UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF FIBER OPTIC SENSOR IN DETECTING THE CONDITION OF SUNFLOWER OIL FOR FOOD INDUSTRY USAGE BY USING FACTORIAL DESIGN

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

by

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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 degree of Bachelor of Electronic Engineering (Telecommunication) with Honours. The member of the supervisory is as follow:

.....

(Project Supervisor)

ABSTRAK

Sensor optik gentian optik telah menjadi salah satu teknologi paling berpengaruh dalam komunikasi kejuruteraan terkini. Kabel optik gentian telah dapat menghantar banyak penghantaran data pada satu masa, yang membawa kepada penggunaan dalam bidang komunikasi lain. Mereka mempunyai keupayaan untuk membawa maklumat yang hebat, kos rendah, dan komunikasi tanpa wayar. Lebih-lebih lagi, sifat optik sensor optik untuk beroperasi tidak cukup dikenalpasti. Oleh itu, kajian ini bertujuan untuk mengkaji pengoptimuman kuasa keluaran sebagai pengesan keadaan minyak bunga matahari. Minyak bunga matahari yang digunakan sekali, dua kali dan tiga kali dengan dimensi yang berbeza direka bentuk melalui perisian Pakar Reka Bentuk (DOE). Kesan sifat yang jenis serat, jenis sumber cahaya, dan masa mencelup telah disiasat untuk mendapatkan keluaran terbaik sebagai tindak balas. Bahagian analisis dijalankan dengan mengkaji kesan sifat dengan menggunakan 2^3 kaedah rekabentuk faktorial. Analisis oleh perisian Pakar Reka Bentuk (DOE) mengenal pasti bahawa penyelesaian optimum untuk minyak bunga matahari yang digunakan sekali ialah jenis serat adalah mod tunggal, jenis sumber cahaya ialah 1550nm, dan masa mencelupkan adalah 20 minit. Tetapan optimum ini dipilih untuk mempengaruhi sensor gentian optik untuk beroperasi dengan kuasa keluaran terbaik.

ABSTRACT

Optical fiber optic sensors have become one of the most influential technologies in recent engineering communications. The fiber-optic cables have come to be able to deliver large bundles of data transmission at a time, leading to use in other areas of communication. They have the capacity to carry great information, low cost, and wireless communication links. Moreover, the optimum nature of fiber optic sensors to operate is not sufficiently identified. Therefore, this study aims to investigate the optimization of the output power as the sunflower oil condition detectors. The sunflower oil used once, twice and three times with different dimensions was designed through Design Expert software. The effect of properties which are types of fiber, type of light source, and dipping time have been investigated to get the best output in response. The analysis section is carried out by studying the effect of properties by using 2^3 factorial design methods. Analysis by Design Expert software (DOE) identified that the optimum solution for once used sunflower oil is type of fiber is single mode, type of light source is 1550nm, and dipping time is 20 minutes. This optimum setting is selected to affect the fiber optic sensor to operate with the best output power.

DEDICATION

To my beloved parents

ACKNOWLEDGEMENT

Alhamdulillah, thank to Allah for His divinity and blessing. I have completed my final year project for Bachelor of Electronic Engineering (Telecommunication) with Honours successfully. I would like to thanks my lovely family for their encouragement and support. I also would like to thank my supervisor, Pn.Rahaini Binti Mohd Said, whose patience in supporting, helping and guiding me on my project. Thanks also to my friends and people that has helped me along the course of finishing this project. Thank you all.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ANOVA	-	Analysis of Variance
DH	-	Double Heterojunction
DOE	-	Design of Experiment
ILD	-	Injection Laser Diode
LED	-	Light Emitting Diode
LD	-	Light Source
MMF	-	Multimode Fiber
SMF	-	Single Mode Fiber
TIR	-	Total Internal Reflection

CHAPTER 1

INTRODUCTION

1.1 Introduction

Originally developed in the 1970s, optical fiber communication systems have revolutionized the telecommunications industry and played a leading role in the future of the Information Age. An optical fiber link is a system link containing glass filament pieces in a protected packing. Optical fiber has become one of the most influential technologies in recent engineering communications. The fiber optic cables have come to be able to deliver large bundles of data transmission at a time, leading to use in other areas of communication. Everywhere in the world this thin-haired fiber optic brings a lot of information from place to place. There are many optical properties required to carry this information. They have the capacity to carry great information, low cost, and have immunity from many disturbances that can generate electrical wires and wireless communication links. In addition, fibers are not affected by electromagnetic radiation disturbances that allow to transmit information and data with less noise and less error. This is evidence of fiber as the best medium of data transmission. In addition, fiber optic sensors are an instrument capable of developing optical fiber sensors in oil concentration determination. This research is for develop the fiber optic sensor. Therefore, this experiment is to study the best combination of optical sensors that optimize output power as sunflower oil detector. In addition, this paper will show about optimizing the fiber optic sensors to detect sunflower oil conditions for the food industry. Each oil concentration is different in every use of sunflower oil and has a different probability level. Sunflower oil is oil extracted from

sunflower seeds. The content of vitamin A in sunflower oil, is one of the most useful content. Its main use is in cooking, where the high point of smoke makes the oil of fine oil fry. Sunflower oils are used for a variety of purposes such as cooking oil, cosmetics manufacturing margarine and medicines. In general, sunflower oils have a balanced nutritional content, thus providing an important benefit to body health, especially in food production. Other industrial uses besides food industry include beauty and health products. However, this experiment is to analyze the sensitivity of optical fiber sensors to determine the concentration of sunflower oil that can be used for specific purposes as in the food industry. This examination may help other strategies to detect fluid focus for different scientists. The good ingredient behind this experiment is to identify optic fiber capabilities in concentration tracking. The end result of this experiment produces several different power outputs.

1.2 Problem Statement

Nowadays, most of the productions of food industry does not care about produce the healthy and nutritious diet, particularly in the usage of cooking oil. Cooking oil is one of the most important elements for human health in daily food intake. One of the oil used in food industry is sunflower oil which contains vitamins and good fats that are good for health. Until today, there are no an instruments can detect the conditions of sunflower oil. So, the aim of this study is to investigate the best combination of fiber optic sensors which optimize the output power as the sunflower oil condition detectors.

1.3 Objectives of Project

Based on the project 'Optimization of Fiber Optic Sensor in Detecting the Condition of Sunflower Oil for Food Industry by Using Factorial Design', here are some of the objectives that have been obtained:

i. To study and develop the Fiber Optic Sensor.
ii. To investigate the best combination of Fiber Optic Sensor which optimize the output power as the sunflower oil condition detectors.
iii. To establish mathematical model for fiber optic sensor as the sunflower oil condition detectors.

1.4 Project Scope

As a limit in a study, the scope of which has been set for this study to look at the oil viscosity by using a light source output power. In addition, to find the best combination of fiber optic which optimizes the output power for sunflower oil condition sensor in which an oil that has been used once, twice and three times.

CHAPTER 2

LITERATURE REVIEW

2.1 The Basic Principles of Fiber Optic Communication

Optical fiber communication is a communication technology that uses light pulses to transfer information from one point to another via optical fiber. Information that is sent is basically digital information generated by telephone systems, cable television companies, and computer systems. Optical fiber is a dielectric cylinder waveguide made from low loss materials. The waveguide nucleus has a refractive index slightly higher than the external medium (coating), so that the pulsation of light is guided along the fiber axis with total internal reflection (TIR). The optical fiber communication system consists of optical transmitters to convert electrical signals to optical signals for optical fiber transmission. A cable containing several bundles of optical fiber, optical amplifier to enhance optical signal power, and optical receiver retrieve the received optical signal back to the original electrical signal sent. Figure 2.1 shows basic fiber optic communications system. (Francis Idachaba, Dike U. Ike, and Orovwode Hope, 2014)

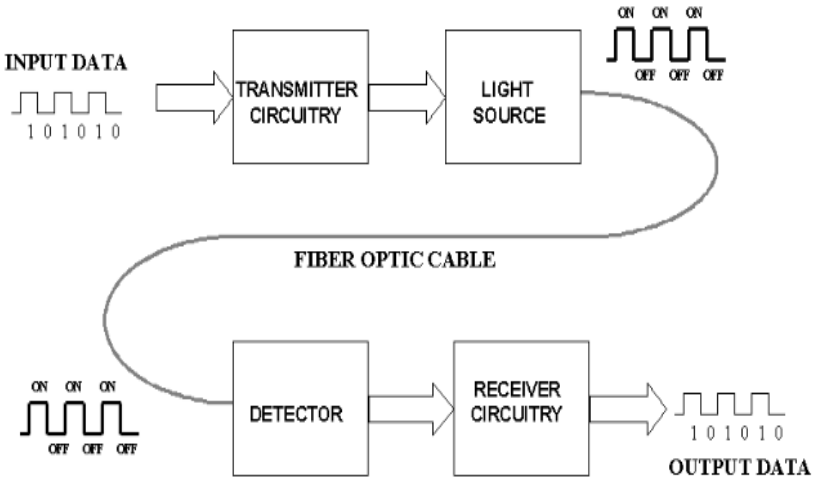

Figure 2.1: Basic Fiber Optic Communication System

Fiber optic communications is a technology used to transmit signals such as data, video or sound modulated with a pulse of light that serves as an electromagnetic carrier wave that sends a glass tube over long distances with very little loss. Data connection between two points is provided in a system fiber channel for fiber optics communication. It consists of a data transmitter consisting of a laser diode (LD) or a Light Emitting Diode (LED) that converts electrical signals into light, transmission fiber where modulated light transmits, and receivers consisting of photodetectors that convert light into electrical signals in Figure 2.2. (S. Babani, A. A. Bature, M. I. Faruk, N. K. Dankadai, 2014)

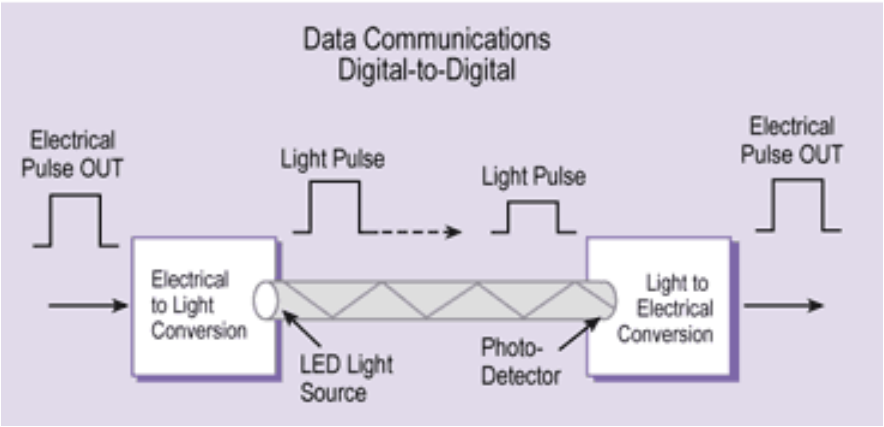

Figure 2.2: Data Communication

Two major categories for optical fiber is the step index optical fiber and graded index optical fiber. The single mode step index has a core diameter of less than 10 micrometers and only allows one path of light at a time. Morever, on the fiber optic multimode step index has a core diameter greater than or equal to 50 micrometers and allows some light paths, which means that it can cause model dispersion. Graded index optical fibers have their core refractive index gradually moving further from the center of the core. This increased bias in the center of the core minimizes the speed of some light rays, thus enabling all light rays to reach the receiver at almost the same time, thereby reducing the spread. Figure 2.3 illustrates various optical fiber modes. (Francis Idachaba, Dike U. Ike, and Orovwode Hope, 2014)

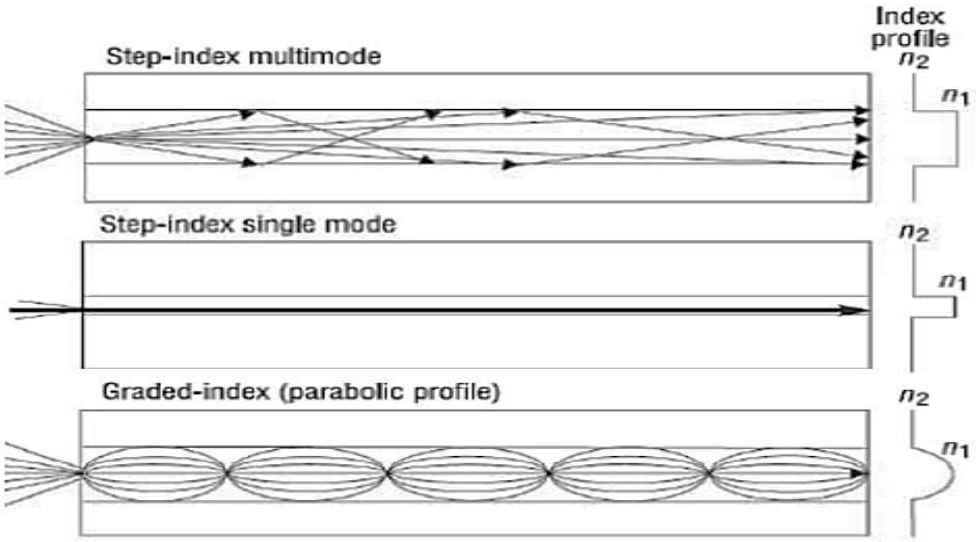

Figure 2.3: Optical Fiber Modes

In optical fiber communication, the use of single mode and multimode fiber construction depends on the application. For a single fiber mode scatter mode only one mode is transmitted straight through the fiber in Figure 2.4. In the spread of multimode fiber light, the light moves through the fiber following the unique light path called mod in Figure 2.5. (Mark Curran, Brian Shirk, 2012)

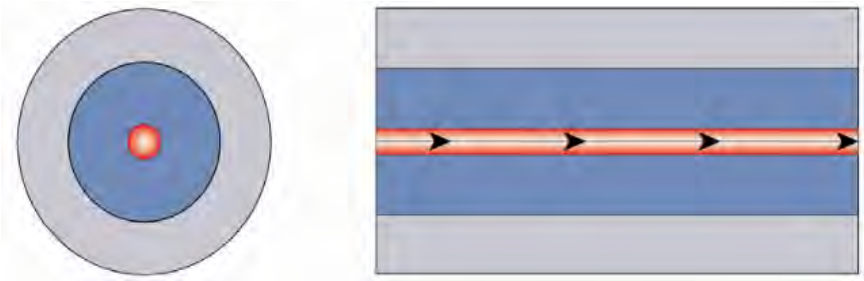

Figure 2.4: Single Mode Fiber Light Propagation

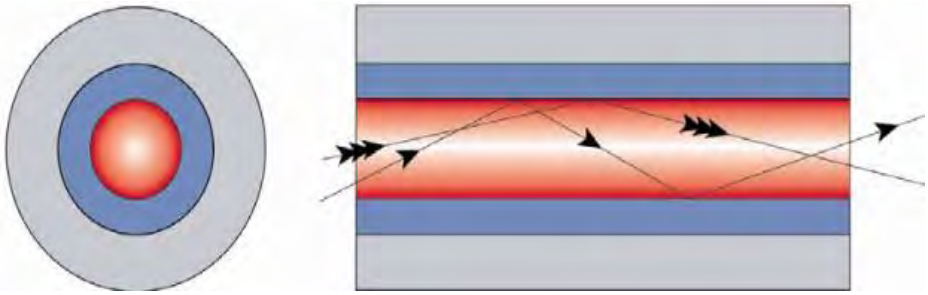

Figure 2.5: Multimode Fiber Light Propagation

For size fibers, multimode fibers typically have core diameter/core mounting 100/140 microns, 50/125 microns and 62.5/125 microns as shown in Figure 2.6. Single mode fibers have a core/mounting ratio of 9/125 microns at wavelengths of 1310nm and 1550nm. (Mark Curran, Brian Shirk, 2012)

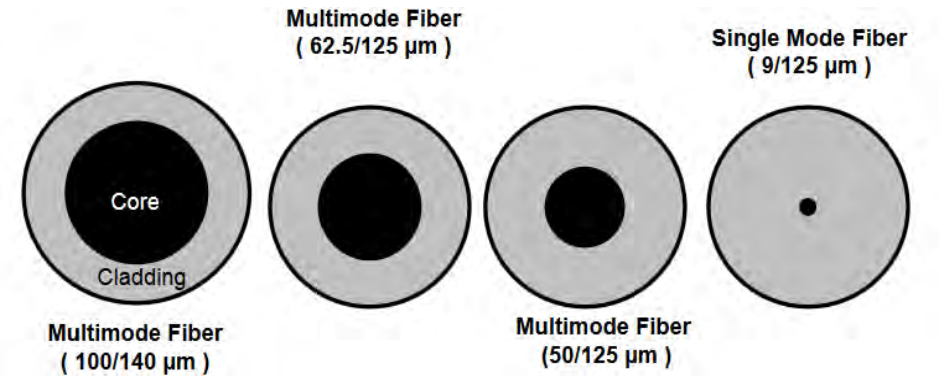

Figure 2.6: Popular Optical Fiber Core/Cladding Diameter Ratios

2.2 The Basic Parts of Fiber Optic System

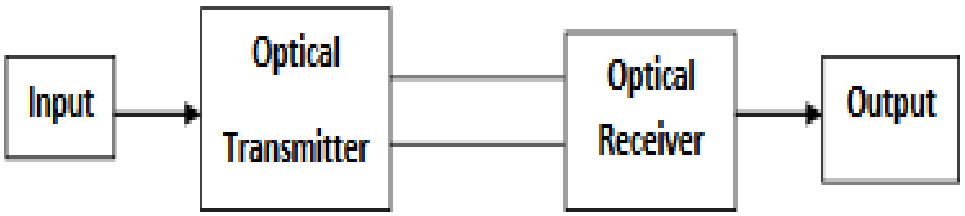

Figure 2.7: Generic Optic Communication System

2.2.1 Transmitter

The transmitter unit converts an electrical signal to an optical signal. The example of light source is LED or LD. The driving circuit for the light source changes the electrical signal into the driving current. (Engr Dr Mrs G.N Ezeh, Okwe Gerald Ibe, 2013)

2.2.2 Information channel

The information channel is a way between the transmitter and the receiver. In optical fiber communication, glass or plastic glass is the material for the channel. The characteristics of low attenuation and large angle of light acceptance. Repeaters can be used for digital systems. They convert the optical signals are very weak and distorted to the electricity and then redistribute digital pulse train longer for delivery. (V.S.Bagad, 2010)

2.2.3 Receiver

The receiver takes light or photon and converts it back to an electric signal, also known as a photodetector. In most cases, the resulting electrical signals are the same as the original signal being passed to the transmitter. The receiver has basic parts. They convert optical signals into electrical signals and output circuits that reshape and rebuild the original signal before delivering it to the output. Transmitter and receiver circuit can be very simple

or somewhat complicated depending on application usage. (Engr Dr Mrs G.N Ezeh, Okwe Gerald Ibe, 2013)

2.3 Main Sections of Fiber Optic Cable

Without the principle and fiber optic mechanisms in telecommunications can be very difficult if there is no basic fiber optic. Fiber optics uses thin strands of hair smooth glass or plastic to transmit data as a pulse of light. Optical fibers consist of three main parts which are core, coating and buffer, shown in Figure 2.8.

2.3.1 Core

The core is in the middle of the cable and silica. It works as a light transmitting section of the fiber and acts as the boundary layer.

2.3.2 Cladding

Cladding produced by a pure silica and acts a guide for light waves to move down the cable. If these components are missing, the light is difficult to move in waves and weak to get out of the core. Then, it will reflect back into the core.

2.3.3 Outside Jacket

The outside jacket or buffer coating, it is presence in the middle layer. It has acrylic polymer. It is as protective cladding and core to ultraviolet light and strengthen the cable. It is also protects data from electromagnetic interference. (Ritesh A. Jadhav, Dattatraya S. Shitole, 2013)