TECHNICAL REPORT

NUMERICAL SOLUTION OF 2-D MAXWELL'S EQUATION USING FINITE DIFFERENCE TIME DOMAIN

MUHD. NUR ALIYUDDIN ABD SAMAD	2014262424
MUHAMMAD FARIS AHMAD FADLI	2014409966
HASAN AL BASHRI SARIP	2014227928

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IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

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TABLE OF CONTENTS

ABSTRACT

Maxwell's equations is an equations used describe the relation of electric and magnetic fields. The applications of electric and magnetic field are mostly can be found in daily appliances such as WiFi, mobile phone, microwave, and others. With the increasing of electromagnetic in current technology, Maxwell's equations has become an important equations used to solve the electromagnetic problem. The study on this topic, mostly discuss the basic of Maxwell's equations and how to solve the equations. Because the complexity of the equations, the use of a computer software are required to help in solving the equations. By using a numerical approximation method, the equations become easier to evaluate. From the existing method the method used in this project is a finite difference time domain method or also known as Yee Algorithm to approximate the solutions of Maxwell's equations. In this project, all of the objectives are achieved. Firstly, the finite difference time domain method are successfully integrate into 2-Dimensional Maxwell's Equation. Secondly, updating functions are derive to enable the implementation of the equations in MATLAB. Then, the equation are solved and visualization of the solution are used to analyze the behavior of the field. Lastly, the Courant number, S_c are analyzed to find the stability factor of the solution. From this study, the analyzed value of Courant number are stable when $0.702 \leqslant S_c \leqslant 0.707$. The model is build based on 2D TE wave for Maxwell's Equation. However, the same procedure can be applied to build TM wave which is to find the value of tangential electric field (Ez) in which, by replacing three update function for TE wave to TM wave update function as well as replacing magnetic source to electric source.

1 INTRODUCTION

Maxwell's equations are a partial derivative equation (PDE) used to analyses the relation between electric field and magnetic field. The equations are named after a physicist and mathematician James Clerk Maxwell, who formulates the early form of this equations. The Maxwell's equations can be applied in many electric and magnetic related technology such as wireless communication device, power generator, electric motor and others. Based on Maxwell's equations, electric field and magnetic field generated by changes in charge and current. Maxwell equations are formed by applying Physics law related to electric field and magnetic field, such as, Gauss's law, Faraday's law and Ampere law Turnbull (2015).

The focus in this project is to solve for Maxwell Equation using numerical method. Numerical method is method of finding approximate solutions for mathematical equations. There are many numerical method for solving Maxwell equations, but finite difference method (FDM) are used in this project. FDM is method of solving PDE by replacing all partial derivative and other term in approximated value. However, due to complexity of Maxwell's equations, the finite difference time domain method (FDTD) has been used. FDTD or also known as Yee Algorithm are finite difference method to solve PDE with domain in form of time. To make it easier and time saving, the computer software such as MatLab was used to make the calculation.

The Problem statement for this project is heavy processing and longer time needed to stimulate large field, the grid must be modified depending on interface boundary condition so that it did not disperse, and the approximation method has a lower accuracy compared to its analytical method.

The objective in this study are to derive the 2-dimensional finite difference time domain equation of Maxwell's Equation, to the derived updating function so that a better understanding on how the implementation works, to solve the Maxwell equation using MATLAB software and to analyzed Courant number, S_c for the stability factor of the solution.