the home owner or office building security personnel monitor and record the proceeding of their house and office even when they are not present. Traffic surveillance camera was been used in the monitoring traffic condition.

The first stage of any vision system is the image acquisition stage which included cameras, and its connection to the computer or processors [1]. Hardware component such as camera will be attached to the computer in acquiring data to be processed. After acquiring the data, it will transferred the data into a computer in a readable format which is digital format. JPG, GIF, TIFF, PNG, BMP are commonly digital image file types were used to encode digital images.

2.2 Software Component

Software component is where digital image will be processed and the desired objects from the image will be detected. Image represented in 3 common image formats ; 1) one-sample per point image, 2) three-sample per point image and 3) four-sample per point image. One-sample per point image is in 2-dimensional and only have one value for each pixel. The example of this format is image in binary representation and grayscale representation. Binary image consists of only two pixels value which are 1 or 0 and pixel value of 1 is signify with a black pixel meanwhile pixel value of 0 signify a white pixel. Grayscale image have pixel value range in 0 – 256 which 0 signify black to 256 signify to white. Three-sample per point represented the color image. Each pixel of the image consists of three values which are the red, green and blue pixels. Each plane of red, green and blue has level range from 0 – 256. Four – sample per point consists of four values in image. the examples of this format are CMYK, YRGB and RGBA image. CMYK signify with cyan, magenta, yellow and black and it is commonly the standard of printing. YRGB signify the yellow, red, green and blue and the example of this is in the application of Sharp's LCD color display technology meanwhile RGBA consists of red, green, blue and alpha. Alpha stands for opacity. To achieve the objective of the vision system, software like MATLAB can be used to process the image acquired. Image processing technique will be applied to achieve the goal of detecting an object in an image.

After the data were acquired and stored in the computer, software like MATLAB can be used to process the data. The software component is where the digital image will be processed and the desired object from the image will be detected. These components allow to pass information between MATLAB workspace and data acquisition hardware. The flow of acquired data consists of two independent steps: 1) data acquired from the hardware was stored in the engine, 2) data extracted from the engine and stored in the MATLAB workspace or output to a disk file. Outputting data means that data acquired is flowing to the hardware device. Two independent steps involved in flow of output data which are, 1) data from MATLAB workspace is queued in the engine and 2) data queued in the engine is output to the hardware.

2.3 Image processing

Pre-processing image is the step process before image processing. Some of the information or image acquired need to be pre-processed in order to make improvement and enhancement to the image. Enhancement of the image is crucial in making image more suitable for specific purpose. Image enhancement are including highlighting interesting detail in images, removing noise from image and making image more visually appealing [1]. Two broad categories of image enhancement technique are spatial domain techniques and frequency domain techniques. Spatial domain technique applied direct manipulation of image pixels. The advantage using the spatial domain technique are more efficient computationally and require less processing resources to implement. Frequency domain technique applied manipulation of Fourier transform or wavelet transform of an image. The basis of spatial domain technique is histogram processing. Histogram processing can be used to enhance the image beside massively used in image processing such as in image compression and image segmentation. Real-time image processing commonly used the histogram processing due to the easier to calculate in software and using an economic hardware. Application of histogram processing used in intensity transformation and histogram equalization. Some of the

fundamental of spatial filtering are neighborhood operations, spatial filtering, smoothing operations, the edges effects and correlation and convolution. Neighborhood operation is the basis of spatial filtering in an image where include in a few simple neighborhood operations such as min, max and median. Min set the pixel value to the minimum in the neighborhood, max set the pixel value to the maximum in the neighborhood meanwhile median value of set of numbers is the midpoint value in that set. Spatial filtering is an extension of neighborhood operations where some calculation will be done in the neighborhood pixels with the corresponding subimage. The simplest spatial filtering is smoothing spatial filters. This operation is simply taking the average all of the pixels in a neighborhood around a central value. It is very useful in removing noise from images and to highlight gross detailing an image. The edges effect can be solved by a few approaches which are omitting missing pixels in where normal neighborhood process is maintained at the edge. Secondly, pad the image with either at the edes normally with either all black pixels (0) and all white pixels (1). Last approached can be applied is replicate the border pixels with the same value. Involving several techniques which can be implemented are image filtering, image restoration and or color processing. The product of the data pre-processing will be the final data to be process in the next step. Image filtering is a conceptually simple, though powerful technique to extract image.

2.4 Vision System Application

One of the application in surveillance and security system is platform monitoring system for railway station safety in the study of Sechan Oh, Sunghuk Park and Changmu Lee [3]. This application used of CCTV (Closed Circuit TV) to prevent and monitor the safety accident in railway station. CCTV is installed at busy areas for monitoring and and controlling passenger's situation from CCR (Central Control Room) or local station.

This system has been developed a platform safety system as a government research and development project by the Korea Railroad Research Institute. Image processing technique was applied in this system which monitors almost entire length of the track line in the platform, and determines in real-time whether human or dangerous obstacles is in the preset monitoring. Several cameras have been attached to the station to conduct as a surveillance system in monitoring area whether human or dangerous object was fallen in the area or not. Besides that, the system provides station, CCR employees and train driver with the video information about the accident situation including alarm message.

The configuration of this system consists of information acquisition unit, fusion unit and information multicasting service unit. A series of process such as train detection, object detection, object recognition and object tracking were conducting by the detection processor. In the monitoring area, the information acquisition unit detects and perceives dangerous factors such as fallen passenger and disastrous fire. The fusion unit makes more intelligent and meaningful information by using inputted the monitored results from every single camera sensor for analyzing the situation. According to the results from situation analysis, it generates different alarm messages for local station and CCR employees and train driver. The information multicasting service unit provides different clients, such as local station employee, CCR employee and train driver with corresponding alarm message including SOP(standard operation procedure) with video information about the accident situation in order to deal promptly with emergencies.

Detection process in this system consists of two steps which are train detection and object or human detection and tracking. For every single camera in monitoring the area, it is important to find the accurate states to make the decision of dangerous factor for fallen object. Four train states have been decided for each detection camera. Firstly, OFF state which describe there is no train, IN state means train is approaching, ON state

means the train is arrived and stopped meanwhile OUT state means the train is pulling out. The procedures of train detection include the frame difference, labelling and merging and lastly train motion area detection. Frame differences step is the process of pixel by pixel subtraction between current frame and previous one. If the subtraction result of pixel exceeds the preset threshold value, the system regards the pixel as real motion. In object or human detection and tracking results of dangerous in platform monitoring area classified in two situations which is fallen object in the area and a sudden global change on the lightning conditions. Movement in monitoring area in OFF state will determine the fallen object by using backtracking method which tracks movements in previous frames. To track object, the system saves object movement information in previous frames and back tracks objects when object moves in OFF condition.

Another application of vision system is in a system for detection of object entering into prohibited area in surveillance video by Bin Yao and Ping Shi study [4]. This system is based on the moving object detection and tracking technology. Gaussian Mixture Model with background segmentation was used in moving detection while centroid-based method was used for motion tracking. Detection of object entering into prohibited area in surveillance video could be defined as the automatic detection of movement of a single or multiple objects and moving trajectory tracking. When a person enters or crosses the pre-set prohibited area, the alarm is generated. Detection of object entering into prohibited area has been widely used in various kinds of intelligent video surveillance products at home and abroad. It shows that this intelligent video analysis technology is based on computer vision can give the alarm and provide useful information using the fastest method, helping security staff to deal with the crisis more effectively, cut down false positive and false negative.

In designing and implemented this system, several stages involved like masking the prohibited area, object detection using the difference of the current image and the real-time updated background model and object tracking using centroid-based algorithm. There are three commonly used motion detection algorithms in the static

background: background subtraction, differential between adjacent frames and optical flow. Background subtraction method uses the difference of the current image and background image to detect moving regions. It is able to provide the most complete feature data generally, but it is sensitive to the dynamic scene changes such as light and external interference. Frame difference method extract the movement area of the image using the time difference based on pixels between the two or three adjacent frames in the continuous image sequence. It has strong adaptability for the dynamic environment, but it can't extract the characteristics pixels of all the relevant area in general, and the empty phenomenon may appear within the entity. Optical flow method uses the optical flow features of a moving object which changes over time. The advantage of this method is that it can detect the independent moving object at the premise of camera movement. Most optical flow calculation method is very complex and the anti-noise ability is very poor, so it can not apply to real-time full-frame video stream processing without specific hardware support. This system applied background subtraction as it is compatible in using fixed camera-specific application in video surveillance.

In this paper, it proposed to use a Gaussian Mixture Model in motion object detection as it is satisfactory for many applications. The advantages of this method is that when something is allowed to become part of the background, it does not destroy the existing model of the background. When the background model is obtained, the difference between the current image and background model is computed to detect moving region. The detect results must be processed with noise and morphological filters, and then the more accurate moving object is obtained. The task of moving object tracking is to monitor the spatial and temporal changes of the moving object in the video sequence, including the existence, location, size and shape of the moving object. It is equivalent to create corresponding matching between the continuous image frames based on position, velocity, shape, texture, color and other relevant characteristics. Moving object tracking is the basis of motion analysis and classification. There are a lot of researches dealing with tracking. These methods can be divided into two categories: the motion-based method and the model-based method. The motion-based method is faster relatively, but it has many difficulties in dealing with non-rigid object. The

model-based method uses the high-level semantic and knowledge, and it is more reliable.

A study of detection of objects including persons using image processing by Masao Takatoo, Chieko Onuma and Yoshiki Kobayashi [10] state that functions for detection of objects including persons are applied to surveillance for plants, public institutions can be summarized in detection of intruders where when someone enters a prohibited area, the system detects the intruder. Secondly in detection of left objects where the system detects objects which are left as they are for a longer time than a preselected time. Additionally, even if they are left for a shorter time than the preselected one, if they are left in a state where no one is there, the system detects the objects. Thirdly in detection of doubtful inanimate objects where when a person leaves a surveillance area after leaving an object in the area, whether some other people are present or not, the system detects the object as a doubtful inanimate object. Lastly, in a application of detection of doubtful persons satisfies at least one of the definitions given.

CHAPTER 3

METHODOLOGY

This study comprises two parts which are part 1 will be detailed in software development and part 2 will be the detailed in hardware development of warning system.

3.1 Part I : Software Development

This study will be using image processing main elements which are image acquisition, image pre-processing, image processing, feature extraction, object classification and classification decision as shown in Figure 3.1 for developing a warning system based on object detection and tracking.

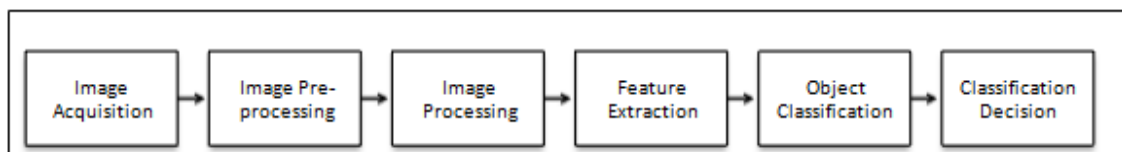


Figure 3.1: Image Processing Main Elements

Image acquisition step involves the hardware commonly used of camera and its connection to the computer or processors. Computer or processors will receive the image in digital format. Image pre-processing step is a step to improve and enhance the image for processing step. Image processing step is a further step in analysing the image to obtain desired object. A lot of image processing techniques can be used in this step such as morphological processing, edge detection and compression. Feature

extaction is where a set of desired features extracted from data pixels of the image which are good for classification. Obejct classification and classification decision are steps to make decision based on test and analysis done on the image [1]. For this paper, all steps are used to analyse the problem stated below:

1. Detection for moving object / visitor from one area to another area.
2. Tracking moving object from one area to another area.
3. Classification area between 'object detected' and 'no object detected'.

3.1.1 Image Acquisition / Data Acquisition

To work around this, a camera must be connected to computer in acquiring data. Figure 3.2 shown below is a camera used during this study.



Figure 3.2: SONY Handycam DCR-SR47 HDD

Key Specifications:

- 1/8" Advanced HAD™ CCD Imager
- 2.7" wide touch panel LCD display (123k pixels)
- Built-in zoom microphone
- Power On by opening LCD display
- USB 2.0 interface

The data is collected in 'MPG' format which will be converted later into 'AVI' format in order for data to be readable in MATLAB. The video resolution in MPG and AVI format is around 720x576. The average time of each data collected is in 10 seconds duration video to use as an input to the system. The video with 25 frames per second (fps). Data taken will be stored in database. However during collecting the data, a few parameters such as distance and height of the located camera is neglected. This kind of parameter is not needed because the main objective is to detect object entering ICU.

3.1.2 Basic Concept of Visitor Flow in ICU.

A scene likely a scene in ICU room were recorded using this camera in acquiring data. Offline database method means data already been recorded and process it later while real-time database method in the mean that time display it and do processing are in the same time. In this study, offline database method will be used instead of real-time database method, enables to play back these animation offline during the next process. As shown in Figure 3.3 below, an illustration in ICU room was illustrated.

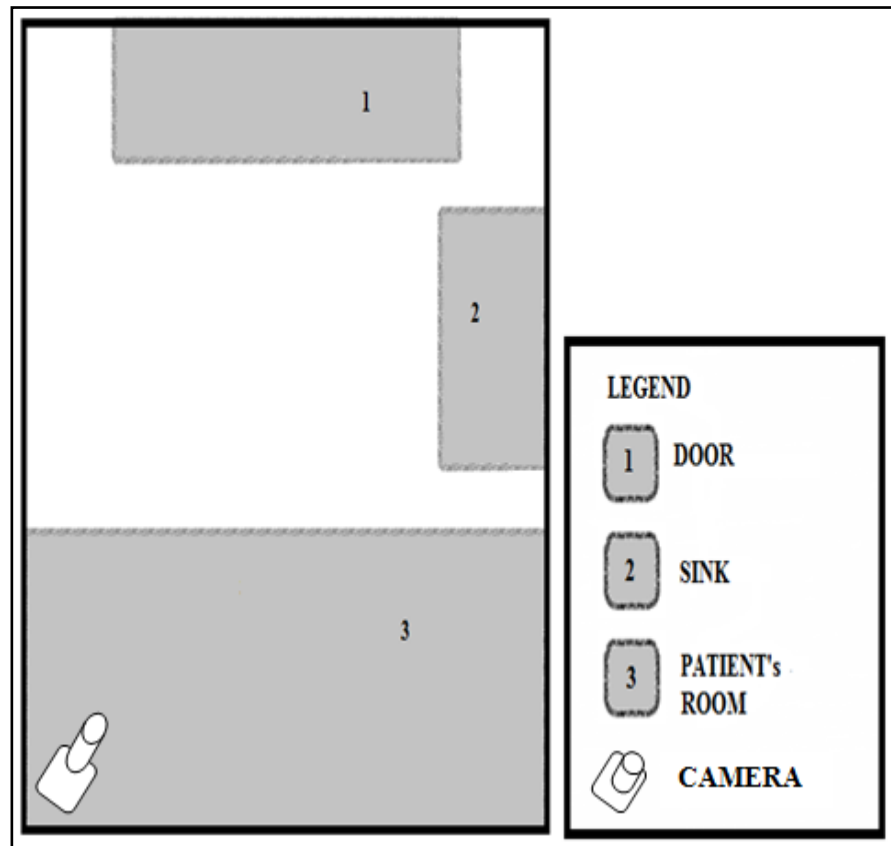


Figure 3.3: Illustration in ICU

The illustration in Figure 3.3 above, it is clearly shows that area 1 is ICU's door which is the first area the moving object will be detected. Second, area 2 indicates as sink area where this area is compulsory for the visitor to go wash their hands. Lastly, area 3 is patient's room where is the last place that visitor will go. The static camera was attached upper in the corner of left side of ICU. As in this study, some scene based on several cases were taken for data collection to be process.

CASE	FLOW OF VISITOR
A	1 - 2 - 3
B	1 - 2
C	1
D	1 - 3

Table 3.1 Flow of Visitor based on Some Cases

3.1.3 Image Pre-Processing

After obtaining video of several scenes in image acquisition step, data taken early will be pre-processed to change the video sequence into frame sequence using *mmreader*, *read* and *get* function. Basically, video is a reconstructing of sequence of still images representing in motion. *mmreader* function create a multimedia reader object. It will read in video data from a multimedia file. Next is *read* function which read in all video frames. As in previous step in data acquisition, the video is an $H \times W \times B \times F$ matrix where H is the image frame height, W is the image frame width, B is the number of bands in the image whivh in this study, the video read in RGB means 3 bands. Lastly, F is the number of frames read in. *get* function will get the object properties. The image yield will be in JPEG format and RGB format. JPEG stands for Joint Photographic Experts Group image compression standard. The output image in this process will be read in *uint8* value.

Next step in pre-processing is to change the RGB image into a format readable by MATLAB software. MATLAB cannot process image in RGB due to its image combination of three component of colour array where its represented by red, green and blue. Figure 3.4 shown below is reference image of ICU area in RGB format.



Figure 3.4: (a) Image of ICU Area in RGB format (b) Foreground image with object in RGB format

By using *imread* function, it will read image by string in specific folder which stored the image. *imread* can read any baseline JPEG image as well as JPEG image with some commonly used extensions. The output class of read image is in *uint8* value. Then, apply a *rgb2gray* function to convert the RGB image into 255 level gray-scales by eliminating the hue and saturation information while retaining the luminance. The output image is in *uint8* value. Figure 3.5 is the grayscale image after converting.



Figure 3.5: (a) Image of ICU Area in grayscale format (b) Foreground image with object in grayscale format