UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN OF SURGICAL LIGHTING SYSTEM USING IMAGE PROCESSING TECHNIQUE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation &Robotics) with Honours. The member of the supervisory is as follow:

……..

(PN SALEHA BINTI MOHAMAD SALEH)

ABSTRAK

Sistem pencahayaan pembedahan direka dengan tujuan untuk meningkatkan tapak dan process pembedahan, mengurangkan kos elektrik, dan meminumkan pengalih perhatian pakar bedah dari tapak pembedahan. Projek ini adalah kombinasi rekaan antara elektroknik, perisian dan mekanikal. Bagi bahagian elektronik, Arduino Mega dan Raspberry Pi telah digunakan dalam projeck ini. Raspberry Pi digunakan untuk pemprosesan imej, manakala Arduino adalah untuk mengawal motor stepper. Raspberry Pi akan menghantar isyarat kepada Arduino apabila ia menangkap objek yang berwarna biru dalam bingkai. Ketika Arduino menerima isyarat daripada Raspberry Pi, Arduino akan menghantar signal kepada pemandu motor L298N untuk memandu motor stepper. Motor stepper digunakan untuk mengerakkan lampu dari satu kedudukan ke posisi lain. Untuk bahagian perisian, program yang sesuai akan dimuat naik ke Arduino dan Raspberry Pi 3. Selepas itu, perkakasan dan perisian akan digabungkan bersama-sama. Akhirnya ialah rekaan mekanikal. Mekanisme H-bot telah digunakan dalam sistem percahayaan pembedahan.

ABSTRACT

The surgical lighting system is designed with the purposes to enhance the surgical site and process, reduce the cost of electricity, and minimize the distraction of a surgeon from the surgery site. This system is using an image processing technique. This project is a combination of electronic, software and mechanical design. For the electronic part, an Arduino Mega board and a Raspberry Pi board are used in this project. Raspberry Pi is used to do the image processing, while the Arduino is used for controlling the stepper motors. The Raspberry Pi will send out signals to the Arduino when it captured a blue coloured object in the frame. When Arduino received the signal from the Raspberry Pi, it will transmit the signal to the L298N motor driver in order to drive the stepper motor. The stepper motors are used to move the light and camera from one position to another position. For the software design, there are some suitable programs or coding will upload to Arduino Mega and Raspberry Pi 3. After that, combined the hardware and software together. At the end is mechanical design. H-bot mechanism is applied in the surgical lighting system. It is expected to move the light from one position to another position with the speed of 0.2083cm/s.

DEDICATION

To my beloved parents, I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout my life. Their sacrifice had inspired me from the day I learned how to read and write until what I have become now. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams.

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LIST OF ABBREVIATIONS

LA	Luminaires Action
IDE	Integrated Development Environment
CAD	Computer-Aided Design
DVT	Deep Vein Thrombosis
OpenCV	Open Source Computer Vision Library
RGB colour	Red-Green-Blue colour
I/O pins	Input / Output pins
GUI	Graphical User Interfaces
USB	Universal Serial Bus
VCI	Voice Control Interface
CSI	Camera Serial Interface

CHAPTER 1

INTRODUCTION

1.0 Introduction

The background, problem statement, objectives and scopes of this project will be discussed in this chapter. The background of the study is mainly talking about the medical procedure and surgery. However, the problem statement is conferred about what is the problem to cause this project is carried out. Besides that, the scopes of the projects are to ensure the objectives can be achieved.

1.1 Background of Study

The medical procedure is a process of an action aimed at achieving or resulting in the healthcare outcomes. There are several kinds of medical procedure, such as propaedeutic, diagnostic, therapeutic, surgical, anaesthesia, and so on. Surgical is a crucial and risky medical procedure. Some surgeries posed a higher risk due to the difficulty of the procedure, the significance of the organ and the body part which are going to operate.

Furthermore, there are several common risks that can occur during or after surgery. Firstly, blood clots usually are referred to as deep vein thrombosis (DVT) are a significant risk of surgery [1]. DVT can be caused by the inactivity during recovery or it may start at the area of surgery. Besides that, skin is a natural barrier to protect the human body, therefore infection can take place at any time when the skin is opened. Even though surgery is done in a very clean environment, but surgical incision had created a major chance of infection to invade the body. Furthermore, the injury will also be caused during

surgery. In the process of surgery, damage to parts of the body can take places. For an instance, a patient who underwent the surgical removal of the appendix may cause an accident injury on the intestine, which is attached to the appendix. This damage may be discovered during surgery and repaired immediately, or problems may arise during rehabilitation when medical personnel detects problems. Moreover, surgery can cause paralysis. It is one of the most critical complications in the surgical procedure. Although it is very uncommon, it can occur during surgery, especially for the surgical procedure which related to the brain and spine. The percentage of paralyzed after surgery may be greater. It depends on the type and position of surgery.

Since the surgical procedure is critical and it bringing large effect to the human being who is going to be operated, therefore the operation room should have a better environment which can reduce the distraction and increase the efficiency of the surgeon. Figure 1.1 shows an example of the environment in a surgical room.

Figure 1.1: Surgical Room

1.2 Problem Statement

Operation light is a medical equipment which is to assist the surgeon during surgery by providing a consistent light beam in a specific region and do not project any shadows. Surgery is a crucial and significant medical treatment procedure for a human being subjected to. Therefore, an optimum luminance must be there at any time during the surgery. Figure 1.1 shows the statistic of luminaires action (LA) performance in different phase during surgery. According to Moojiweer.R (2011), it found the rate of repositioning of the lighting system is high and it is cumbersome during surgery especially at the operation phase is the highest [2]. Even though electric motors are provided to ease the adjustment of the light, but the sometimes the position of the light is not accurate and not achieve the requirement or need of the surgeon. Therefore, the surgeon needs to operate the light by releasing one hand from the operation area. Even if the illumination system is controlled by the nurse, there will have a communication between surgeon and nurse has to be done to locate the light. This two method have disadvantages which are the surgeon may be distracted and lost his or her focus from the operation.

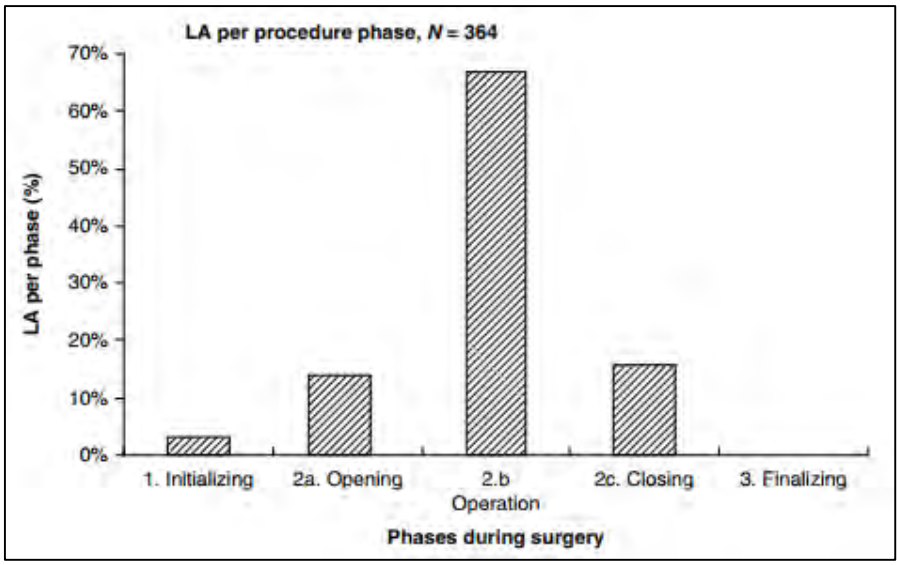

Figure 1.2: LA Performance in Different Phase during Surgery [2]

1.3 Objective

In this study, there are a few objectives that will be achieved:

i. To design an automation surgical lighting system by following the hand movement of the surgeon

ii. To develop an algorithm for automation surgical lighting system by using image processing techniques

iii. To test and analyse the performance of the system in term of light intensity

1.4 Scope

In order to achieve the objectives of the project, there are several important criteria that need to consider:

i. SolidWorks will be used to design the surgical lighting system.

ii. OpenCV (Open Source Computer Vision Library) will be used as the library for image processing.

iii. The colour tracking will only be focused.

iv. The system is operated on a specific area (rail) only.

v. The specific colour (blue colour) of the glove is detected and the colour is not present in the surrounding area of the system.

vi. The light specification, types of surgery and environment condition of surgery is not the main focus of this project.

vii. The light intensity of the environment is assumed constant.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, the theory and numerous information which related to this project title will be discussed. Furthermore, the methods used by previous researches will also be reviewed and some analysis about it will be done.

2.1 Theory

2.1.1 Surgical Light

Surgical light is a medical equipment that used during a surgical procedure. It is used to assist the surgeon by providing a high luminance to a specific area. A good surgical light should be not projected shadow to the area which is operating by the surgeon. Based on the World Health Organization (WHO), the surgical light designed to run for a period of time and do not emitting excessive heat. Surgical light can be classified by the type of the lamp, such as conventional (incandescent), and LED. It also can be classified by the installation configuration on, such as ceiling-mounted, on a floor stand, wall-mounted. Figure 2.1 shows an example of a surgical light. The type of the surgical light in the figure is LED ceiling-mounted surgical light.

Figure 2.1: Ceiling-Mounted Surgical Light

2.1.2 Image Processing

A tactic to transform an image into digital form and carry out several operations on it, so as to get an improved image or to pick up several valuable data from it is known as image processing. Nowadays, image processing has been growing in response to three major issue with the image:

(i) Image digitization and coding to make an easy transmission, printing, and storage of images;

(ii) Image enhancement and retrieval in order, for instance, the image of the surface of other planets captured by the different probe can more easily to understand or analyze;

(iii) Image segmentation and description as an early period of Machine Vision. [3]

Generally, there is three basic step in order to have done image processing. Firstly, using suitable equipment to capture and record images such as camera or laptops, or using equipment such as an optical scanner to import the image. Next, the captured image will be analyzing and manipulating, which consist of the