ANALYSIS OF BENDING AND STRAIGHT WAVEGUIDE USING MATLAB AND GRAPHICAL USER INTERFACE (GUI)

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This report submitted in partial fulfilment on the requuirements for the award of Bachelor in Electronic Engineering (Telecommunication Electronics) with Honours

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DEDICATION

"In the Name of ALLAH, the most Beneficent, the Most Merciful"

Special Dedication to my parents

(Mr. Ab Abas Bin Mohd Salleh and Madam Rafiah Binti Rafii)

To my supervisor Engr. Mohd Muzafar Bin Ismail

My family and my friends

Thank you for all your care, support and believe in me.

APPROVAL

This report is submitted to the Faculty of Electronics and Computer Engineering of UteM as a partial fulfilment of the requirements for the Degree of Bachelor in Electronic Engineering (Telecommunication Electronics)

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ENGR. MOHD MUZAFAR BIN ISMAIL

(Official Stamp of Supervisor)

ACKNOWLEDGEMENT

Alhamdulillah....Praise to ALLAH S.W.T....

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ABSTRACT

Analysis of Bending and Straight waveguide modelling is very useful nowadays for it hard to find software that provides mathematical simulation for optical waveguide. This project targeted on modelling Bending and Straight waveguide as the main component in optical devices. The analysis and modelling is important and give extra attention before it can be practically used. The purpose of simulation is to obtain the electric field profile and effective refractive index, n_{eff} of the waveguide that varies according to input parameters such as dimension of waveguide structure, refractive index of material and operated wavelength. Matlab and Graphical User Interface (GUI) applied in developing this simulation program using the Matlab R2012a software. GUI will come from the Matlab program, where a window with an editable text field or graphical figures will be used. After inputs and simulation has been simulated, the window will pop out, indicates the output result. The design of the user interface and the functionality of the application will be the final part of the process. This may benefit the user on analytical approximation solutions, time and cost. The objective of this project is to develop simulation software for an optical waveguide structure using GUI. It also to analyst an optical waveguide by using applications from Matlab in order to make analysis work easy and as well as for educational study on computer analysis and design. The obtained result will then be compared with the existing analysis using another method. The factors that contribute to the accuracy of simulated result obtained is agreeable with theory.

ABSTRAK

Analisis Lenturan dan lurus model pandu gelombang sangat berguna pada masa kini kerana ia sukar untuk mencari perisian yang menyediakan simulasi matematik untuk pandu gelombang optik. Projek ini disasarkan pada model pandu gelombang lentur dan lurus sebagai komponen utama dalam alat-alat optik. Analisis dan model adalah penting dan memberi perhatian tambahan sebelum ia boleh digunakan. Tujuan simulasi adalah untuk mendapatkan profil medan elektrik dan indeks biasan yang berkesan, n_{eff} waveguide yang berbeza-beza mengikut parameter input seperti dimensi struktur pandu gelombang, indeks biasan bahan dan gelombang yang dikendalikan. Matlab dan Graphical User Interface (GUI) digunakan dalam membangunkan program simulasi ini menggunakan perisian Matlab R2012a. GUI datang dari program Matlab, di mana tingkap dengan medan teks disunting atau angka grafik akan digunakan. Selepas masukan dan simulasi dimasukkan, tetingkap akan dipaparkan, menunjukkan hasil keluaran. Reka bentuk antara muka pengguna dan fungsi permohonan itu akan menjadi bahagian proses terakhir. Ini boleh memberi manfaat kepada pengguna untuk menyelesaikan masalah dari segi analisis, masa dan kos. Objektif projek ini adalah untuk membangunkan perisian simulasi untuk struktur pandu gelombang optik menggunakan GUI. Ia juga untuk menganalisis pandu gelombang optik dengan menggunakan perisian daripada Matlab untuk membuat analisis yang mudah serta kajian pendidikan mengenai analisis komputer dan reka bentuk. Keputusan yang diperolehi akan dibandingkan dengan analisis yang sedia ada dengan menggunakan kaedah yang lain. Faktor-faktor yang menyumbang kepada ketepatan hasil simulasi dipersetujui dengan teori.

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b	-	Normalized propagation constant
c	-	Speed of light; Phase velocity [m/s]
B	-	Magnetic flux-intensity complex amplitude [Wb/m^2]
d	-	Differential
div	-	Divergence
D	-	Electric flux density [C/m^2]
E	-	Electric field [V/m]
F	-	Force [$kgms^{-2}$]
H	-	Magnetic-field complex amplitude [A/m]
H	-	Magnetic field [A/m]
j	-	$(-1)^{1/2}$ integer
J	-	Electric current density [A/m^2]
k_o	-	Free space propagation constant [rad/m]
l	-	Length [m]
m	-	Number of modes
M	-	Magnetization density [A/m]
n	-	Refractive Index
n_g	-	Refractive Index of guiding layer
n_s	-	Refractive Index of substrate layer
n_c	-	Refractive Index of cladding layer
NA	-	Numerical Aperture
p	-	Electric polarization density [C/m^2]
Q	-	Electric Charge [C]
T	-	Time [s]
β	-	Propagation constant [rad/m]

ε	-	Electric permittivity of a medium [F/m]
ε_o	-	Electric permittivity of a free space [F/m]
ε_r	-	relative dielectric constant of the material [F/m]
θ	-	Angle
θ_c	-	Critical angle
λ	-	Wavelength [m]
λ_o	-	Free space wavelength [m]
μ	-	magnetic permeability [H/m]
μ_o	-	magnetic permeability of free space [H/m]
∇	-	Gradient operator
$\nabla.$	-	Divergence operator
$\nabla\times$	-	Curl operator

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CHAPTER 1

INTRODUCTION

1.1 Background of Project

Over the past few years, the bending waveguides was introduced in radar equipment. As we all know, the installation of bending waveguides is very difficult and expensive to produce. Then it becomes a proof, as the power increases, the speed of the aircraft and missile applications made that would have enhanced the bending technique. First, to reduce transmission losses, a new method to generate internal corners that meet close tolerance cross section. Second, a faster method to bending can be found. Lastly, a smaller bend radius, the closer spacing of compound bends and bends adjacent swaged section and twisted to be made to meet the demands of the new design. To make bending waveguides has a reasonable uniformity of production, improvement and innovation specifically done for statistical quality can be realized [1].

In this sophisticated technologies, lasers and fibers are the key components of optical communication systems and it is given a big impact among the public. Telecommunications has shown that it plays an important role in the modern world. Bending waveguides are made from material structures that have a core region which has higher index of refraction than the surrounding regions [2]. The fabrication and analysis of bending waveguides constitute the most basic knowledge needed for understanding and designing guided-wave components.