Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF HUMIDITY SENSOR USING OPTICAL LOOP FIBER FOR MEDICAL INDUSTRY

ABDULLAH RAZIN BIN MOHD SHARIF

Bachelor of Electronics Engineering Technology with Honours

2021

DEVELOPMENT OF HUMIDITY SENSOR USING OPTICAL LOOP FIBER FOR MEDICAL INDUSTRY

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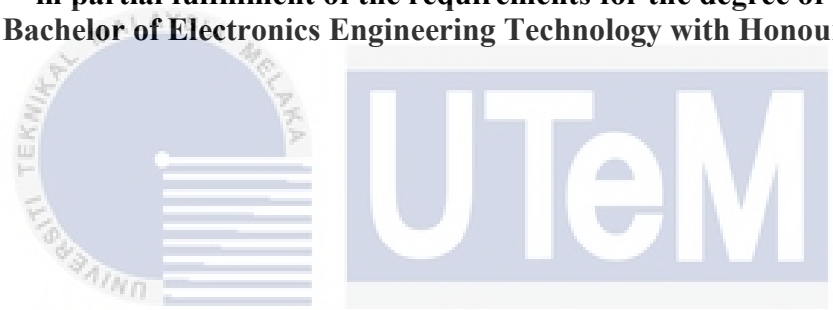
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
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Tajuk Projek: Development of Humidity Sensor using Optical Loop Fiber in Medical Industry

Sesi Pengajian : 1 2021/2022

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DEDICATION

To my beloved mother and father

To my kind lecturers

And not forgetting to all my friends

For their

Love, sacrifice, encouragement and best wishes

ABSTRACT

The accurate reading measurement of humidity is important for many sectors such as in medical industry. Compared with electronic sensors, fiber optic sensors have many advantages, and a lot of research has been done in this field in recent years. The development of optical structures for humidity determination and new materials for this purpose are analysed. This is a study to develop fiber optic humidity sensor. This fiber optic humidity sensor using loop fiber structure. It has been determined that air moisture and temperature are close related to humidity percentage level which is crucial for medical industry (especially for ventilator and drugs storage). Therefore, the prevalence of infectious disease in the air can be reduced by higher ventilation rates and storing the live-saving drugs in suitable condition of humidity.

ABSTRAK

Pengukuran kelembapan bacaan yang tepat penting bagi banyak sektor seperti dalam industri perubatan. Berbanding dengan sensor elektronik, sensor gentian optik mempunyai banyak kelebihan, dan banyak kajian telah dilakukan dalam bidang ini dalam beberapa tahun terakhir. Pembangunan struktur optik untuk penentuan kelembapan dan bahan baru untuk tujuan ini dianalisis. Ini adalah kajian untuk mengembangkan sensor kelembapan gentian optik. Sensor kelembapan gentian optik ini menggunakan struktur gentian gelung. Telah ditentukan bahawa kelembapan dan suhu udara sangat dekat dengan tahap peratusan kelembapan yang sangat penting untuk industri perubatan (terutama untuk penyimpanan ventilator dan ubat-ubatan). Oleh itu, prevalensi penyakit berjangkit di udara dapat dikurangkan dengan kadar pengudaraan yang lebih tinggi dan menyimpan ubat penyelamat dalam keadaan kelembapan yang sesuai.

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I am most grateful to my parents, Mohd Sharif bin Othman and Zaimah binti Yusof and my siblings for their love and prayers during my studies. Special thanks to my partner, Nurul Munirah for all her motivation and understanding.

I would also like to thank my friends who advise me from time to time and help me complete the project.

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δ	-	Voltage angle
	-	
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LIST OF ABBREVIATIONS

V	-	Voltage
	-	
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CHAPTER 1

INTRODUCTION

1.1 Background

Optical fiber often made by glass or plastic that is flexible and transparent fiber. Optical fibers are used most frequently as a method to transmit light between the two ends of the fiber and notice wide usage in fiber-optic communications, wherever they enable transmission over longer distances and at higher bandwidths than electrical cables. Fiber optic are regularly made up of two types, single mode fibers which are used for long distance and multimode fibers which are used for short distance purpose.

There are two types of optical fiber sensors that are intrinsic sensor that uses fiber optics as a sensor equipment and extrinsic sensor uses a method of transmitting signals from a remote sensor to the hardware that processes the signals. Fiber optic sensors are very suitable for critical environments such as noise, strong vibration, extreme heat, humidity and unstable environments. These fiber optics sensors suitable for small-scale area and set the position of the sensors precisely.

A light source produce spectrum that is reflected by objects that are recognized through human eyes and brain approach this signal, which yet implement human to see. In law of reflection, it determines the incident rays, reflected ray and normal remain in same plane. The angle of incidence is equal to angle of the reflection. In refraction, a light ray passes to one medium from another medium because of the differences in density between two substances. Snell's law of refraction defines the relationship between the angle of incidence to the angle of refraction.

This project is to develop fiber optic sensor for medical industry to detect the level of humidity in specific area. Besides, the purpose of this project is also to analyze the effect of fiber bending, where bending the cable will cause the light beam to disperse from the fiber optic and cause higher losses. The humidity sensor on the medical ventilator is useful for pumping warm and humid air to keep the patient comfortable. Plus, this humidity sensor can reduce costs and improve results without compromising quality of drugs in pharmaceuticals section.

1.2 Problem Statement

There are numerous kinds of fiber optic sensors that have been evolve for various type of utilization. In medical industry, development of sensors is important to aid patients. Medical industry has determined the air moisture and temperature as relative humidity becomes an important factor in finding comfort when using ventilator and humidity changes may have more serious consequences for inefficient drugs. Ventilation dilutes concentrations of viruses or bacteria in the air that can cause infectious diseases. Therefore, higher ventilation rates reduce the prevalence of infectious diseases in the air. So, throughout this project, optical fiber sensor is used to detect air moisture for room that use ventilator and can be useful in medical industry.

1.3 Project Objective

The major purpose of this project is to propose a efficient and adequate methodology to evaluate system wide humidity sensor using optical loop fiber distribution network with reasonable accuracy. The objectives are as follows:

a) To study the operation of Optical Loop Fiber.

b) To develop Fiber Optic Humidity sensor.

c) To analyze the performance of Humidity Sensor using Optical Loop Fiber with different level of humidity.

1.4 Scope of Project

The scope of this project are as follows:

a) Testing with different level of humidity.

b) Comparing fiber optic sensor with humidity sensor.

c) Using the same light source in the optical fiber.

d) Comparing the results of different level of humidity in different environment.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature search was carried out on the entire project and its implementation. The appearance and some documents used in this project are mentioned in this chapter. This chapter also explains all related research.

2.2 Fiber Optic

Fiber optics can be used as a medium for the telecommunications organization as it is adaptable and can be packaged as links. It is particularly beneficial for long distance calls as the light travels through the fiber with little fading compared to electrical connections. This allows long separations to be distributed with a pair of repeaters. Fiber optics also are used in communications, lighting, medicine, automation, optical research, and sensor manufacturing. As a small tube, glass fiber has many advantages, such as good flexibility, easy processing, large length, and immunity to electromagnetic fields.

Radiation-induced defect centers are formed by the ionization and displacement of atoms in the molecular bonding network of silica glass (SiO2), and the transmission characteristics of the optical fiber are strongly affected by the radiation environment.

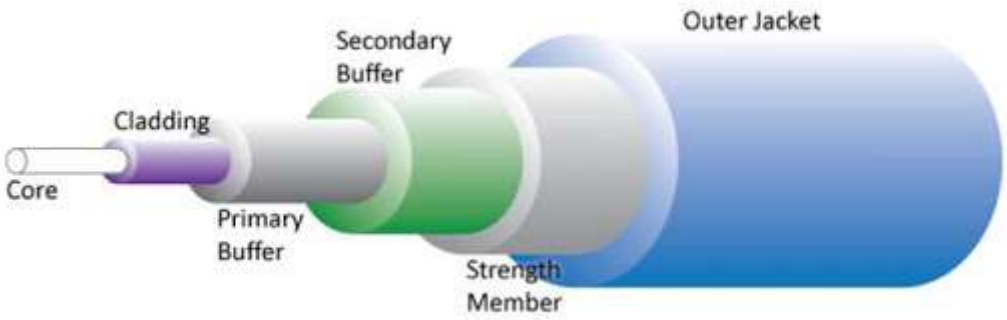

Figure 2.1: Structure of Fiber Optic

Optical fibers consist of core, cladding and external coating including primary buffer, secondary buffer, strength member and the outer jacket to protect and strengthen the fiber. There are two types of fiber optic that are single mode and multimode.

2.2.1 Single Mode

Single-mode fiber allows higher data throughput because it can maintain the accuracy of each flash during a long period of excursion, and there will be no dispersion caused by different modes. Some single-mode fibers and single-mode fiber components are in the hybrid optical path, such as flexible fibers for light sources, detectors, and single-mode fiber couplers. If the single mode fiber is bent, the core control transmission light in the single mode fiber and the whispering gallery light will interfere, thereby affecting the transmission light.

In Figure 2.3, the ultra-high numerical aperture single-mode fiber manufactured by Thorlabs of Germany has a nominal working wavelength range of 1100-1600nm, a numerical aperture of 0.28, and a nominal attenuation of less than 20dB/km.

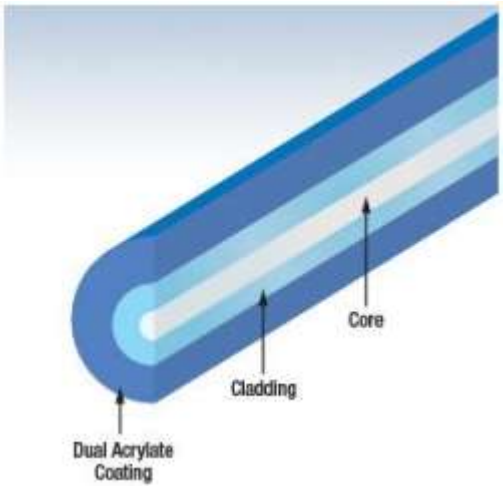

Figure 2.2: Ultra-high numerical apeture single-mode fiber

2.2.2 Multimode

Multimode optical fiber was first manufactured and popularized, simply referring to the way in which multiple modes or light beams simultaneously support each other through a waveguide. Multimode fibers with core sizes greater than 100 microns are usually used to collect enough scattered light in fiber optic spectroscopy systems. Optical fiber is a kind of optical fiber, mainly used for short-distance communication, such as buildings or underground.

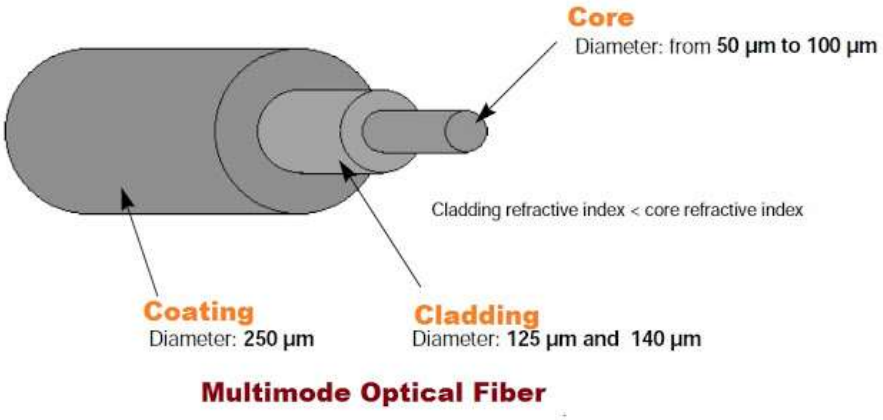

Figure 2.3: Multimode optical Fiber

The superposition of two or additional waves and their combination to create one single wave can be defined as multimode interference. The vertical coupling of multi-mode fibers encounters great difficulties due to mode conversion and is far from being applied. Figure 2.4 display the difference between single mode and multimode optical fiber.

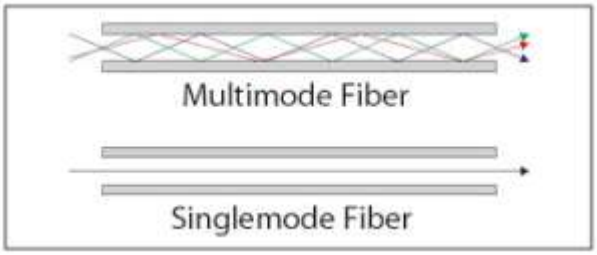

Figure 2.4: Difference between Multimode fiber and single mode fiber

2.3 Reflective and Refractive

In fiber optics, it uses the principle of total internal reflection to capture the transmitted light and to confine the light to the core of the fiber. The movement of light from one material to another changes its speed, causing the light to change its direction of movement. Refractive index measurement considered to be one of the key aspects of studying the physical, chemical and biological properties of materials. The intensity of light reflected from the surface is determined by the surface's texture and the distance between the surface and the light source. The refractive index of glass or other optical materials is a measure of the speed of light in the material, and changes in the refractive index will cause the light to bend. Snell's law states that the angle at which light reflects when propagating from one material to another depends on the refractive index of the two materials (core and cladding).