Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF OPTICAL MICROFIBER SENSOR FOR HUMIDITY DETECTION

ABDUL HAFIZ BIN AHMAD ZAINI

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
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Alamat Tetap: MT 1858 LORONG 29 TAMAN SRI AMAN 78300 MASJID TANAH MELAKA

DR. MD ASHADI BIN MD JOHARI
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektronik Dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik Dan Elektronik
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I declare that this project report entitled "Development of Optical Microfiber Sensor for Humidity Detection" 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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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

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Supervisor Name : DR MD ASHADI BIN MD JOHARI

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DEDICATION

Alhamdulillah, all praise to Allah.

I dedicate this report to my beloved parents, AHMAD ZAINI BIN OTHMAN and MAINMON BINTI ABU BAKAR, As well as my precious siblings,

And to all my families, friends, partner in crime,

And those who supported me along this long journey,

Cheers to their constant encouragement and endless, repetitive motivational rants.

ABSTRACT

This research describes the development of an effective optical microfiber sensor for humidity detection. As for the objective of this project is to study the operation and the performance of humidity sensor by using optical microfiber technology, to develop the humidity sensor using optical microfiber and testing its sensitivity and performance in several humidity level tests, and last but not least to analyze the performance of Humidity Sensor using optical microfiber in different environment and experiments. The technique of producing a new size of optical microfiber is through tapering or D-shape but in this it using tapering. Basically tapering is a firing the fiber until the size of fiber up to the smallest size before it going to broken. For this project, it managed to get to 7.8 um with different wavelength (1310nm and 1550nm) for testing. In this project, the sensitivity and linearity of the sensoring are the findings due to the comparison value of gradient and R^2 based on the graph from OTDR. From all the comparison results, we can know the best ideal of wavelength for sensoring. Hence, it shows that we managed to fulfilled the objectives.

ABSTRAK

Penyelidikan ini menerangkan pembangunan penderia mikrofiber optik yang berkesan untuk pengesanan kelembapan. Bagi objektif projek ini adalah untuk mengkaji operasi dan prestasi sensor kelembapan dengan menggunakan teknologi microfiber optik, untuk membangunkan sensor kelembapan menggunakan microfiber optik dan menguji kepekaan dan prestasinya dalam beberapa ujian tahap kelembapan, dan akhir sekali untuk menganalisis prestasi Penderia Kelembapan menggunakan mikrofiber optik dalam persekitaran dan eksperimen yang berbeza. Teknik menghasilkan saiz baru microfiber optik adalah melalui tirus atau bentuk D tetapi dalam ini menggunakan tirus. Pada asasnya tirus ialah penembakan gentian sehingga saiz gentian sehingga saiz terkecil sebelum ia pecah. Untuk projek ini, ia berjaya mencapai 7.8 um dengan panjang gelombang yang berbeza (1310nm dan 1550nm) untuk ujian. Dalam projek ini, sensitiviti dan lineariti penderiaan adalah dapatan kerana nilai perbandingan kecerunan dan R2 berdasarkan graf daripada OTDR. Daripada semua hasil perbandingan, kita boleh mengetahui panjang gelombang ideal terbaik untuk penderiaan. Oleh itu, ia menunjukkan bahawa kami berjaya mencapai objektif.

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δ	-	Voltage angle
λ	-	Wavelength
c	-	Speed of light
n	-	Cavity length
	-	
	-	
	-	
	-	

LIST OF ABBREVIATIONS

FBG	-	Fiber Bragg Grating
ORL	-	Optical Return Loss
ISAM	-	Indexed Sequential Access Method
LAN	-	Local Area Network
FSR	-	Free Spectral Range
IPA	-	Isopropyl Alchool
OTDR	-	Optical Time Domain Reflector
PMD	-	Polarization Mode Dipersion
COD	-	Coefficient of Determination
FOS	-	Fiber Optic Light Source

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CHAPTER 1

INTRODUCTION

1.1 Background

Optical microfiber is a data transmission mechanism that uses light pulses to convey information through a microfiber, which is often constructed of plastic or glass. Electromagnetic interference has no effect on optical microfibers since they are made of glass. In order to transmit signals, total internal reflection of light (TIR) is used in microfiber cable transmission. The microfibers, in conjunction with the optical microfiber, are meant to aid in the transmission of light, depending on the optical power source and transmission distance requirements. Long-distance transmission is accomplished via the use of single-mode microfiber, while short-distance transmission is accomplished through the use of multimode microfiber Compared to metal wires, microfiber optic claddings need greater protection because to the delicate and soft nature of the material used on the outside of the microfiber optic cable.

Microfiber optic sensors, which employ optical microfiber cables to detect objects correctly in a number of applications, are becoming more popular. An example of a sensing device that makes use of microfiber optic technology is a microfiber optic sensor, which monitors physical quantities such as temperature and humidity as well as pressure, strain, voltages, and acceleration. The term "intrinsic sensor" refers to a sensor that is built into the device itself. In the context of signal transmission between a distant sensor and an associated signal processing module, it is referred to as an optical microfiber transfer system (extrinsic sensor). Microfiber optic sensors are becoming more popular as the sensor of choice in a variety of industries due to its resistance to electromagnetic interference and ability to sustain very high temperature.

They have increased environmental sensitivity, arguably the highest resistance to electromagnetic interference, compact size, low weight, robustness, flexibility, and the capacity to offer multiplexed or scattered sense. They also have the potential to provide multiplexed or dispersed sense One of the most frequent sensors is a Fabry-Perot (FP) based optical sensor used as a sensing element, which is characterized by its high sensitivity, small size, and durability in harsh settings. When compared to the intensity demodulation method, the spectrum demodulation method is frequently more expensive or not fast enough to demodulate acoustic waves of high frequency or rapidly fluctuating pressure signals for high bandwidth applications requiring rapid response time. However, when compared to the intensity demodulation method, the spectrum demodulation method is frequently more expensive or not fast enough.

The goal of this project is to design and develop a humidity sensor for the medical market using optical microfiber technology. The optical microfibers have exceptional optical and mechanical qualities, including greater resistance to water and corrosion, resistance to electromagnetic interference and nuclear radiation, and the ability to work effectively in low-temperature environments, in addition to their high sensitivity. This project's major goal is to target the medical business in particular. In order to properly get the information of the patients without any environment interference, the medical industry standard mandates a better accuracy of measurement, as well as reduced interference in radio frequency (radiation).

1.2 Problem Statement

In the medical industry, product quality is held to a very high level. Because the technology and uses of optical microfibers in the medical sector have grown significantly in recent years, the need for an accurate and long-lasting sensors system has risen. To increase the quality of precise measurements, the typical electrical sensor equivalent must be replaced with a wireless and light weighted material with superior performance.

1.3 Project Objective

The goal of this project is to provide an efficient and acceptable method for evaluating humidity sensor use with high accuracy using an optical microfiber distribution network. There are several objectives that will be achieved in this study as shown below :-

a) To study the operation and the performance of humidity sensor by using optical microfiber technology.
b) To develop the humidity sensor using optical microfiber and testing its sensitivity and performance in several humidity level tests.
c) To analyze the performance of Humidity Sensor using optical microfiber in different environment and experiments.

1.4 Scope of Project

The scope of the project is specified as follows to prevent any confusion about the project owing to various limits and constraints:

a) Trying with variety level of humidity.

b) Analyze the microfiber optic sensor with humidity sensor.

c) Keep observing the same light source in the optical fiber.

d) Differentiate the output of all level humidity in different medium.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The fundamental concept of microfiber optics, as well as the microfiber optic sensor, are addressed in this chapter. The major sources for this project include previous efforts as well as supplementary resources such as journals, articles, and books related to the subject. Toward the end of this chapter, the theoretical underpinning and operation of microfiber optic sensors are described in depth. This chapter also summarizes all of the previous studies on the issue.

2.2 Microfiber Optic

Glass microfiber optics, which have a diameter about equal to the diameter of a human hair, are tiny strands of highly clean glass. Sending the light will messages over long distances while the optical microfibers been bundled together.

The jacket, which is the cable's outer covering, protects the bundles and is made up of three layers: buffer coating, cladding, and core. A plastic buffer coating is put to the microfiber to protect it from moisture and damage. The outer optical material that surrounds the core and reflects light into the core is referred to as cloaking. The thin glass center of the microfiber, through which light is transmitted and received, is the core of a microfiber optic cable.

Single-mode and multi-mode microfiber optics are the two forms of microfiber optics. The single-mode communication system has a smaller core and transmits infrared laser light across