



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT A LIQUID SENSOR USING FIBER OPTIC FOR ENGINE
LUBRICATION OIL AND OPTIMIZATION USING DESIGN OF
EXPERIMENT (D.O.E) TECHNIQUE**

This report submitted in accordance with requirement of the Universiti Teknikal
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(Telecommunication) (Honours.)

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) (Hons). The member of the supervisory us as follow:

.....

(Aminah Binti Ahmad)

ABSTRAK

Pada dasarnya, Reka bentuk eksperimen (DOE) adalah teknik statistik yang digunakan dalam kawalan kualiti untuk merancang, menganalisis dan mentafsirkan set eksperimen bertujuan untuk membuat keputusan yang bijak tanpa menanggung kos yang tinggi dan memakan banyak masa. Masalah-masalah yang berlaku boleh dianalisis dan tindakan penambahbaikan yang boleh dilakukan dengan serta-merta. Terdapat banyak kelebihan menggunakan teknik DOE dan untuk contoh bilangan ujikaji perlu dilakukan boleh menentukan dan dinyatakan dengan jelas mengikut kaedah-kaedah yang terlibat dalam teknik ini seperti Factorial penuh, kaedah Taguchi, Factorial pecahan dan lain-lain. Antara pelbagai jenis DOE, reka bentuk eksperimen Factorial adalah kaedah yang saya akan menggunakan dalam kajian saya ini. Rekan bentuk factorial dirancang untuk mengkaji fungsi-fungsi bebas-langsung dan sambungan antara faktor-faktor yang mempengaruhi tindak balas. Melalui kaedah Reka-bentuk faktor, saya mampu untuk menentukan faktor yang optimum yang akan menyumbang kepada penerima gentian optic minyak mineral dan mengurangkan perubahan melibatkan, Akhirnya, kita boleh mendapatkan keputusan yang lebih tepat dan lebih baik dengan mengulangi menggunakan beberapa jenis factorial. Oleh itu, untuk melaksanakan eksperimen kaedah Reka bentuk faktor, kita akan dibantu oleh beberapa parameter terpilih dalam menjana output berdasarkan perubahan kombinasi faktor-faktor yang berlainan. Pengesanan gentian optic minyak mineral dilakukan didalam makmal gentian optic di Universiti. Selepas mengumpul data yang diperlukan, kita akan dapat untuk menjanakan graf dan memerhati keluaran supaya kita boleh mempunyai kefahaman yang lebih jelas tentang kepentingan setiap factor yang digunakan bagi mendapat keluaran yang optimum.

ABSTRACT

Basically, Design of Experiment (DOE) is a statistical technique used in quality control for planning, analysing and interpreting sets of experiments aimed at making wise decisions without incurring a high cost and consuming much time. The problems occurred can be analysed and an improvement action can be done immediately. There are a lot of advantages of using DOE technique and for example the number of experiments need to be carried out can be define and stated clearly according to the methods that involved in this technique such as Full Factorial, Fractional Factorial, Taguchi Method and etc. Amongst the various types of DOE which is Factorial Design of Experiment is one of the methods in which my research design will be focusing on. Factorial design is planned to study non-direct functions and connections between factors influencing reaction. Through the factorial design method, I am able to determine the optimum factor which will contribute most to the fiber optic mineral oil sensor and reduce the variation involve. Ultimately, we could obtain a more precise and better result by repeating using several type of factorial. Thus, in order to perform the factorial design of experiment method, we will be assisted by tabulated parameters in generating outputs based on the variation of different combinations of factors. The optical fiber mineral oil sensor experiment is carried out within the university compound. After collecting the data needed, we are able to plot graphs and observe the output so that we could have a clearer understanding of the significance of each factor that we used in order to get an optimum output.

DEDICATION

Specially dedicated to,

My beloved parents, family members, and friends for supports, encouragements, understanding, guiding, and all the favour. May Allah bless all of you.

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LIST OF SYMBOL AND ABBREVIATIONS

DOE	=	Design of Experiment
OFAT	=	One Factor at a Time Method
TQM	=	Total Quality Management
TPM	=	Target Performance Measure
NPM	=	Noise Performance Measure
LED	=	Light Emitting Diode
FFD	=	Full Factorial Design
DFSS	=	Design for Six-Sigma
IDDM	=	Insulin Dependent Diabetes Mellitus
NIDDM	=	Non-Insulin Dependent Diabetes Mellitus
MMF	=	Multi-Mode Strands
SMF	=	Single-Mode Strands
PCS	=	Plastic-Clad Silica
ASE	=	Amplified Spontaneous Emission
OSA	=	Optical Spectrum Analyzer
ANOVA	=	Analysis of Variance
LRIS	=	Liquid Refractive Index Sensor
SPR	=	Surface Plasmon Reverberation
dB	=	Decibel
nm	=	Nanometer

CHAPTER 1

INTRODUCTION

1.1 Project Background

A lubrication is a substance that being used to reduce the friction between surfaces in a certain area, in other word it reduces the heat that being generated when a surface contact with each other. It might likewise have the capacity of transmitting powers, transporting remote particles, or warming and cooling the surfaces. This property to reduce the friction is well known as lubricity. In addition, big industrial application, use lubrication for many different purpose.

In a world of communication, fiber-optic is a form of transmitting data starting with one place then onto the next by sending beats of light through an optical fiber. The light structures form an electromagnetic carrier wave that is adjusted to convey data being sent. This project is to expend the use of fiber optic as a sensor not only sent data as we know today. The fiber optic sensor is used to detect the thickness of oil lubrication for a certain period of time, each time the lubrication being use by the engine it will get thick and this will damage the engine if it not changes. Therefore, fibre optic sensor will be develop to detect the suitable time for the lubrication oil to be change.

This project is also use design of experiment (D.O.E) technique which is a systematic method. This technique is a method to determine the relationship between factor affecting a process and the output of that process. In other word, it is used to find cause and effect relationships. This information is needed to manage process input in order to optimize the output

1.2 Problems Statement

Mineral oil is use for lubrication engine oil and importance to keep the engine in the best performance. They are many brand in market that have their advantages and disadvantages. Fiber optic sensor is develop to test the different of 2 brand in market that is mineral oil. Design of experiment will be use to analyses the optimum performance of each oil and determine the best among 2 brand.

In such many year fiber optic has a major impact in communication system but never much to know in becoming a sensor. By this project fiber optic sensor is develop to become a sensor for lubrication oil. This research is about to determine the must to know function and implement fiber optic to develop to becoming a liquid sensor for lubrication oil that is mineral oil.

1.3 Project Objectives

The main objectives in this research can be describe with three factor, which lead to project success. The objectives of the project are:

- a) To study Fiber Optic Sensor (F.O.S)
- b) To develop Fiber Optic Sensor to detect mineral oil
- c) To analyse performance of FOS using Design of Experiment (DOE)

1.4 Project Scope

The scopes of this project involved the development of liquid sensor using fiber optic for engine lubrication oil and using design of experiment technique. In this project it is important to study on the compatibility of fiber optic as sensor to identify the concentration of lubrication oil. Analysing the system establishment for fiber optic as sensor. The data will be analysed by the power loss of fiber optic, where general hypothesis will be made.

Analysis will be conducted by varying the parameter that is time, source light, brand of oil and type of fiber optic. This parameter is use as the main point for this research on determine the variable for the fiber optic sensor that will be test. Lastly the result can be analysed and studied and implement to a good use in daily life.

1.5 Summary

For this chapter 1, it tells the introduction of the project that will be done. From the project background a small brief about lubrication oil, fiber optic and design of expert. The problem statement that being state is a point that need to be solve and know, by doing this research each of the problem give an impact for the research to complete. The project scope tells the scope that need to be done so it will not exceed the expectation to go beyond the limit of the research,

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter states all the studies and reviews from previous projects and other sources that help to successfully design, built and implement the entire task during this project. There are some previous projects that similar to this project and can be search across the internet and paper work done by the researcher who is inspired with the optical communication. For this project, the summation is all about to develop the fiber optic sensor.

2.2 Basic System of Communication

They have 2 type of communication that is analogue and digital

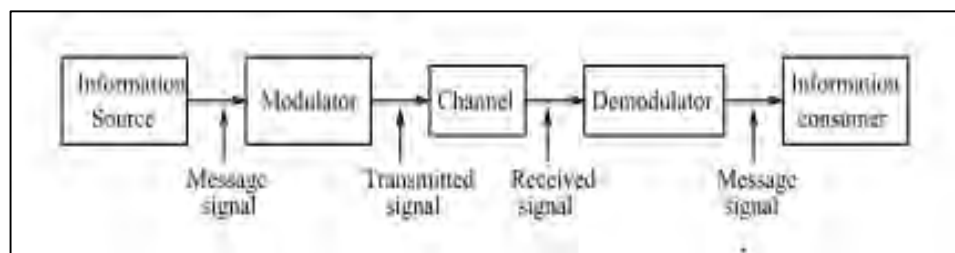


Figure 2.1: Analogue communication

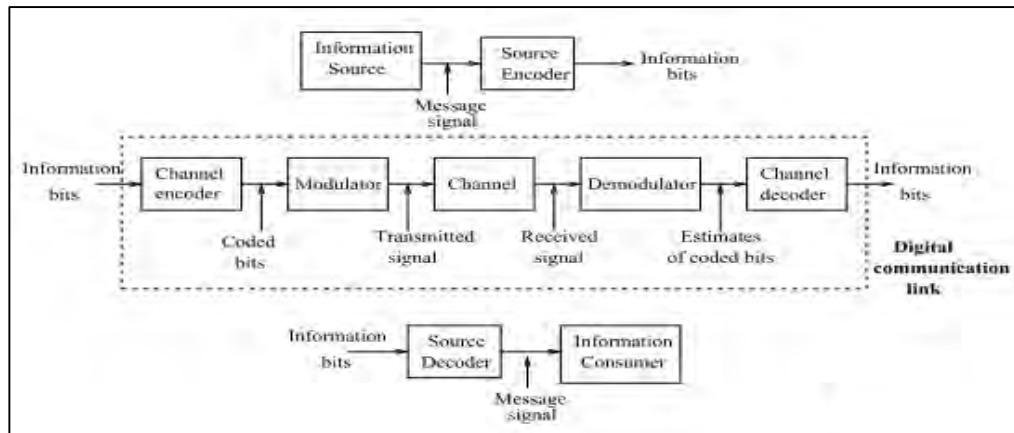


Figure 2.2: Digital communication

The figure above shows the basic of block diagram for communication system. Each of the block have they function. For each of the step to transmit the information to other side of the receive. As the figure about show two block diagram. Believe it or not by comparing the block diagram for analogue and digital communication respectively. The digital communication system involves far more processing. However, this is not an obstacle for modern transceiver design, due to the exponential increase in the computational power of low-cost silicon integrated circuit. By that digital communication has the advantages compare to analogue. In reality digital is more use than the analogue because the system will keep on improving. (Schiff, 2006)

There are three basic system of communication which is transmitter, channel for transmit the signal and receiver to receive the signal from transmitter. This is a summery to understanding the concept of communication for a fiber optic sensor for this project. (U.Madhow, 2008)

2.2.1 Transmitter

The transmitter modulates the information/data onto a carrier signal, amplifies the signal and broadcast it over the channel. It is a sub system that takes the input data and processes it.

2.2.2 Channel

Channel is the medium which transfer the modulated signal from the transmitter to the receiver section while on the same time air acts as the channel for broadcasting such as radio, television and Internet. Channel might also be a wiring system for example like a cable or fiber optic

2.2.3 Receiver

The receiver is a system which receives the transmitted signal from the channel and processes it to recover the message signal. The receiver has to be accomplished to distinguish the signals from others signal which that it might be use the same channel or tuning. Other than that, a receiver also should be able to amplify the signal for processing and demodulate to remove the carrier and then processes the input signal for reception and generate the output that being sent.

2.3 Fibre Optic

2.3.1 Basic Fiber Optic Communication System

Fiber optic is a medium that change the look of telecommunication field this day, it is an information carrier conveying data starting with one point to another as light. Compare to copper type of transmission, fiber optic is not electrical in nature. A fiber optic framework consists of a transmitting device that convert an electrical signal into a light signal, an optical fiber cable that carries the light, and a receiver that accepts the light signal and converts it back into an electrical signal. Unlike the copper the high data transfer (bandwidth) capacity abilities and low cost make it perfect for a fast and ideal for gigabit transmission and beyond. (Massa, 2008)

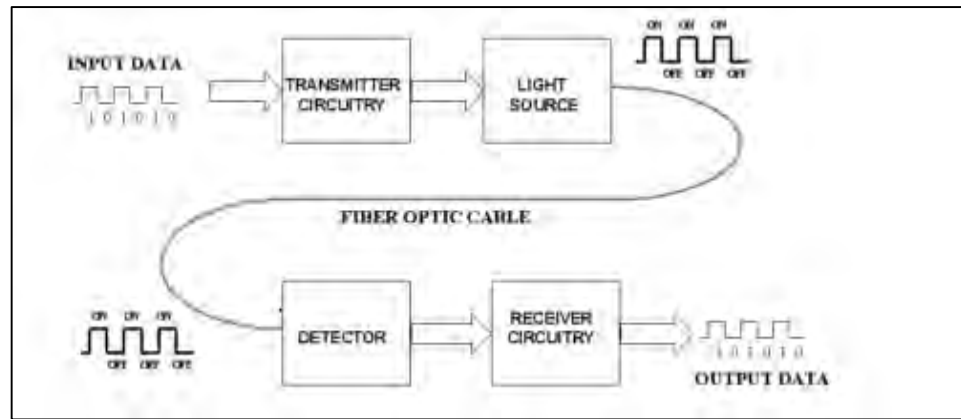


Figure 2.3::Basic fiber optic communication system

In order to comprehend the project of fiber optic sensor on fiber optic application work, it is important to understand the components of fiber optic link, with a specific end goal to grasp how fiber optic applications work, there are four primary segments in a fiber optic connection that is:

- a) Optical Transmitter
- b) Optical Fiber
- c) Connectors
- d) Optical Receive

2.3.2 How Does Fiber Optic Work?

Optical fiber is a very thin strand of pure glass, which goes about as a waveguide for light over long separation. Uses a primary known as “total internal reflection”, when light tries to go between two different media. (Steenbergen, 2013), Lambert M. Surhone, Miriam T. Timpledon, Susan F. Marseken (2010).

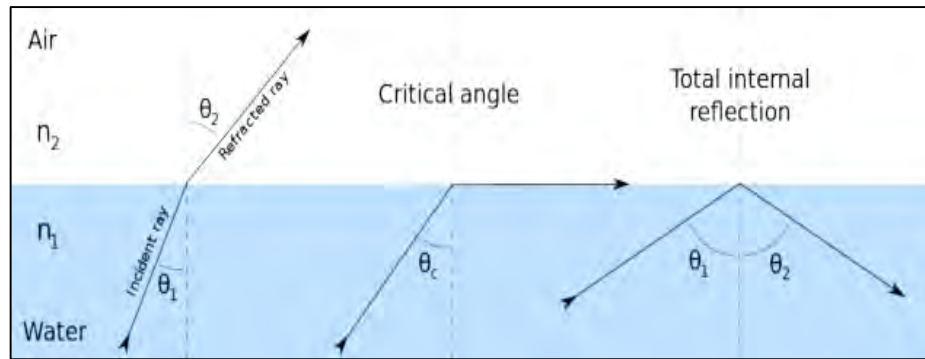


Figure 2.4: Ray of refraction

To discuss the speed of light, it normally discussing the speed in a vacuum (space), which is 3.00×10^8 m/s. when light go through something else, for example, glass or plastic, it travels at a different velocity. The velocity of light in a given material is identified as index of refraction, n , which is define as the pace of light in vacuum to the rate of the light in the medium;

$$\text{Index of refraction: } n = c / v$$

At the point when light goes starting with one medium then onto the next, the speed changes, as does the wavelength. The index of refraction can also be expressed as terms of wavelength

$$n = \lambda / \lambda_m$$

Where λ is the wavelength in vacuum and λ_m is the wavelength in the medium, in spite of the fact that the velocity changes and wavelength changes, the frequency of the light will be consistent. The frequency, wavelength, and velocity are connected by: $v = f\lambda$. The changing in light speed that happen when light through to one medium onto the next is in charge for the bending of the light, or refraction, that happens at an interface. If light from one medium into second medium, and angles are measured from the ordinary to the interface, the point of transmission of the light into the second medium is identified with the angle of incidence by Snell's law: