ANALYSIS AND CALCULATION OF FIBER TO FIBER CONNECTION LOSS

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To
My parents
Mohd Ramli b. Ismail& Rahimah bt Md. Ramli

My siblings,
Mastura, Nurhafizah, Nur Aida Adila, Mohd Azrul Hisyam & Nur Azila Umairah

For your infinite and unfaunding love, sacrifice, encouragement and best wishes

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ABSTRAK

Dalam kajian ini, saya telah membangunkan sebuah kalkulator menggunakan bahasa pengaturcaraan Visual Basic 6.0 yang dapat digunakan untuk mengira komunikasi putus pada sambungan fiber optik. Kalkulator ini digunakan untuk mengira komunikasi putus jenis sambungan fiber tunggal,' *multimode fiber step index'* dan *'multimode fiber graded index'*.

Hasil daripada kajian, didapati bahawa kalkulator yang hasilkan dapat mengira nilai komunikasi putus bage ketiga-tiga jenis sambungan tersebut dengan jayanya.

ABSTRACT

In this research, the software calculator has been build using Visual Basic .0. This software calculator can calculate connection loss of fiber optic. This calculator to calculate connection loss in single mode fiber, multimode fiber step index and multimode fiber graded index.

As the result, this software calculator can calculate connection loss for three cases and produce the accuracy result.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Misalignment and hetergonic of fiber optic cable in splicing process will effect to the attenuation loss in fiber optic link. This project will design software to calculate the effect of loss which is caused of position misalignment and hetergonic of fiber optic cables to connect. Types of losses connection fiber connection are distance between fiber cables, the way how fiber cable connected, angular between fibers connecter and other. It will be helpful software to support fiber optic learning process. The Visual Basic will be use for guide interface user (GUI), formula and calculating support. This calculator easier to use by inserting the value of parameter such as angle (θ), distance, offset value between joining cores of fiber optic and other value. The result will display automatically. The task of this project is to study literature, software design and testing.

1.2 BACKGROUND OF STUDY

The background of study for this project related about the characteristic of fiber optic, know how many type connection of fiber optic in single mode and multimode, analyze the type of fiber connection losses and write the coding code for each

misalignment using Visual Basic 6.0. This software calculator will display the formula and picture how misalignment connections look alike.

1.3 OBJECTIVE

The objectives of this project are:

- to study and analyze types of losses of fiber optic
- to design friendly software calculator by using VB6.0
- to test the reliability of software calculator.

1.4 SCOPES OF STUDY

The specific scope in this project can be divided into two phase. The first phase is identified and analyzes the different connection condition of losses in splicing fiber optic. And the second phase is to develop software calculator. For the first stage, each condition connection of the fiber optic need to identified and analyze. They are including cases in single mode fiber and multimode fiber. In this part, the comparison between connection in air and without free are was analyze. After that, follow to the second phase. In this phase, study the programming language of Visual Basic 6.0 to develop the software calculator. This software calculator will be display the types of losses in optical fiber such as core-diameter mismatch and numerical-aperture mismatch for intrinsic connection losses and lateral misalignment, angular misalignment and end separation for extrinsic connection losses. Then convert the fiber optic formula into the programming in the VB 6.0. After that, simulate and analysis simulation in VB script. Finally, it will be testing and analyze the performance of this software in terms of processing speed and data accuracy.

1.5 OUTLINE OF REPORT

CHAPTER 1 will be describe the definition of the project. The explanation about this project also include in this chapter. It also introduces the project before do the literature review.

CHAPTER 2 will be discussing about the information and all the research that have the related with this project. Each fact and information that related with this project is get from the different references such as book title, journal and other.

CHAPTER 3 will be explaining about design of software. It was including the coding code to make the software calculator.

CHAPTER 4 is describing about the project result and outcome discovery. The project outcome discovery will be presented from data analysis result.

CHAPTER 5 will be explaining the conclusion of the whole project which includes project finding, achievement analysis and conclusion the research implementation which have been used. The project suggestion for enhancement also discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 BACKGROUND STUDY

This is background study on this topic related to the project that is about splicing in fiber optic. This is also about step to splice, characteristics and types of optical fiber.

2.2 LITERATURE REVIEW

2.2.1 Optical Fiber

An optical fiber is simply a very thin piece of glass which acts as a pipe, through which light can pass down. The light can be turn on and off to represent digital information. Besides that, it can be gradually change in amplitude, frequency or phase to represent analog information. It's widely used in fiber optic communication which permits transmission over longer distance and at higher data rates than other forms of wired and wireless communication. [3]

The term optical fiber covers a range of different designs including graded index optical fiber, step-index optical fiber and more recently photonic crystal fiber.

Normally, it will be used with the design and the wavelength of light of the propagating in the fiber. From that, the type of fiber optic will determine either multi-mode optical fiber or single-mode optical fiber. Based on their uses, the fibers are built into different kind of cable.

2.2.1.1 Construction of an Optical Fiber

An optical fiber consist a tube of glass constructed of a number of layers of glass. It will be appear to have a number of concentric rings when looked at profile. The illustrate layer of glass as shown in figure 2.2. Each layer or known as ring have a different refractive index. From the previous discussion, it can be seen that the requirement that total internal reflection occur needed to send light down the center of these concentric glass tubes. This will be duct the light through a fiber. The outer glass require a lower refractive index than the inner glass tube in which the light is traveling to achieve total internal reflection the outer glass ring [1]. Figure 2.1 until Figure 2.3 illustrates the construction of a typical optical fiber.

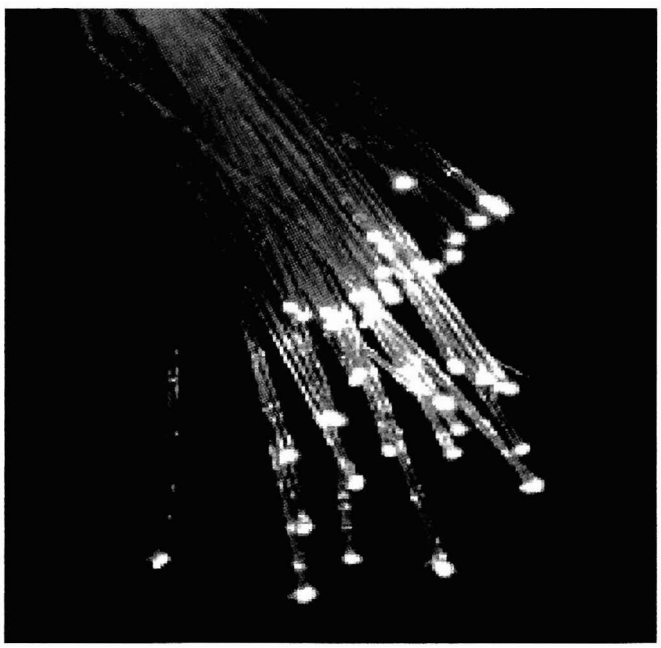

Figure 2.1 Optical fiber

Figure 2.2 Optical fiber cables

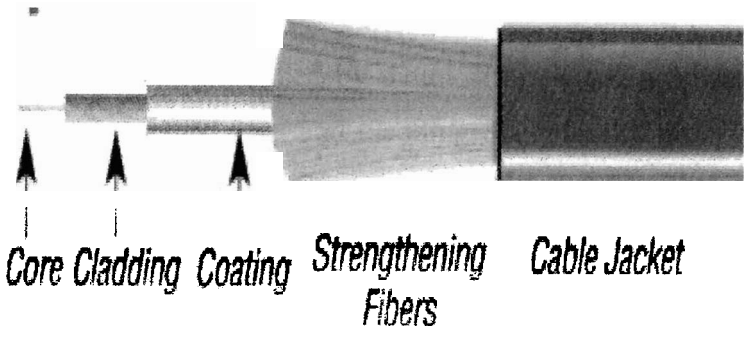

Figure 2.3 Construction of optical fiber

2.2.2 Types of Optical Fiber

There are three variety types of optical fiber such as single-mode fiber, multi-mode step index and multi-mode step index fiber. Each of them has their specification. For example, multimode optical fiber mostly used for communication over shortest distance like within a building or on link lengths of up to 550meters, more the sufficient for the majority of premises application.

Typical transmission speeds/distance limits are 100Mbit/s up to 2km (100BASE-FX), 1Gbit/s for distance up to 500-600meters (100BASE-SX) and 10Gbit/s for distance up to 300meters. Due of this reason multi-mode optical fiber

generally used for backbone application in building because of the high capacity and reliability.

Multi-mode optical fiber has a higher 'lighting gathering' capacity compare to single-mode optical fiber. However, the limit on speed × distance is low because multi-mode optical fiber has a larger numerical aperture (NA) that support more than propagation mode. Hence, it is limited by modal dispersion compare to single-mode that has a higher limit on speed × distance. So, single-mode optical fiber has smallest numerical aperture (NA). Consequently, multi-mode optical fiber has higher pulse spreading rates than single-mode optical fiber. Due of this reason, multi-mode has limiting information transmission capacity [7].

Multi-mode optical fibers are described by their core or cladding diameter. Thus, 62.5/125μm has a core size 62.5μm and cladding diameter 125μm. Figure 2.4 show the multimode optical fiber while Figure 2.5 and figure 2.6 are illustrates the information transmission capacity of multi-mode step index and multi-mode graded index.

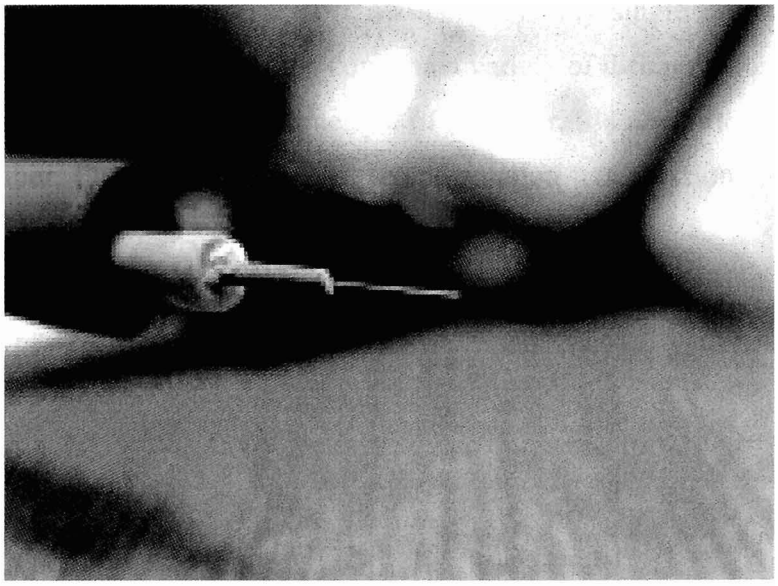

Figure 2.4 Multimode optical fiber

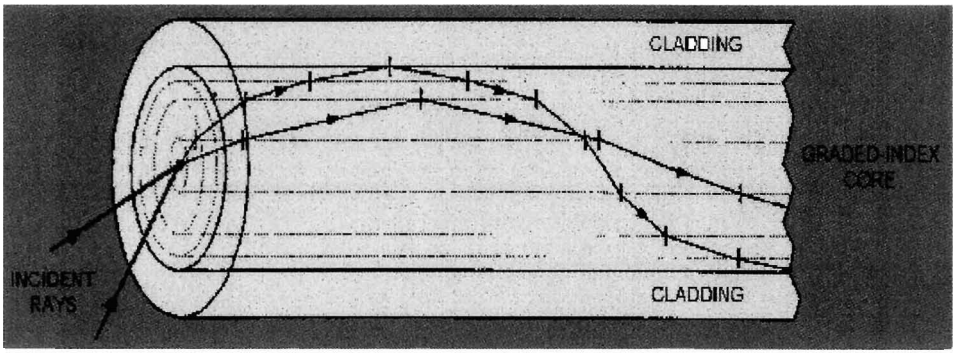

Figure 2.5 Multimode graded index fiber' light propagate

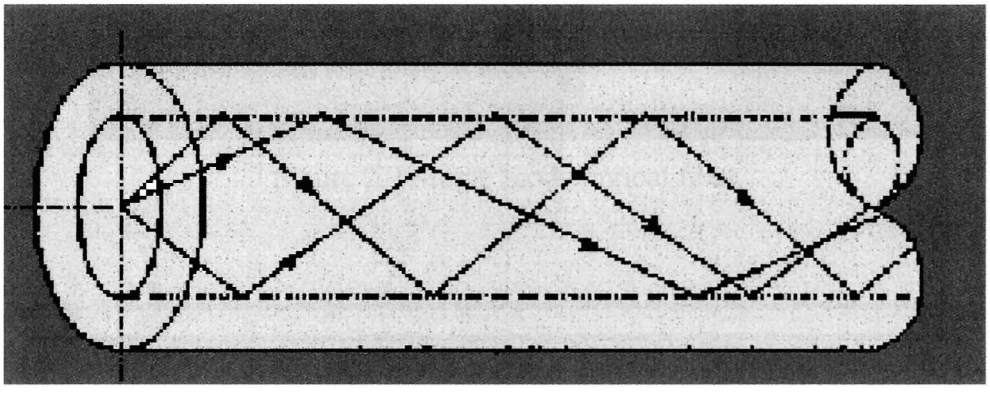

Figure 2.6 Multimode step index fiber's light propagate

Single-mode optical fibers are designed to carry only single ray of light or known as mode. This ray of light often contains a variety of different wavelengths. Although the ray travel parallel to the length of the fiber, it's also often called the length of the fiber. Figure 2.7 illustrates the information transmission capacity of single-mode fiber.

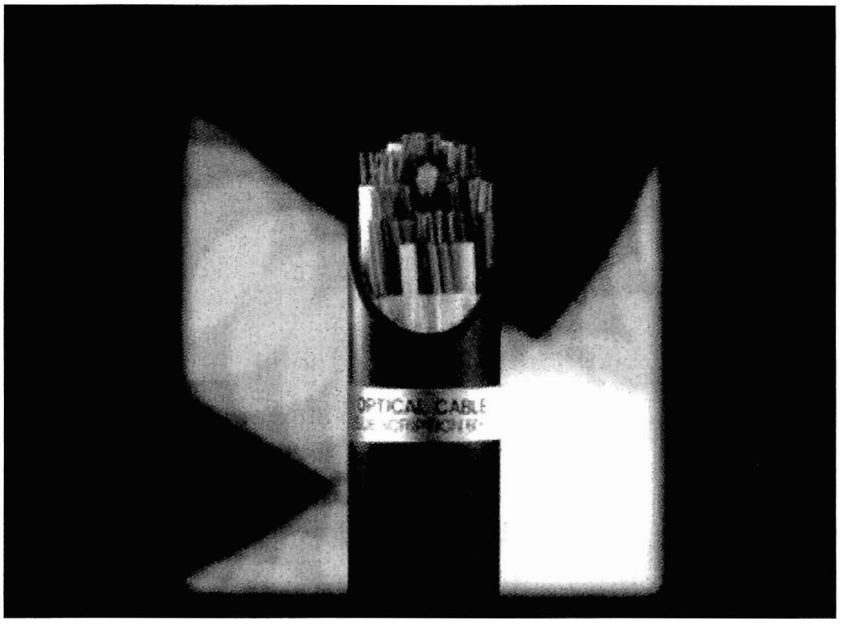

Figure 2.7 Single mode optical fiber

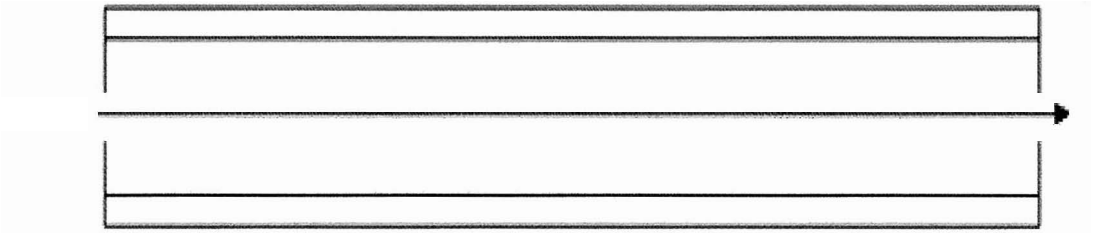

Figure 2.8 Single mode fiber's light propagate

Unlike multi-mode optical fiber, single mode fibers do not exhibit dispersion resulting from multiple spatial modes. It's also better at retaining the fidelity of each light pulse over long distances than are multi-mode fibers. Due of this reason, single-mode fibers can have a higher bandwidth compare to multi-mode fibers. Besides that, equipment for single-mode fiber is more expensive than equipment for multi-mode fibers but single-mode fiber usually cheaper in bulk[5].

Other than that, single-mode fiber has a core radius between 8μm and 10μm and a cladding radius is 125μm. Because of that, the wavelength of the light or more known as lambda is 1310nm or 1550nm. There are a number of special types of single-mode fiber which have been chemically or physically altered to give

special properties such as dispersion-shifted fiber. Data rates are limited by polarization mode dispersion and chromatic dispersion[5].

2.3 SPLICING

There are many source splice loss in the optical fiber. One of them is the different between two fibers. Although optical fiber is made to very precise specification, there are still very slight differences between fibers. It can know when the numerical aperture (NA) of the transmitting fiber is larger than the receiving fiber or when the core diameter of transmitting fiber is larger, it's may cause some losses. For example, loss can produce if the cores are not perfectly circular unless they are perfectly lined up. Even the cladding makes a difference in the cladding; its can caused the core to be misalignment. Fiber manufacturers have made much progress in reducing these problems. Fiber produce to a 5micron tolerance has a maximum loss of 0.6dB. It newer manufacturing techniques allow tolerance of 1 (0.1dB) to 2 (0.2dB) microns.

Connecting two fiber optic cables requires precise alignment of the mated fiber cores or spots in a single-mode optical fiber cable. So that, it's required all the light is coupled from one fiber-optic cable across a junction to the other fiber optic cable.

2.3.1 Types of Splicing

There are two principle types of splices such as fusion and mechanical. Fusion splices use an electric arc to weld two fiber-optic together. The localized heat to melt or fuse ends of two optical fibers together is the process that involved in fusion splicing. By preparing each fiber ends fusion is the beginning splice process. Besides that, all the protective coatings have been removed from the ends