UNIVERSITI TEKNIKAL MALAYSIA MELAKA

OPTIMIZATION OF FIBER OPTIC SENSOR IN DETECTING THE CONDITION OF PALM OIL FOR SME 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 Electronics Engineering Technology (Telecommunications) with Honours

by

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I hereby, declared this report entitled “Optimization of Fiber Optic Sensor in Detecting the Condition of Palm Oil for SME Industry Usage by Using Factorial Design” is the results of my own research except as cited in references.

Signature	:	…….
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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 the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

……

(MADAM RAHAINI BINTI MOHD SAID)

ABSTRAK

Kertas ini bertujuan untuk menggunakan gentian optik sebagai sensor cecair untuk mengesan kepekatan minyak sawit. Hasil akhir akan menjadi pemahaman tambahan mengenai sensor optik gentian dan boleh digunakan dalam sektor industri SME. Mempunyai 3 sampel minyak kelapa sawit dengan perbezaan kepekatan antara penggunaan pertama, penggunaan kedua dan penggunaan ketiga. Bagi setiap tumpuan, akan mengalami proses penurunan bersama serat optik sebelum proses pengukuran. Setiap kepekatan akan menghasilkan keputusan yang berbeza dalam setengah plot normal dihasilkan untuk mengenal pasti kepentingan atau sifat penting dan interaksi yang mempengaruhi kuasa keluaran. Ciri-ciri penting terpilih digunakan untuk analisis selanjutnya dan meringkaskan jadual Analisis Varians (ANOVA). Serat optik berjaya menjadi sensor cecair kelapa sawit dan akan berprestasi tinggi dengan menggunakan panjang gelombang 1550nm sumber cahaya dan mod tunggal serat optik dan mengukur kepekatan dalam tiga keadaan.

ABSTRACT

This paper purposed application of fiber optic as liquid sensor for detection the concentration of palm oil. The final result would an additional understanding about fiber optic sensor and could be used in SME's industry sector. They are 3 sample of palm oil with difference concentration between first usage, second usage and third usage. For every concentration, would experience a dipped process together with fiber optic before measuring process. Each of concentration would present different result in half normal plot is produced to identify the significance or important properties and interaction that the effecting the output power. The selected significant properties are used for further analysis and summarize in Analysis of Variance (ANOVA) table. Fiber optic is successfully to be palm oil liquid sensor and would be in high performance by using 1550nm wavelength of light source and single mode of fiber optic and measuring concentration in three condition.

DEDICATION

I am grateful to ALLAH SWT for his grace. Within this report I, Munirahasmaa Binti Mustapai (B071410026) of UTem was successfully completed the report of final year project during two semesters. “Especially for my beloved parent Mustapai Bin Yasin and Nik Nab Binti Mohd Nor and my dearest sibling, who had given me much support, encouragement and advice to complete this project. And do not forget to all dearest fellow friends and UTeM staffs for helping and cheering my day when I lose the direction on my doing my project. Thanks you so much, I love u all.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ANOVA	-	Analysis of Variance
DOE	-	Design of Experiment
DWDM	-	Dense wavelength multiplexing division
EMI	-	Electromagnetic interference
FFA	-	Free Fatty Acids
FOS	-	Fiber Optic Sensor
LAN	-	Local Area Network
LD	-	Laser Diodes
LED	-	Light Emitting Diodes
SME's	-	Small and Medium Enterprises
TDM	-	Time Division Multiplex
TG	-	Triacylglycerol's
WDM	-	Wavelength Division Multiplex
df	-	Degree of the Freedom
<	-	Less than
>	-	More than
μm	-	Micrometer
nm	-	Nano meter

CHAPTER 1

INTRODUCTION

1.1 Introduction

Fiber optic has become one of the most influence technologies in communication engineering recently. The usage of optical fiber today are quite numerous. With the explosion of information traffic due to the internet, electronic commerce, computer networks, multimedia, voice, data, and video, the need for transmission medium with the bandwidth capabilities for handling such vast amounts of information is paramount. Optical fibers can be used as sensors to measure strain, temperature, pressure, and other parameters. Fiber optic is widely used not only for most communication, but widely used in illumination applications. Fiber optic is very famous in industries field because their characteristic of fiber optic itself, which are transmission is faster, less attenuation, impervious to electromagnetic interference (EMI), and not easily broken and not flammable. A part from that, the main application for fiber optic are for telecommunication, sensors, fiber lasers, bio medical and automotive and many other industries. However, this paper would present implementation of fiber optic cable as liquid sensor. The light travelled inside fiber optic would be interfered by existing of liquid molecules around fiber optic cable. This would be the result of experiment because each of concentrations would consists of different molecules and different molecules and different value of light source travelled. Fiber optic used to detect the concentration of palm oil in three condition which is different with first, second and third of usage. This

analysis is proposed for technology in Small and Medium Enterprises (SME's) industry. This study will be run the experiment by using fiber optic sensor to analyze the fiber optic sensor when it is used as a liquid sensor for detecting the condition of palm oil used in the application of mathematics to determine which level of the fiber optic can be used for optimum. Fiber optic is successfully to be palm oil liquid sensor and would be in high performance of light source and measuring concentration. Design of Experiment (DOE) will be main medium as a tool to investigate the best fiber optic sensor. As DOE can helps to locate the ideal process for top performance and discover the optimal product formulations and the vital factors in the process.

1.2 Problem Statement

This research proposed to analyze the concentration of palm oil in three condition used fiber optic as a tool for SME's industry. The condition of oil is the one most important element in health because oil is one of the main ingredient to make a food. Normally, some SME's industry are not concern about oil condition that can be effect much the human health. So this research will conducted to analyze the concentration of palm oil using the fiber optic sensor.

1.3 Objective

This paper is a study on "Optimization of Fiber Optic sensor in Detecting the Condition of Palm Oil for SME Industry Usage by Using Factorial Design". The objective of this project are as follow;

i. To study and develop Fiber Optic Sensor (FOS) for concentration of palm oil detection.

ii. To investigate best combination of Fiber Optic Sensor (FOS) which optimize the output power.

iii. To establish the mathematical model for Fiber Optic Sensor as the palm oil condition detector.

1.4 Scope

The scope of this project is to study and develop fiber optic sensor for palm oil concentration detection. This project to ensure that objective is achieve. However, for any project to be done, the limitations of the scope of the work must be very realistic and applicable. In other hand, first analyze the concentration of palm oil in three condition which is different with first, second, and third of usage. Second, develop the fiber optic sensor to detect the concentration of palm oil. Lastly, analyze data obtained and select the data that have optimum results.

CHAPTER 2
LITERATURE REVIEW

2.1 Literature Review

In this chapter two, literature review contains the current knowledge included substantive findings, as well as the theoretical contribution to a particular subject or topic. Purpose of this chapter is to identify and analyze all the intellectual information and necessity in the process of build fiber optic sensor by using factorial design.

2.2 Factorial Design in Optimization

In statistics, full factorial experiments are an experiment whose design consists of two or more factors, each with a possible discrete or "level" value, and experimental unit takes on all possible combinations of this level to cover all those factors. The DOE technique is used to develop the experimental plan needed to determine the important factors that affect the productivity of the process and the optimum source level combinations that will result in the best process productivity. Factorial design consists of full factorial design and fractional factorial design. A full factorial DOE is a planned set of tests on the response variables with one or more factors with all combinations of levels.

DOE is a design method can be used for process development or process troubleshooting to improve the proses performance and get the optimum output. In this project, will applied the factorial design to improve the manufacturability of the product, improve the process in the industrial, enhanced field performance and reliability, lower product cost and shorter product development time. DOE (Design of Experiments) help you investigate the effect of input variables (factors) on the variable output (response) at the same time. Use DOE to identify the process conditions and product components that influence quality and then determine which factor settings to optimize results. (Zahraee et al. 2013)

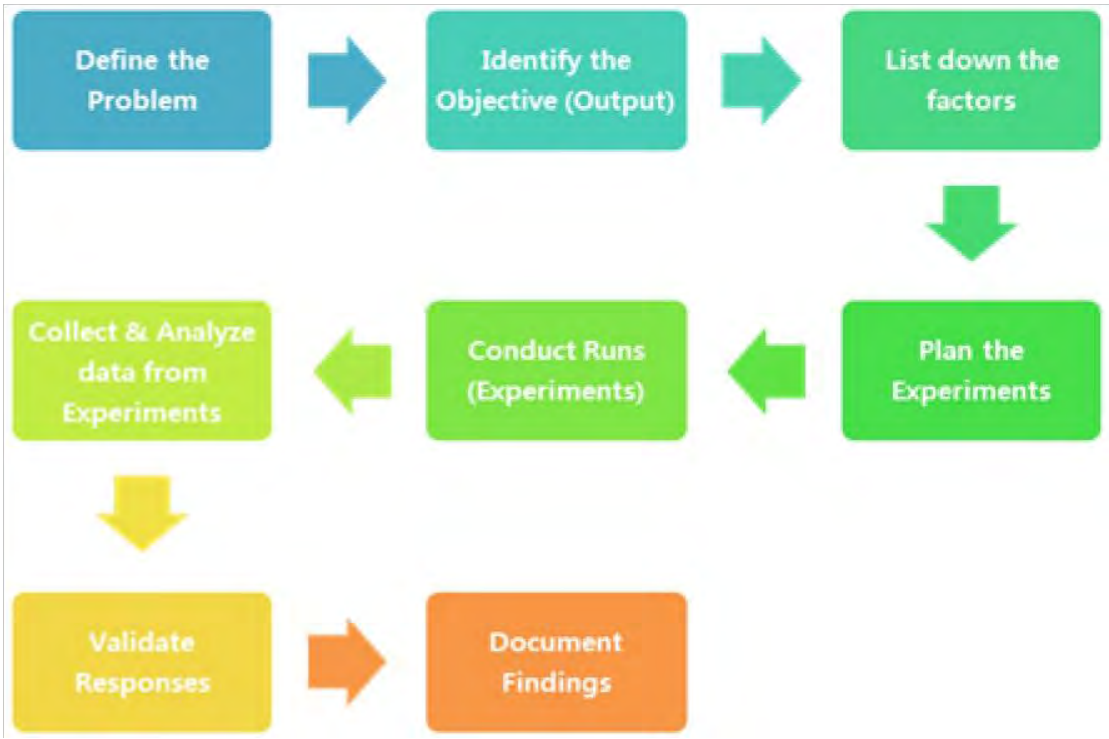

Figure 2.1: Flow Chart Design of Experiment

2.3 Fiber Optic Cable

Optical fiber cables are the medium of transmission for signals in optical communication systems. A fiber optic cable is made up of three main section. They are the core, cladding, and buffer coating. This is shown in Figure 2.2. The core is in the center of the cable and it consists of silica. It functions as a light emitting part of the fiber and acts as a boundary layer for cables, then the cladding. This cladding consists of pure silica and acts as a guide for light waves to move down the cable. This component is very important because light travels in waves and will shoot out and if these components are not present. This cladding will eventually reflect the core again. For buffers, it is in the center of these three layers and it is composed of acrylic polymers. This buffer shield protects the cladding and core against ultraviolet light and provides rigidity of the cable. This buffer coating is also useful for obtaining data from electromagnetic interference. (Jadhav & Shitole 2013)

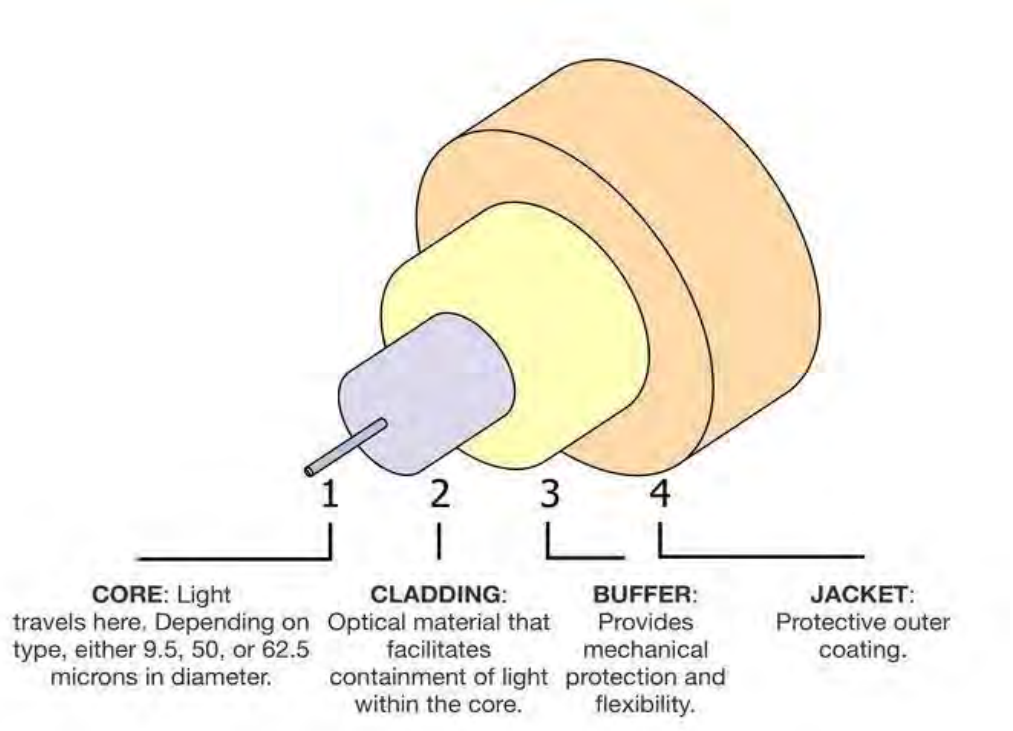

Figure 2.2: Fiber Optic Cable Construction

Fiber optics is sending signals down hair-thin strands of class or plastic fiber. The light is “guided” down the center of the fiber called the “core”. The core is surrounded by an optical material called the “cladding” that traps the light in the core using an optical technique called “total internal reflection”. The core and cladding are usually made of ultra-pure glass. The fiber is coated with a protective plastic covering called the “primary buffer coating” that protects it from moisture and other damage. More protection is provided by the “cable” which has the fibers and strength members inside an outer covering called a “jacket”. (Amaku et al. 2014)

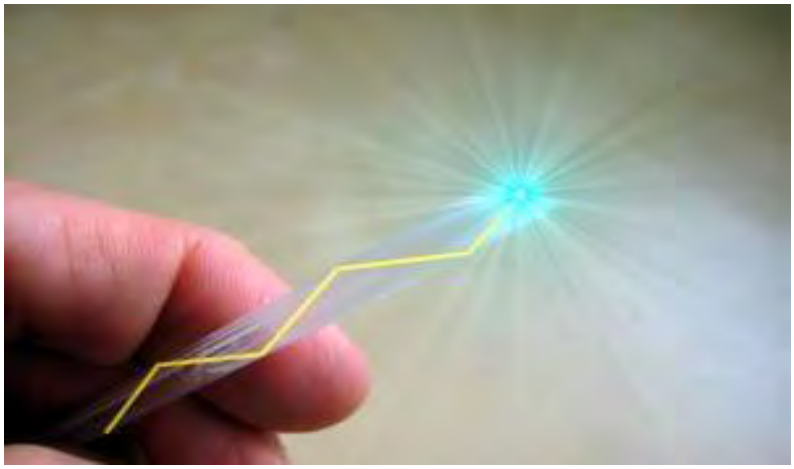

Figure 2.3: Light pipe; Optical fiber transmits the beam of light down a thin sheet of plastic or glass by making them bounce repeatedly against the wall

2.4 Fiber Optic Sensor

Optical fiber sensors can be classified under three categories. First, the location sensing, operation, and applications. Based on sensing location, optical fiber sensors can be classified as extrinsic or intrinsic, these fibers are only used to carry light to and from external optical devices where sensing occurs. In this case fiber is only a component that carries light. The comparison of extrinsic and intrinsic optical sensors is shown in **Figure 2.4**. (Sahani et al. 2015)

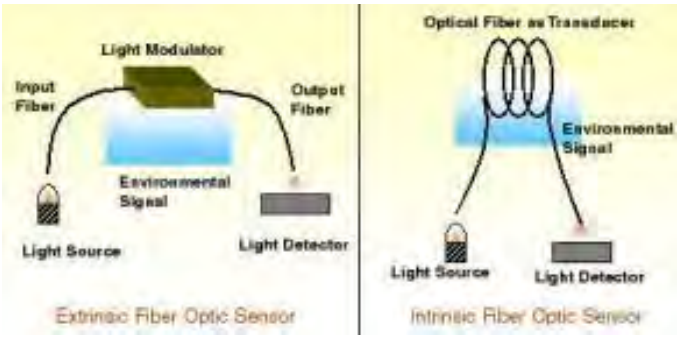

Figure 2.4: Extrinsic and Intrinsic is a Type of Fiber Optic Sensor

The advantages of fiber optic fibers from there. First, the harsh environmental ability against strong EMI (electromagnetic immunity interference), high temperature, chemical corrosion, high pressure and high voltage. Seconds very small size, passive and low power. Third, excellent performance such as high sensitivity and broad bandwidth. Fourth, long-range and final operations, multiple or distributed measurements, are widely used to compensate for their primary weaknesses with high costs and end user uncertainties. (Li et al. 2012)

Various ideas have been proposed and various techniques have been developed for a wide range of sizes and applications. The general structure of the optical fiber sensor system is (shown in Figure 2.5). It consists of optical sources (laser, LED, laser diode etc.), optical fiber, sensors or modulator elements (transducers measured to optical signals), optical and electronic sensor (oscilloscopes, optical spectrum analyzers and so on) (Ghassan et al. 2015)

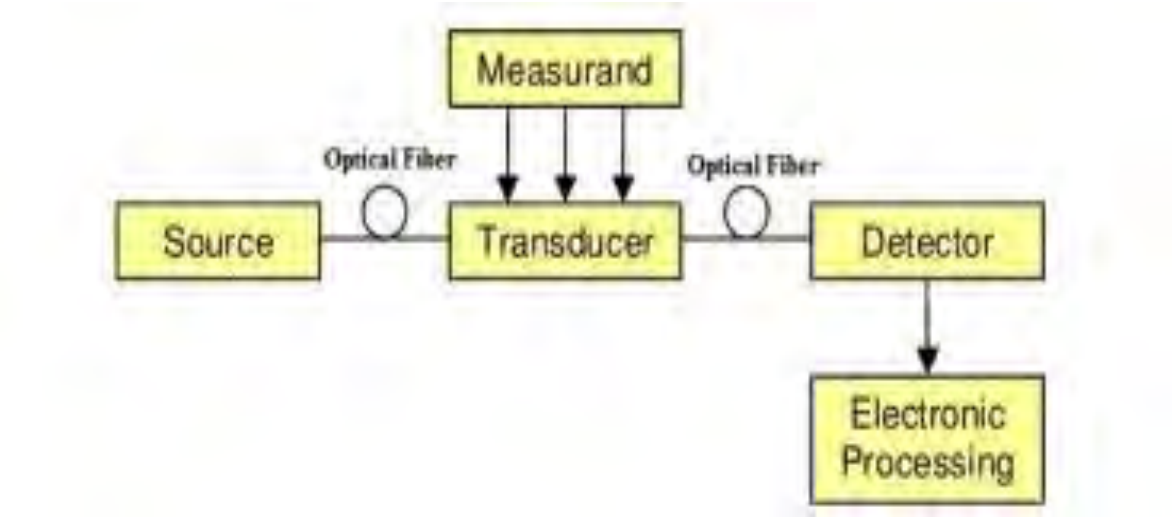

Figure 2.5: The basic components of the sensor system Fiber Optics.

There are advantages of fiber optic sensor including its ability to be light weight, very compact and small. Easy to mount light, low ISI, resistance to electromagnetic interference, high sensitivity, wide bandwidth and environmental resistance making it widely used in different fields. All the features mentioned this the best use of optical fiber as a sensor and a network of optical fiber is very advantageous in the industry for long-term investment. (Ghetia et al. 2013)

2.5 SC Fiber Optic Connector

Fiber optic connectors are used to join optical fibers in which the ability to connect/disconnect is required. Connectors are mechanical devices that are installed at the end of the fiber optic cable, light source, receiver, or housing. He lets it run into the same device. Transmitter provides information light to fiber optic cables through connector. The receiver gets information that gives light from fiber optic cables through the connector. Connectors must direct the light and collect light. (Paper 2008)