Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF OPTICAL MICROFIBER LOOP SENSOR FOR HUMIDITY APPLICATION

MUHAMMAD AFIQ IQBAL BIN FADZLI

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

2022

DEVELOPMENT OF OPTICAL MICROFIBER LOOP SENSOR FOR HUMIDITY APPLICATION

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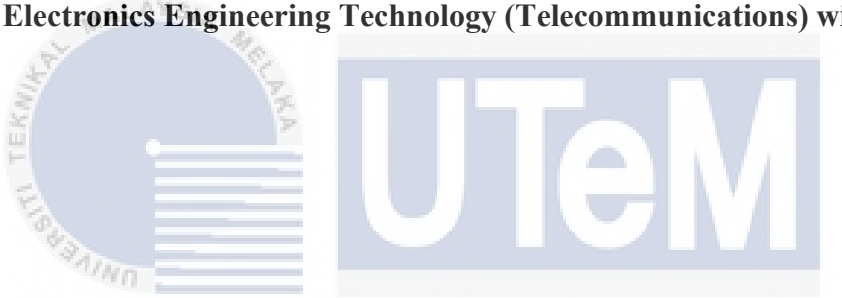
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Telecommunications) with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development of Optical Microfiber Loop Sensor for Humidity Application

Sesi Pengajian : 2022/2023

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I declare that this project report entitled “Development of Optical Microfiber Loop Sensor for Humidity Application” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Supervisor Name : DR. MD ASHADI BIN MD JOHARI

Date : 13/01/2023

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Co-Supervisor :

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Date :

DEDICATION

To my beloved mother, Zuyaidah Bt Abu Bakar, and father, Fadzli Bin Fadzli,
To my kind lecturers
And not forgetting to my loved
partner, Shazrah And all friends
for their
Love, sacrifice, encouragement, and best wishes
Along with all hardworking and respected Supervisor
Dr. Md Ashadi Bin Md Johari

ABSTRACT

Reliable humidity readings are critical in many industries, including the medical field. Fiber optic sensors have several advantages over electronic sensors, as well as much study has been done on this subject in recent years. The development of optical structures for humidity determination and the development of novel materials for this purpose are investigated. This is a research project to create a fiber optic humidity sensor. The loop fiber structure is used in this fiber optic humidity sensor. The relationship between air moisture and temperature and humidity percentage level has been discovered, which is important for the medical industry (especially for ventilator and drugs storage). As a result, more excellent ventilation rates and storing life-saving medications in the appropriate humidity conditions can lower the prevalence of infectious diseases in the air.

ABSTRAK

Bacaan kelembapan yang boleh dipercayai adalah kritikal dalam banyak industri, termasuk bidang perubatan. Penderia gentian optik mempunyai beberapa kelebihan berbanding penderia elektronik, serta banyak kajian telah dilakukan mengenai subjek ini dalam beberapa tahun kebelakangan ini. Pembangunan struktur optik untuk penentuan kelembapan dan pembangunan bahan baru untuk tujuan ini disiasat. Ini adalah projek penyelidikan untuk mencipta sensor kelembapan gentian optik. Struktur gentian gelung digunakan dalam sensor kelembapan gentian optik ini. Hubungan antara kelembapan udara dengan suhu dan tahap peratusan kelembapan telah ditemui, yang penting untuk industri perubatan (terutamanya untuk penyimpanan ventilator dan ubat). Akibatnya, kadar pengudaraan yang lebih tinggi dan menyimpan ubat yang menyelamatkan nyawa dalam keadaan kelembapan yang sesuai boleh mengurangkan kelaziman penyakit berjangkit di udara.

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Last but not least, I want to thank me, for believing in myself, for doing all this hard work, for having no days off, for never quitting, for just being me at all times.

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θc	-	Critical Angle
n_1	-	Refractive index of the medium around the fiber
n_2	-	Refractive index of the cladding
λ	-	Wavelength

LIST OF ABBREVIATIONS

dB	-	Decibels
µ	-	Micro
NA	-	Numerical Aperture
POF	-	Plastic Optic Fiber
FBG	-	Fiber Bragg Grating
SC	-	Standard Connector
UPC	-	Ultra Physical Contact
ASE	-	Amplified Spontaneous Emission
OTDR	-	Optical Time-Division Mirror

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CHAPTER 1

INTRODUCTION

1.1 Background

Optical microfiber is a flexible and transparent fibre made of glass or plastic. Optical microfibers are most employed to convey light between the fibre's two ends, and they are widely used in fibre-optic communications, where they allow transmission over longer distances and at higher bandwidths than electrical cables. Single-mode fibres, which are used for long-distance communication, and multimode fibres, which are used for short-distance communication, are the two types of fibre optics that are commonly utilized.

There are two types of optical fibre sensors extrinsic optical fibre sensors employ a method of delivering signals from a distant sensor to the hardware that analyses the data, whereas intrinsic optical fibre sensors use fibre optics as sensor equipment. Fibre optic sensors are appropriate for high-noise, high-vibration environments, as well as extreme heat, humidity, and inherently unstable environments [1]. These fibre optic sensors are perfect for small-scale applications and allowfor accurate sensor positioning.

A light source emits a spectrum that is reflected by things that are recognized by human eyes, and the brain responds to this signal, which is still used by humans to see. The law of reflection states that incident, reflected, and normal rays must all remain on the same plane. The incidence angle is the same as the reflection angle [4]. Because of the changes in density between two

substances, a light beam travels by refraction from one medium to another. The link between the angle of incidence and the angle of refraction is defined by Snell's law of refraction.

This project aims to create a microfiber optic sensor for use in the medical business to detect humidity levels in specified locations. The medical ventilator's humidity sensor is essential for pumping warm and humidified air to keep the patient comfortable. Furthermore, without compromising the quality of products in the pharmaceuticals department, this humidity sensor can save expenses and increase outcomes. Furthermore, this study aims to investigate the impact of fibre bending, in which bending the cable causes the light beam to spread from the fibre optic, resulting in more significant losses.

1.2 Problem Statement

In the medical industry, sensor development is crucial to patient care. The medical community has established that air moisture and temperature are critical components in achieving comfort when using a ventilator and that fluctuations in relative humidity can have more severe consequences for drugs that are not working. Infectious diseases are caused by diluting virus or bacteria concentrations in the air caused by ventilation. As a result, improved ventilation helps to keep infectious diseases at bay. As a result, optical fibre sensors are employed throughout this research to detect air moisture in ventilated rooms, which might be valuable in the medical field. Fibre optic sensors exist in several forms and sizes, and they are being designed for a wide range of uses.

1.3 Project objective

The main goal of this project is to develop an effective and appropriate approach for evaluating system-wide humidity sensors with satisfactory accuracy by utilizing an optical loop fibre distribution network. The objectives are as follows:

a) To study the operation of Optical Microfiber Loop.

b) To develop Microfiber Optic Loop sensor for Humidity.

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

1.4 Scope of Project

The scope of this project is as follow:

a) Testing with different level of humidity.

b) Using the different wavelength light source in the optical fibre.

c) Comparing the result of different level of humidity.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This part covered the entire project's literature review and the project development. Additional materials for this project, such as journals, articles, and books from prior works related to the project's topic, would serve as primary sources. This chapter will cover everything from the fundamentals to related research applications. This stage is necessary to grasp the concept of fibre optics and how they work before moving on to the next step, which is to develop a Microfiber Optic Sensor for humidity application.

2.2 Fibre Optic

Since it is versatile and may be bundled as connections, fibre optics can be employed as a medium for telecommunications organizations. It is beneficial for long-distance communications because, unlike electrical connections, a light goes through the fibre with minimal fading. A pair of repeaters can be used to spread lengthy separations. Communications, lighting, medicine, automation, optical research, and sensor manufacture are among areas where fibre optics are employed. Glass fibre offers some benefits as a tiny tube, including superior flexibility, ease of production, long length, and electromagnetic field immunity [1].

Ionization and displacement of atoms in the molecular bonding network of silica glass (SiO2) generate radiation-induced defect centres. The radiation environment has a significant impact on the transmission characteristics of the optical fibre.

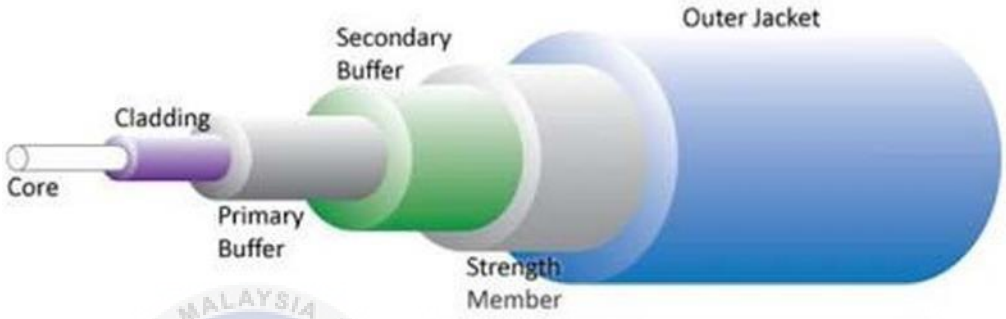

Figure 2.1: Structure of Fibre Optic [2]

Optical fibres include a core, cladding, and external coating that includes a primary buffer, secondary buffer, strength member, and outer jacket to protect and strengthen the fibre. Single mode fibre optics and multimode fibre optics are the two forms of fibre optics.

2.2.1 Single Mode

Flexible fibres for light sources, detectors, and single-mode fibre couplers are examples of single-mode fibres and single-mode fibre components found in the hybrid optical path. Because single mode fibre can maintain the accuracy of each flash over a long period of excursion with no dispersion from different modes, it provides for faster data throughput. The core control transmission light in the single-mode fibre and the whispering gallery light will interfere if the single-mode fibre is bent, causing the transmission light to be affected.