UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development Of Monitoring System In Operating Theater Using Arduino Ethernet Shield

This report submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

SYARIFUDDIN BIN NAZRI
B071410515
950912055119

FACULTY OF ENGINEERING TECHNOLOGY
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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree Of Bachelor of Electronics Engineering Technology (Telecommunications) With Honours. The member of the supervisory is as follow:

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(Project Supervisor)

ABSTRACT

This project was conducted purposely for monitoring the ambient temperature, relative humidity and pressure inside the operating theater. DHT 22 was used in the operating theater and it will act as temperature and humidity sensor. The temperature required inside the operating theater is in range between 15 ℃ - 27 ℃. For the relative humidity, the range required is between 30% - 60%. This relative humidity and temperature range will affect the rate of bacteria and fungus breeding. BMP 280 is used in this project to sense the differences pressure between the hospital corridor and inside the operating theater. The difference pressure inside the operating theater and the hospital corridor should be more than 15 %. This pressure difference is monitored to ensure that the contaminated air from outside will not enter the operating theater. This project will assist the operating theater team to decide either the operating theater is suitable to use for surgery or not.

DEDICATION

To my beloved parents, Mr. Nazri Bin Abdul Rahman and Mrs. Siti Rafiah Binti Ismail thanks for your moral support. Besides that, I would like to dedicate this project to my supervisor, Mr. Ir. Nik Azran Bin Ab Hadi that assists me develops this project. I also want to thanks to my lecturer and friends that help me to develop this project from the beginning to the end of this project session.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

%	-Percentage
°	-Degree
IDE	-Integrated Development Environment
OT	-Operation Theater
V	-Volt
Atm	-Atmospheric
DC	-Direct Current
LCD	-Liquid Crystal Display
Ft	-Feet
m	-meter
ASHRAE	-American Society of Heating, Refrigerating, and Air Conditioning
ACH	-Air Change Per Hour
ISO	-International Standard Organization
OTP	-One Time Programmable
USB	-Universal Serial Bus
UARTs	-Universal asynchronous receiver-transmitter
HVAC	-Heating, ventilation, and air conditioning
HEPA	-High efficiency particulate air
MERV	-Minimum Efficiency reporting Value
MAC	-Media Access Control
IP	-internet protocol
SPI	-Serial Peripheral Interface
TCP	-Transmission Control Protocol
UDP	-User Datagram Protoco
UV	-Ultraviolet
RH	-relative humidity

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter presents the overview for overall description for this project. Thus, it is including background of project, objective and scope. The organization of the report also state in this chapter for the preview of the report ahead.

1.1 Background

Operating theaters require special care in terms of temperature, humidity and pressure. This is because, any negligence of all these parameters will lead to some side effects. All of the parameters which are temperature, humidity and the pressure inside the operating theater need to be monitored and follow the specification assigned by the management of operating theater. Based on the Melhado (2006) journal, the humidity value in the operating theater need to be maintain in range between 30% - 60%. One of the main reason this requirement needs to be met because if the value of humidity is exceeding 60%, the chances of fungus and bacteria to grow in the operating theater will be much higher. If the percentage of humidity reaching a value of 60%, the bacteria already exists and fungus will occur. When the temperature is too low, it will lead to uncomfortable working environment which can affect the focus of the team. Besides that, the suitable temperature for working inside the operating theater is in range between 15℃ - 27℃. Other than that, if the temperature dramatically decreases or increases it can affect the patient. The low temperature can cause bacteria breeding while the temperature is too high can cause complication to post-operative patients. In the M.Loomans (2006) journal, the temperature in the

operating theater cannot be too cold because the patient can have hypothermia. Therefore, to prevent the hypothermia, the high ambient temperature in the operating room is recommended. Then, a monitoring system will be developed to view all of the parameters using LCD that will be placed outside the operating theaters and using a computer screen.

This system able to view the temperature, humidity and pressure inside the operating theater. Besides that, this system also can notify the status of the operating theater either it is ready and safe to be used for the surgery. By that point, this system also can help the management of operating theater to detect any damage happen in the operating theaters. Therefore, all of the surgery process held in the operating theaters went well.

1.2 Problem statement

In hospital, operating theater is an important facility. Currently, hospitals only use LCD (liquid crystal display) outside the operating theater to monitor the status and condition in the operating theater. Many hospitals do not have centralized system where a place can view the status and condition for all of the operating theaters. This project can help the management pf operating theater team to take an action earlier if any faulty occur such as air conditioner system is malfunction based on the specification. For emergency cases such as accident, doctors or surgeons need to use the operating theater as soon as possible. By developing this project, the in-charge team can make decision based on operating theater status and conditions displayed on the computer screen. Previously, the operating theater management team need to check manually the status and condition in the operating theater before the operating theater ready and can be used for any surgery. By using this system, it can automatically inform the operating theater management team either the operating theater is ready for any surgery or not.

1.3 Objectives

The objectives of this project are to:

a) To study the working principle for the Arduino Ethernet Shield, temperature & humidity sensor and pressure sensor.
b) To develop the monitoring system in the operating theater using Arduino Ethernet Shield.
c) To analyze the performance of the monitoring system.

1.4 Scope of Project

This research will cover on designing a monitoring system that can view the status of readiness for an operating theater. The parameters that will be taken for this project will be temperature, humidity and pressure inside the operating theater. The purpose of these parameters used in this research is to determine the status of the operating theater for the surgery. This research will be used an Arduino Uno board. This device will monitor all of the parameters and decide either the operating theater suitable to be used for a surgery or not. Next, this research will include the usage of Arduino Ethernet shield. This component will transfer all of the data from the monitoring system to a computer screen. The data transferred can be viewed on the computer screen by using windows based software. The windows software also can determine either the operating theater is ready for surgery usage or otherwise. By viewing the data on the computer screen, this system can assist the management of operating theater to identify or detect any faulty occurred in the operating theater.

1.5 Project Significance

It is expected to develop a system that can monitor and determine the status of the operating theater by using the Arduino Mega board. Other than that, this system will automatically function and will assist the person in-charge who will decide whether the operating room is ready or not based on the data. This project can give benefit towards the hospital team that can overcome any serious problem occurs.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

A literature review is a body of a text that aims to review the critical points of current knowledge for any related information so as to enhance the understanding of the concept and certain terminology which is used in the project.

2.1 Introduction of Operating Theater

Operating theater is a confined space where the surgery take place. In this limited space, many parameters need to be considered before the surgery can be conducted.

Figure 2.1: The Operating Theater

In the operating theater, there has a table and a chair at the center of the room. The team involve for a surgery are the surgeon and the assistant, which are hospital nurses.

Anyone who enter the operating room need to wear a sterile suite that provided by the hospital. For the surgeon, he or she will wear an apron to protect from the blood stains. There a few procedures have to be follow before a surgery can be carried out. For an example, the eye surgery has a few procedures need to be satisfy before a surgery can be carried out which are:

a) The surgery team need to prepare the patients correctly, with a cleaning of the face and the skin preparation around the eyes. The team also need to mark the eyes for the operation to avoid mistakes.
b) All of the instruments, drapes and the dressings should be sterilized. For an example, if an intraocular lens comes from the manufacturer in the sterile wrapping, then surgery team need to make sure that the packaging has not damage.

c) The handling of all instruments and dressings used should be in correct orientation.

The types of operating theater also divided into two categories, which are the standard operating room and the specialized operating rooms. The specialized operating theater can be used to carry out the operation of Neurosciences, Pediatrics (children and adolescents), Orthopedics (musculoskeletal system) and cardiac. The general operating theater can be used for the minor operations such as Ophthalmology. The general operating can be found in the district hospital.

When using the operating theater, there are many parameters need to consider seriously. This is because, in this room will involve with an individual life. Other than that, the surgical team and the patient comfort should be maintain during the surgery. So that, four parameters need to be considered before using the operating theater and while using the operating theater.

The parameters need to be considered are:

a) Airflow in the room and air conditioning system.
b) Microorganisms contains in the operating room.
c) Temperature and humidity needed.
d) Pressure inside the operation theater.

2.1.1 Airflow in the room and air-conditioning system

The airflow in the closed area such as operating theater is very important such as in operating theater. The airflow system in the operating room can affect the comfort level of both surgical team and patient. If the airflow is not structure in proper manner, many adverse effects can be occurred such as infection to patient wound after

the surgery. In order to prevent the worst situation, many types of airflow system had been implemented in the operating theater. From the Farhad Memarzadeh (2002), there are many types of airflow system that had been implemented in the operating theater as can be seen below.

Table 2.1: Type of Airflow System in the Operating Theater.

NO.	AIRFLOW SYSTEM	NOTES
1	Conventional	Air is supplied at high level (one side), exhausted at low level (two sides)
2	Laminar	Exhaust grilles are located at low level (two sides)
3	Laminar	Exhaust grilles are located on one side and high and low level
4	Laminar (mixed level exhausts)	Exhaust grilles are located on one side and high and low level
5	Laminar (low level exhausts)	Exhaust grilles are located on one side at low level
6	Laminar (high level exhausts)	Exhaust grilles are located on one side at high level
7	Unidirectional flow with curtains	Curtains on all four sides, 10ft x 12ft x 5ft (3.05m x 3.66m x 1.52m) high (extends to ceiling) Air is exhausted on one side at high and low levels
8	Upward displacement	Exhaust grilles are located on bottom of 1ft x 1ft x 2ft (0.3m x 0.3 m x 0.61 m) stubs
9	Non-aspirating diffusers	Air is exhausted at low level, 1ft (0.3m) from the floor
10	Low supply/ high exhausts	Air is supplied at low level (two side), exhausted at high level (two sides)
11	Goldman concept	Nozzle is provided via chimney and is located 5ft (1.52 m) above floor level. Air is exhausted at low level on two sides and a ceiling level immediately above patients.

Based on the table above, the operating theater had implemented many type of ventilation system to ensure the safety for the patients. What can be concluded based

on the table above, the ventilation or the airflow system in the operating room is update by days to ensure the safety of patients during and after the surgery. Based on the Europe standard CBZ, 2004 the recommended type of ventilation in the operating theater is the “laminar” down flow plenum with three shapes which are rectangles, T and octagonal. Figure below shown the pattern of airflow for the laminar down flow plenum. Based on the ASHRAE (2013), laminar airflow can reduce the residence time of larger particles in the air.

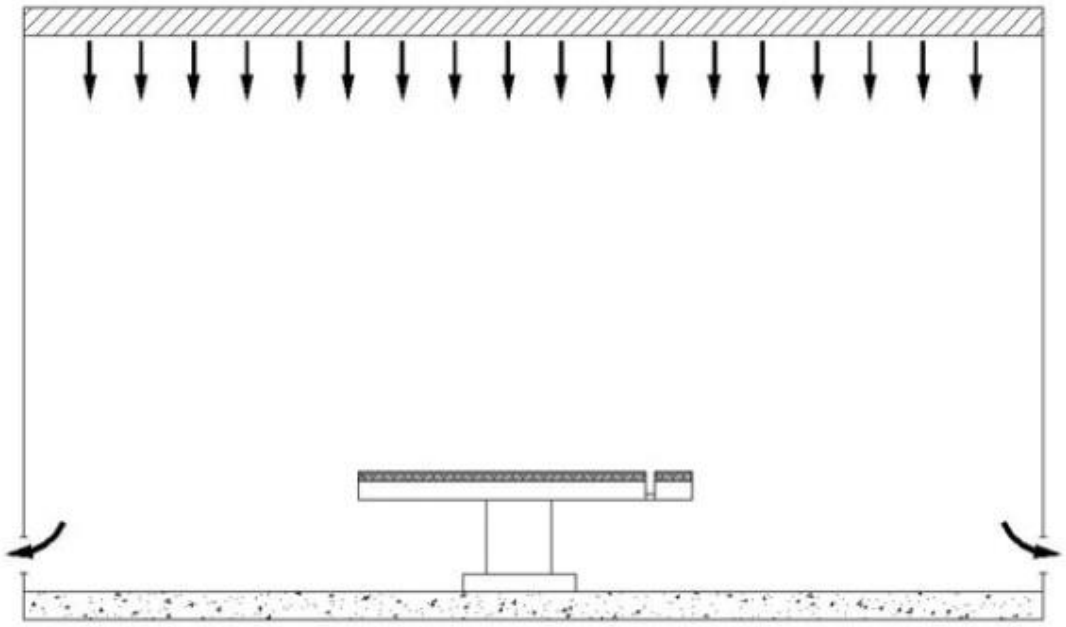

Figure 2.2: Laminar Air Flow System

Based on the Guidelines for Environmental Infection Control in Health Care Facilities Ventilation and air-conditioning system in the health-care facilities are designed to:

a) Maintain the indoor air temperature and humidity at comfortable levels of staff, patients and visitors.
b) Control odors.
c) Remove contaminated air.
d) Facilitate air handling requirements to protect susceptible staff and patients from airborne health-care-associated pathogens.
e) Minimize for transmission of airborne pathogens from infected patients.

Operating room is a critical area for the infection control, where a patient is opened to the surrounding environment while in an immune suppressed condition. The patients can be easily attack by the infectious agent that get into the room and the surgical site. The only method can be used to reduce the time and number of microbes to which a person exposed is by increasing the air change rate into the space. The table below provided by the CDC (2003) will be shown what is the effect of air change rate on the particles removal from the operating room.

Table: 2.2: Effect of Air Change to The Rate of Particle Removal

Air Changed Per Hour, Ach	Time Required for Removal Efficiency Of 99%, min	Time Required for Removal Efficiency 99.9%, min
2	138	207
4	69	104
6	46	69
8	35	52
10	28	41
12	23	35
15	18	28
20	14	21
50	6	8

Based on the table above, can be concluded that higher air changes rate in a closed space such as operating room the lower the time required for particles removal from the operating room. When increasing the value of air change rate, the power consumption will be increase. Too high air change rate will be result an uncomfortable situation for both patient and the surgical team. Based on the ASHRAE Standard 170 in 2008, the requirements of all these parameters in the table below need to follow by the hospital before build an operation theater.

Table 2.3: Standard Used in The Operation Theater

Space	Temperature, ℃	Relative humidity, %	Pressure
Class B and C operating room	20 - 24	30 - 60	Positive
Operating/surgical cystoscopic rooms	20 - 24	30 - 60	Positive
Delivery rooms(Caesarean)	20 - 24	30 - 60	Positive
Class A operating/procedure room	21 - 24	20 - 60	Positive