PIC BASED FIBER OPTIC PRESSURE SENSOR

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DECLARATION

"I hereby declare that this report is result of my own effort except for works that have been cited clearly in the references."

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"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering (Telecommunication) with Honours"

Signature : ……………………………….
Supervisor's Name : Mr Chairulsyah bin Abdul Wasli
Date : 30 April 2010

DEDICATION

Specially dedicated to my father, mother and my friends for their loving, understanding, care and support

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Assalamualaikum and Alhamdulillah.Praise to Allah S.W.T The Most Gracious, The Most Merciful, there is no power no strength save in Allah, The Higher and The Greatest, whose blessing and guidance have helped me through the process of completing this Final Year Project. Peace and blessing of Allah be upon our prophet Muhammad S.A.W who has given light to mankind.

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May Allah bless all of you. Ameeen
Thank you very much

ABSTRAK

Matlamat utama projek ini adalah untuk mereka alat pengukur tekanan dengan menggunakan gabungan teknologi Pengawal sampukan Boleh aturcara (PIC) dan kabel optik fiber.Kelebihan yang ada pada kabel fiber optic adalah ia mampu mengesan sebarang perubahan sudut yang berlaku and mengira bengkokan yang hadir dimana ia mampu beroperasi sebagai pengukur tekanan.Kajian akan dilakukan berdasarkan keadaan dimana kabel optik fiber didalam keadaan normal dan keadaan yang terdapat bengkokkan .Keputusan yang betul akan diuji menggunakan alatan yang sebenar.Apabila tekanan yang diterima adalah tinggi,data akan dihantar ke PIC untuk dip roses dan seterusnya akan member amaran.

ABSTRACT

The aim of this project was to measure the pressure by using combination technology of programmable interface Controller (PIC) and fiber optic cable. The advantages of the fiber optic cable that can be detect the changing angle and measure level of the cable made it available to become a pressure sensor. Each case was represented in form of graph for normal condition and abnormal condition. The true result of pressure measurement were be investigated by using the true hardware and its will detect based on pressure that given in the fiber optic. When the pressure that applies in the fiber optic is higher, the signal would be sent to PIC for processing and then given the warning.

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a	core radius
Aeff	effective (modal) area of fiber
B	data rate
Bn	noise bandwidth of amplifier
c	vacuum velocity of light
D	fiber dispersion (total)
I(r)	power per unit area guided in single mode fiber
k	Boltzmann's constant
Jm	Bessel function of order m
Km	modified Bessel function of order m
k0	vacuum wave vector
l	fiber length
LD	dispersion length
M	modulation depth
N	order of soliton
n	actual number of detected photons
Neff	effective refractive index
n0	core index
n1	cladding index
P	optical power guided by fiber
PIC	Programmable Interface Controller
PE	error probability
Pf	probability of fiber failure
Ps	received signal power
Ps	signal power
P0	peak power
P0	peak power of soliton
R	detector responsivity (A/W)

RIN	relative intensity noise
RL	load resistor
R(r)	radial dependence of the electric field
S	failure stress
SNR	signal-to-noise ratio measured in a bandwidth Bn
S0	location parameter
t	time
T0	pulse width
U	normalized pulse amplitude
α	profile exponent
αf	frequency chirp
αR	attenuation of Raman-shifted mode
˜β	complex propagation constant
β1	propagation constant
β2	dispersion (2d order)
Δ	peak index difference between core and cladding
Δf	frequency deviation
ΔL	change in length of fiber under load
Δφ	phase difference between signal and local oscillator
Δν	source spectral width
Δτ	time delay induced by strain
ε	strain
ηHET	heterodyne efficiency
θc	critical angle
Θ(θ)	azimuthal dependence of the electric field
λ	vacuum wavelength
λc	cut-off wavelength
ξ	normalized distance
Ψ(r, θ, z)	scalar component of the electric field
ΨS, ΨLO	normalized amplitude distributions for signal and LO

CHAPTER I

INTRODUCTION

1.0 INTRODUCTION

PIC (Programmable Interface Controller) based fiber optic pressure sensor is a technology that combine the function of fiber optic cable and PIC. This project would be develop based on the theory of microbend sensor. The microbend sensor was one of the earliest fiber optic sensors. Microbend loss have always been curse to the fiber optic cable designer, but it is this very same microbend loss effect in optical fiber which was exploited by the microbed sensor designer who adapted the microbend effect to the measurement of many physical parameter and physical variables such as temperature and pressure. Microbend sensors are very interesting sensor with some outstanding performance characteristic that have made them successfully in commercial application.

The early interesting in microbending sensor was for hydrophone application and this work was driven by the Navy's FOSS (Fiber optic sensor systems) program. Since that time, over 100 different studied on microbend sensor have appeared in the literature and the sensor have been adapted to many different measurement application

A micro bender is called an intrinsic fiber optic sensor because light is not permitted to exit from the fiber into free space. The micro bender is a displacement sensor. When the separation between the tooth blocks changes (figure 1), the sinusoidal amplitude of clamped fiber changes accordingly. The light transmission through the clamped region is a very sensitive function of the sinusoidal amplitude of the bent fiber. [1]

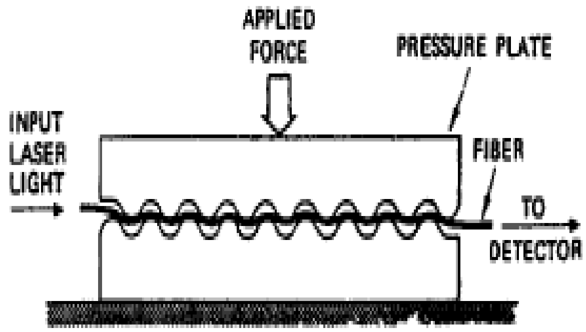

Figure 1: Original diagram of microbend fiber optic sensor

The project would be developing the simple sensor, pressure sensor, acceleration sensor and etc. The project would be developing the simple sensor, system that used light, PIC and fiber optic cable. In the free condition or normal, the certain level is measured as a main point. Then, when the pressure is given ,the cable would be bend the angle of the light would be change and cause the change of measurement level .When the pressure is increase , the bend also become higher, and the differential of the angle at based point would be change and level measure is gets lower. This will be indicator that the cable is in bent condition and the system is in pressure condition.

The hardware would be set up by detecting the value of output Voltage. When the value of output voltage is increase that means the pressure or bending of cable is increase. Based on the output voltage value, if the value of output voltage is more than 5V, the buzzer/LED would be off. But if the output voltage is less than 5V, the buzzer/LED would be ON. These projects are suitable used for home security alarm system, door sensor, escalator detector system, and etc.

1.1 OBJECTIVE

The main objective in this project is to design and develop the pressure sensor by using Programmable Interface Controller (PIC) and fiber optic cable.

1.2 SCOPES OF WORK

The scopes of works in this project are:

I. To study and understanding the basic operation of the Programmable interface controller and communication of fiber optic cable.
II. Study the related formula of the micro bending loss and make the calculation, measurement and comparison of the attenuation, bending loss.
III. Construct the circuit of the receiver and transmitter of fiber optic cable. This circuit would become as PIC based fiber optic pressure sensor.
IV. Create the coding for the programmable logic circuit to detect the bending loss of pressure sensor.

Other scopes of work include:

I. Maintain good log book results.
II. Prepare the necessary document
III. Publishing final report
IV. Project Presentation.

1.3 PROBLEM STATEMENT

The conventional pressure sensors use film resistor, strain gauges, metal alloys, or polycrystalline semiconductor as the resistive media. These materials conduct more or less electricity based on geometric deformations in their structure and make the measurement of the pressure become inaccurately. The disadvantages of conventional pressure sensor is the data that been transmit are in analog. So, it must be converting from the analog to digital at the electronic signal processing and the measurement that obtain would be effect. Nowadays, it is well known that optical fiber sensors play a major role on the performance of various state of the art measurement devices and systems, namely: gyroscopes, accelerometer, strain and temperature sensors, among many other. In order to increase the range of applications of such kind of sensors a great deal of researcher activities has been guided towards the design and implementation of low-cost sensors. This work addresses design, implementation and characterization of a plastic optical fiber microbend sensor, and points out its potential as a low-cost anti-squeeze sensor. Quite reasonable results were obtained using plastic optical fiber sensor and standard optoelectronic detection scheme.

Therefore, PIC based fiber optic pressure sensor is created to overcome the conventional pressure sensor. Beside that the data that are transmit by using fiber optic are digital and make the processing data become easily and quickly. The cost of this project is expensive when we used glass fiber optic and we have decide to used plastic fiber optic in this project because its more cheap that glass fiber optic. The major application of this project is used for safety like to detect the object in the door based on the bending of fiber optic.

1.4 METHODOLOGY

Phase 1:

Meet and discuss with supervisor Mr. Chairulsyah Bin Abdul Wasli about this project. Show the project progress to him and then get more information about programmable interface controller (PIC) and fiber optic from internet, jurnal, e-book and so on. Firstly try to understand the concept and expected result for this project.

Phase 2:

For this phase, discuss with supervisor and do survey on the project process. Try to get and understand the related formula especially about micro bending. Try to find the calculation in this project and the expected results.

Phase 3:

For this phase, obtain the actual diagram of the project design and try to understand the operation of PIC based fiber optic pressure sensor. Then, by using software adobe flash CS4 professional, and create the animation. Show the animation to supervisor and make correction of the design. Then, we could be constructing the circuit of receiver and transmitter in multisim and breadboard.

Phase 4:

For this part, we have simulation of design and create the coding for PIC. After that, we would be constructing the actual hardware of PIC Based fiber optic pressure sensor and then make the comparison between simulation and theoretical result. Finally, submit the thesis of this project.

1.5 REPORT STRUCTURE

This report was divided into five chapters. The first chapter is focusing on the introduction of the project. The introduction consist of the project brief introduction, objective of the project, the project statement, scope of work, project methodology and the report structure.

The second chapter is about the literature review. This chapter is focusing on the documentation of the theory that related in designing receiver. The reviews of the previous case study are also included in this chapter.

The third chapter is mainly about the research methodology. All the progress and work flow are describe in this chapter.

The fourth chapter is about the project progress focusing on the results of the simulation. All the data that were obtain during this semester will be documented in this chapter. The full project results are shown.

The final chapter is focusing on the discussion and conclusion of this report. These include the entire results and its justification. Some suggestion on improving this project also will be discussed

CHAPTER II

LITERATURE RIVIEW

2.0 INTRODUCTION

Over the past 20 years two major product revolutions have taken place due to the growth of the optoelectronics and fiber optic communications industries. The optoelectronics industry has brought about such products as compact disc players, laser printers, bar code scanners, and laser pointers. The fiber optic communications industry has revolutionized the telecommunications industry by providing higher performance, more reliable telecommunication links with ever decreasing bandwidth cost. This revolution is bringing about the benefits of high-volume production to component users and a true information superhighway built of glass.

In parallel with these developments, fiber optic sensor technology has been a major user of technology associated with the optoelectronic and fiber optic communications industries. Many of the components associated with these industries were often developed for fiber optic sensor applications.

Fiber optic sensor technology, in turn, has often been driven by the development and subsequent mass production of components to support these industries. As component prices have fallen and quality improvements have been made, the ability of fiber optic sensors to displace traditional sensors for rotation, acceleration, electric and magnetic field measurement, temperature, pressure, acoustics, vibration, linear and angular position, strain, humidity, viscosity, chemical measurements, and a host of other sensor applications has been enhanced. In the early days of fiber optic sensor technology, most commercially successful fiber optic sensors were squarely targeted at markets where existing sensor technology was marginal or, in many cases, nonexistent. The inherent advantages of fiber optic sensors, which include their

(1) ability to be lightweight, of very small size, passive, low power, and resistant to electromagnetic interference;
(2) high sensitivity;
(3) bandwidth;
(4) Environmental ruggedness, were heavily used to offset their major disadvantages of high cost and end-user unfamiliarity.

The situation is changing. Laser diodes that cost $3000 in 1979 with lifetimes measured in hours now sell for a few dollars in small quantities, have reliability of tens of thousands of hours, and are widely used in compact disc players, laser printers, laser pointers, and bar code readers. Single-mode optical fiber that cost $20/meter in 1979 now costs less than $0.10/meter, with vastly improved optical and mechanical properties. Integrated optical devices that were not available in usable form at that time are now commonly used to support production models of fiber optic gyros. Also, they could drop in price dramatically in the future while offering ever more sophisticated optical circuits. As these trends continue, the opportunities for fiber optic sensor designers to produce competitive products will increase and the technology can be expected to assume an ever more prominent position in the sensor Marketplace. In the following sections the basic types of fiber optic sensors being developed are briefly reviewed, followed by a discussion of how these sensors are and will be applied. [2]

2.2 FIBER OPTIC CABLE

Plastic optical fibers have larger cores (120–1000 microns) than standard multimode fiber, which makes it easier to align connectors. They are easy to install,