Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF TEMPERATURE SENSOR USING OPTICAL FIBER FOR MEDICAL INDUSTRY

JANSEN MARSHAL JUSTINUS

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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JANSEN MARSHAL JUSTINUS

A project report submitted
in partial fulfillment of the requirements for the degree of
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Faculty of Electrical and Electronic Engineering Technology

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Sesi Pengajian: 2021/2022

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I declare that this project report entitled "Development of Temperature Sensor using Optical Fiber for Medical Industry" 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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Student Name : JANSEN MARSHAL JUSTINUS

Date : 11/01/2022

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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 Electronics Engineering Technology (Telecommunications) with Honours.

Signature : 

Supervisor Name : DR. MD ASHADI BIN MD JOHARI

Date : 1 March 2022

Signature :

Co-Supervisor :

Name (if any)

Date :

DEDICATION

To my beloved parents who have supported me,
My mother, Jopina Gijau, for her love,
encouragement, and prayer,
My father, Justinus Bagiu, for his love, guidance, and wisdom.
My dear friends, who have fought alongside me,
Providing laughter, company, and inspiration,
Also to the hard working and respected Supervisor
Dr. Md Ashadi bin Md Johari

ABSTRACT

Fiber optic sensor is currently one of the fastest growing technologies in modern day science. It is garnering interest from researchers because of the fiber characteristics that are highly valued. It is applied and used to sense physical and chemical properties such as micro – bending, strains, vibrations, accelerations, temperatures, pressures, etc. Fiber optic sensor trumps over other traditional sensor because of its low cost for manufacturing, fast response, high sensitivity, and immunity to electromagnetic interference. Fiber optic sensors is classified into various types based on the application and parameters needed to be sensed. With its distinctive and valuable application features, it is applied and used to facilitate a broad range of industries such as aerospace, transportation, biomedical etc. This paper will discuss the basic principle of a fiber optic sensor technology, and the types of fiber optic sensors.

ABSTRAK

Sensor gentian optik kini merupakan salah satu teknologi yang berkembang pesat dalam sains moden. Ini menarik perhatian dan minat para penyelidik disebabkan ciri-ciri eksklusif yang membuatkan teknologi ini sangat berharga. Ia digunakan untuk *sensing* sifat fizikal dan kimia seperti lenturan mikro, regangan, getaran, pecutan, suhu, tekanan, dll. Sensor gentian optik mengalahkan sensor tradisional lain kerana kos pembuatan yang rendah, tindak balas pantas, kepekaan tinggi, dan kekebalan terhadap gangguan elektromagnetik. Sensor gentian optik dapat diklasifikasikan ke dalam pelbagai jenis berdasarkan aplikasi dan sifat yang akan dirasakan. Dengan ciri aplikasi yang tersendiri dan berharga, aplikasi ini digunakan untuk memudahkan pelbagai industri seperti aeroangkasa, pengangkutan, bioperubatan dll. Makalah ini akan membincangkan prinsip asas teknologi sensor serat optik, dan jenis sensor serat optik .

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LIST OF ABBREVIATIONS

FOS	-	Fiber Optic Sensor
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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will cover the necessary introduction into this project, and will cover the background for the project title, the objectives that are laid out to achieve, the problems faced while developing this project, work scopes, and lastly an overview of the entire paper.

1.2 Background

Fiber optic is the referrence to the medium for transmission of information using pulses of light that travels along glass or plastic strands, and is converted into electrical signals at the destination. The transmission speed is incomparable to that of copper as it utilises the speed of light. There is no resistance present in glass compared to traditional metallic wires, therefore fidelity is maintained, with the exception of the travel distance, and the absorbed energy by the cladding. The security is tight and reliable and not easily susceptible to hacking because more knowledge and resources are required. Fiber optics has exceptional data transmission as it is able to send multiple pulses of light in a single strand of glass.

.The way that fiber optic sends information is using pulses of light, however light alone cannot travel great distances in a straight line without having major losses. Instead, the way that light travels in fiber optic cables is in a zig – zag motion, refracting off of the cladding. The zig – zag motion, or the refracting of the light is called total internal reflection, where the light is refracted and reflected forward and propagates within the glass, and for such a phenomenon to occur, engineers utilised what is known as the refractive index. For total internal reaction to be possible, two conditions must be fulfilled; the incident angle hitting the cladding must be greater than the critical angle, and the refractive index of the cladding is lower than the glass, thus bending the light and reflecting the light to stay internally instead of passing through the cladding.

A device that physically detects, measures, or reacts to any sort of stimuli depending on what information is needed to be recorded for, is called a sensor. Fiber optic sensors uses the fiber itself as a sensing element, and is a preferred use due to its highly versatile nature. It is sturdy and robust, while being resistant towards external distortion such as noise, making it suitable for use in environments with extreme conditions such as heat and vibrations. It is also towards electromagnetic interference, making it highly reliable. Fiber optic sensors can reach places that are difficult for traditional sensors, such as the human body to record temperature of tissues because of its miniscule size, and tight spaces due to its flexibility.

This project is to develop and analyze the performance of the fiber optic sensor to detect changes in temperature. This technology is beneficial and applicable to other fields due its property that is immune to RF and microwave radiation paired with its high sensitivity. The purpose of this project is specifically aimed at the medical industry that requires targeted sensitive reading of a patient's temperature wherever in the body due to their small dimensions, while resisting radiation that are present in large hospitals such as MRI machines. This is not limited for patients, but is also applicable in synthesizing medicine where temperature control is crucial.

1.3 Problem Statement

Since the beginning when medicine was being practiced, the medical industry has observed body temperature as one of the first diagnostic procedure to determine the patients condition, as the first step in determining wether a more serious case has developed in the patient. In more specific cases, such as hyperthermia which is a type of cancer treatment, where temperature is increased and focused at the tumor area to kill off harmful cells. Without proper equipment that provides accurate reading to monitor, excessive damage can be done to the surrounding tissue area resulting in an increase of problems. In the case of synthesizing medicine, temperature control is one of the main variables that influences the outcome of a successful synthesis. No proper equiment means no accurate control, leads to higher chance of failing production.

1.4 Project Objective

There are several objectives that is to be achieved by the end of this project, which is as follows:

a) To study the operation of the Fiber Optic in liquid.

b) To develop Fiber Optic Sensor in different concentration of Sodium Hypochclorite.

c) To analyze the perfomance of the Fiber Optic Sensor in Sodium Hypochlorite detection.

1.5 Report Overview

Chapter 2 will be "***Literature Review***", there will be several types of literature related to the project to be explored. Literature relevant to fiber optic will be studied and information will be extracted. Then literatures about the reflective and refractive nature of fiber optic will be reviewed. Lastly literatures about the various types of fiber optic sensor will be investigated. After all relevant information is acquired, a summary can then be formed.

Chapter 3 will be the topic "***Methodology***" for this project. This chapter will explain on the fabrication of fiber optic sensor required to conduct experiment. Procedures that are essential for the fabrication of fiber optic will include the stripping procedure, and splicing procedure, and flowchart of the project conducted. Finally, elaborating the procedure on how the testing will be conducted.

Chapter 4 will talk about the "***Results and discussion*** " of the project. Where the data obtained from experiment is analysed and discussed wether the readings of the data we got accurate or not.

Lastly is chapter 5 that will be "***Conclusion****",* this chapter will conclude the report and summarise wether the project objective is achieved or not

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will be discussing any information pertaining to the project. Past published papers, articles, books will be studied to further strengthen and improve upon the project that is being developed. This chapter will also explore the basic structure of the main component for this project which is the fiber optic.

2.2 Fiber optic

Fiber optic is the medium of transmission of information by way of propagating pulses of light through a dielectric fiber core constructed from either glass or plastic material, that is surrounded by another layer of glass or plastic called the cladding, that has a lower refractive index, n, compared to the core. The difference in refractive index is one of the two conditions to enable the phenomenon called *Total Internal Reflection* where the propagating light stays within the core completely, while the other condition is when the incident angle of the light hitting the surface of the core. The light reflected at the interface changes and is highly dependent on the incident angle of the light coupled with the refraction indexes of the core and cladding. The Figure 2.1 below demonstrates the propagation of light in the fiber optic cable by means of total internal reflection.

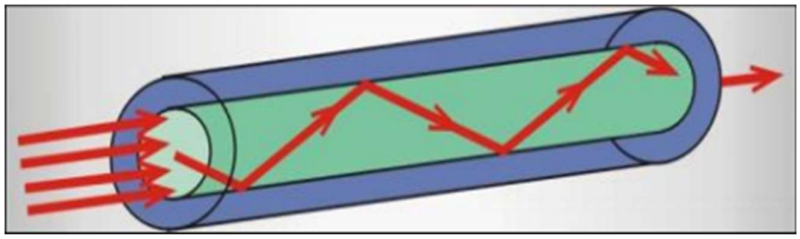

Figure 2.1: Propagation of light in a fiber optic

Fiber optics is an imperative component used in todays communication systems for achieving high speed data transmission, as well in many fiber optics based measurement setups[1]. The following Figure 2.2 displays the basic structure of a fiber optic cable that constitutes the central core, cladding, and an external coating for protecting the insides and overall strengthens the fiber.

Figure 2.2: Basic structure of an optical Fiber

The core is constructed from glass or plastic material and is dielectric, with its center hollowed out allowng better transmission of the light, where it propagates freely with a miniscule amount of loss. The core is surrounded by another layer of material called the cladding that is also manufactured from glass or plastic and is vital to the operation of the fiber. It is made from dielectric material and has an index refraction lower than that of the core, and performs the following functions: