

**UNIVERSITI TEKNOLOGI MARA**

**DISTRIBUTED SINGLE MODE  
FIBER SENSOR AND FIBER BRAGG  
GRATING FOR DISPLACEMENT  
AND TEMPERATURE SENSING**

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Thesis submitted in fulfillment  
of the requirements for the degree of  
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## **AUTHOR'S DECLARATION**

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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## ABSTRACT

This dissertation discuss the research works on distributed optical fiber sensor system consisting of optical fiber-loop sensor incorporating fiber Bragg grating (FBG) for displacement and temperature detections. The fiber-loop sensor was designed using single mode fiber (SMF) to exhibit signal attenuation due to the macrobending perturbation in the optical fiber. A novel fiber-loop design was used to investigate the optical attenuation due to macrobending effect in the fiber-loop. The bending effect would cause higher optical signal loss when the fiber-loop diameter is further reduced due to the force action of displacement. The single mode fiber sensor (SMF-sensor) was characterized using optical time domain reflectometer (OTDR), optical spectrum analyzer (OSA), and optical power meter (OPM and OFM). Single SMF-sensor was characterized and the result was used in developing a distributed sensing system consists of three SMF-sensors along the monitoring line. The SMF-sensor is capable to detect faults simultaneously at several different locations. The fiber-loop sensing-head has a sensitivity of 0.044 dB/mm and 0.024 dB/mm measured using OTDR and OSA respectively. OTDR provides higher sensitivity in detecting displacement per millimeter unit besides precisely locate the fault point. The SMF-sensor was installed on lab-scale hill-slope simulator to test the response of the optical signal when the slope structure was displaced at different directions. SMF-sensor gives higher responsive when detecting displacement in horizontal-direction with a recorded sensitivity of 0.175 dB/mm and able to detect ground displacement initially at  $5\pm 0.1$  mm displacement. FBG incorporated in the system served as temperature sensor. FBG recorded a sensitivity of 0.01 nm/ $^{\circ}$ C when detected temperature changes.

## **TABLE OF CONTENTS**

	<b>Page</b>
<b>AUTHOR'S DECLARATION</b>	ii
<b>ABSTRACT</b>	iii
<b>ACKNOWLEDGEMENT</b>	iv
<b>TABLE OF CONTENTS</b>	v
<b>LIST OF TABLES</b>	ix
<b>LIST OF FIGURES</b>	x
<b>LIST OF ABBREVIATIONS</b>	xv
<b>CHAPTER ONE: INTRODUCTION</b>	
1.1 Background Study	1
1.2 Statement of the Problem	3
1.3 Objectives of the Research	4
1.4 Scope of the Research	4
1.5 Significance of the Research	5
1.6 Outline of the Thesis	5
<b>CHAPTER TWO: LITERATURE REVIEW</b>	
2.1 Conventional sensor Technology	7
2.2 Overview of Photonic Technology	8
2.3 Introduction to Optical Fibers	9
2.4 Mode Propagation in Optical Fiber	10
2.5 Principle of Light Guiding in Optical Fiber	12
2.5.1 Refractive index profile	12
2.5.2 Propagation of light in optical fiber: Total internal reflection	13

2.5.3 Numerical aperture	14
2.5.4 Mode-field diameter	15
2.6 Attenuation in Optical Fiber	16
2.7 Principle of Fiber Bragg Grating	20
2.8 Optical Fiber Sensor	24
2.8.1 Intensity modulated-based sensor	25
2.8.2 Wavelength modulated-based sensor	34
2.9 Field Applications of Optical Fiber Sensor in Structural Monitoring	36
2.10 Advantages of Optical Fiber	37
 <b>CHAPTER THREE: METHODOLOGY AND CHARACTERIZATION OF OPTICAL COMPONENTS</b>	
3.1 Introduction	39
3.2 Optical tools for splicing optical fiber	39
3.3 Optical connector	41
3.4 Optical measuring equipment	41
3.4.1 Optical spectrum analyzer	41
3.4.2 Optical power meter	42
3.4.3 Specification and principle of optical time domain reflectometer	43
3.5 Optical components	51
3.5.1 Specification of single mode fiber (SMF-28)	51
3.5.2 Characterization of optical components	53
3.5.2.1 Characterization of optical coupler	55
3.5.2.2 Characterization of optical isolator	56
3.5.2.3 Characterization of optical circulator	57
3.5.2.4 Characterization of fiber Bragg grating	58
3.5.2.5 Summary of characteristics of optical components	62