



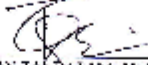
**MODELING PLANAR INVERTED F ANTENNA BASED ON 3D FINITE
DIFFERENCE-TIME DOMAIN (FDTD) METHOD IN GRAPHICAL USER
INTERFACE (GUI) FOR RADIATION PATTERN EVALUATION.**

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**This Report is Submitted In Partial Fulfillment of Requirement for Award of
Bachelor of Electronic Engineering (Telecommunication Electronics) With Honour**

**Faculty of Electronics and Computer Engineering
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It is only befitting that I dedicated this humble work to the noble and illustrious prophet, Muhamad SallallahuAlaihiWasallam, addressed by Allah SubhanahuWata'ala as the “Unlettered” Prophet, yet, the Master of the most extensive knowledge, foretold in previous scriptures, and the Mercy for the Worlds.

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ABSTRACT

The Finite-Difference Time-Domain (FDTD) method is one of known electromagnetic numerical tool that used for design and analysis the antenna. Whereas this method is simpler than Method of Moments (MoM) or Finite Element Method (FEM) and it is space time based domain as a result benefited to wide band frequencies application. The purpose of project is to develop a simulator based on 3D-FDTD method for planar inverted F antenna. Hence the antenna dimension and characteristics such as relative dielectric permittivity, loss tangent and substrate thickness are directly entered by user into the MATLAB based-graphical user interface (GUI) menu which is user friendly and attractive. As a result of simulation the antenna electric field radiation are displayed into three (3) different planes. That radiation patterns can be partly drawn in xy, yz and xz plane at particular frequency. Since this software designed for three (3) dimensional antenna structure than two (2) dimensions, therefore higher computational cost. From this project, we had able create our own specific antenna software toward learning how commercial software such as that CST or HFSS developed. As well as learning tool to motivate for students keeps involving in development of antenna simulator or tool. Normally, prices of electromagnetic software packages especially antenna is quite expensive and license per year basis. Finally, this project also relevant and parallels with the latest technology in antenna design.

ABSTRAK

Kaedah "Finite-Difference Time-Domain" (FDTD) merupakan salah satu perkakasan numerikal elektromagnetik yang digunakan untuk merekabentuk dan menganalisa antenna. Di mana kaedah ini lebih ringkas daripada "Method of Moments" (MoM) atau "Finite Element Method" (FEM) dan ianya berdasarkan ruang masa domain hasilnya memudahkan untuk aplikasi frekuensi jalur lebar. Tujuan projek ialah membangunkan simulator berasaskan kaedah 3D-FDTD untuk antenna satah F terbalik. Di sini ciri-ciri dan dimensi antenna seperti dielektrik permittiviti relatif, kehilangan tangent dan ketebalan substrate dimasukkan terus oleh pengguna ke dalam menu paparan muka pengguna grafik (GUI) MATLAB yang mesra guna dan menarik itu. Hasil simulasi antenna, radiasi medan elektrik dipaparkan dalam tiga (3) satah berbeza. Bentuk radiasi itu boleh digambarkan berasingan dalam satah berbeza xy , yz dan xz pada frekuensi tertentu. Oleh kerana perisian ini direkabentuk untuk struktur antenna tiga (3) dimensi berbanding dua (2) dimensi, maka kos pengkomputeran lebih tinggi. Daripada projek ini, kita mampu mencipta sendiri perisian tertentu antenna ke arah memahami bagaimana perisian komersial seperti CST atau HFSS itu dibangunkan. Juga sebagai alat pembelajaran bagi memotivasi pelajar sentiasa melibatkan diri dalam pembangunan alat atau simulator antenna. Kebiasaannya, harga pakej perisian elektromagnetik terutamanya antenna adalah sangat mahalnya dan asas kepada tahun lesen. Akhir sekali, projek ini juga relevan dan selari dengan teknologi terkini dalam rekabentuk antenna.

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CHAPTER I

INTRODUCTION

1.1 PROJECT OVERVIEW

This project will be exposed and introduces about fundamental and application to the differential time domain Maxwell's equations of Cartesian coordinate to simulate planar inverted F antenna. Then, should to know these equations have been discretized for using in development Finite Different Time Domain (FDTD) method for modeling full wave electromagnetic structure. Finite Different Time Domain (FDTD) is simple and easy to implement numerically and time based simulation method as result better for wideband frequency response. This method has advantage over other simulation methods in that it does not use empirical approximations. This project also, to find radiation in region far away from antenna the near-field to far-field (NFFF)

transformation technique and Fast Fourier Transformation (FFT) will be implemented. By changing several parameter of the antenna, radiation pattern can be visualized and studied. Besides that to verify antenna radiation pattern from Finite Different Time Domain (FDTD) software it will be compared to commercial software either CST or HFSS.

1.2 OBJECTIVES

The objectives of this project are

- 1) To model planar inverted F antenna using 3D Finite-Different Time-Domain (FDTD).
- 2) To implement MATLAB programming in planar inverted F antenna modeling.
- 3) To analyze the radiation pattern of planar inverted F antenna.

The main objective for this project to model planar inverted F antenna with designs the software where to develop 3D finite-difference time-domain (FDTD) in graphical user interface (GUI) for radiation pattern evaluation.

1.3 PROBLEM STATEMENTS

This project was motivated from the learning of numerical modeling. Normally called Computational Electromagnetic Modeling (CEM) involving in project it is a simple and cost efficient. In analytical method is used, theoretical of fundamental must be strong to designing any structure. Others method can be used is experimental, but this method need to high cost and take a long time to modeling planar inverted F antenna

if does not get a best result. The antenna is excited by a voltage source, and sampled voltage and a sampled current are defined on and around the voltage source to form an input port. So that, Finite-Different Time-Domain (FDTD) is used for solve the Maxwell equation. For the reason is, it will easier to modeling than implement experimental. Thus, it reduce cost, time and can test for different planar inverted F antenna dimension.

The Finite-Difference Time-Domain (FDTD) method has gained tremendous popularity in the past decade as a tool for solve Maxwell's Equation in the time domain. It is a based on simple formulations that do not require complex asymptotic or Green's functions. Although it solves the problem in time, it can provide frequency-domain responses over a wide band using the Fourier transform. It can easily handle composite geometries consisting of different types of materials including dielectric, magnetic, frequency-dependent, nonlinear, and anisotropic materials. The FDTD technique is easy to implement using parallel computation algorithms. Application of the FDTD method is usually straightforward, the solution domain is typically discretized into small rectangular or curvilinear element, in time used to compute the electric and magnetic fields from one another. FDTD excels at analysis of inhomogeneous and nonlinear media, though its demands for system memory are high due to the discretization of the entire solution domain, and it suffers from dispersion issues as well and the need to artificially truncate the solution boundary. FDTD finds applications in packaging and waveguide problems, as well as in the study of wave propagation in complex dielectrics.

1.4 SCOPE OF WORKS

1.4.1 Understanding Finite-Difference Time-Domain (FDTD) algorithm

This project presents about modeling planar F antenna using finite difference-time domain (FDTD) method in graphical user interface (GUI) for visualize radiation pattern. Finite-Difference Time-Domain (FDTD) is a popular electromagnetic modeling techniques. It is easy to understand, easy to implement in software, and since it is a time-domain technique it can cover a wide frequency range with a single simulation run. The finite-difference time-domain (FDTD) algorithm is an especially popular tool because it is simple, robust, and easy to understand. The perfectly matched layers (PMLs) as a boundary to terminate the finite-difference time-domain (FDTD) lattices to simulate open boundary problems. However, the PML is shown to be ineffective for absorbing evanescent waves. As a result, the PML must be placed sufficiently far from an obstacle such that the evanescent waves have sufficiently decayed. However, this increases the number of cells in an FDTD computational domain and hence the computational memory and time requirements. besides that, another problem reported for PML is that it suffers from late-time reflections when terminating highly elongated lattices or when simulating fields with very long time signatures. This is partly due to the weakly causal nature of the PML. A strictly causal form of the PML, which is referred to as the complex frequency-shifted PML (CFS-PML) was developed. It has been shown that the CFS-PML is highly effective at absorbing evanescent waves and signals with a long time signature. Therefore, using the CFS-PML, the boundaries can be placed closer to the objects in the problem space and a time and memory saving can be achieved, thus avoiding the aforementioned weakness of the PML.

1.4.2 Familiarize Finite-Difference Time-Domain (FDTD) Program

The starting point for the construction of an FDTD algorithm is Maxwell's time-domain equations. The differential time-domain Maxwell's equations needed to specify the field behavior over time are. Study application of Maxwell's equations, for this project only use Ampere's Law and Faraday's Law. The equations are :

- 1) To study application of Ampere Maxwell's Law

$$\frac{\partial \vec{D}}{\partial t} = \nabla \times \vec{H} - \vec{J} \quad (1.4.2a)$$

- 2) To study application of Faraday Law

$$\frac{\partial \vec{B}}{\partial t} = -\nabla \times \vec{E} - \vec{M} \quad (1.4.2b)$$

Where the symbols are defined as :

H = magnetic field (A/m)

D = electric flux density (C/m²)

J = electric current density (A/m²)

E = electric field (V/m)

B = magnetic field density (V/m²)

1.4.3 Antenna design in FDTD

Dimensions in mm

Substrate thickness = 0.787mm

Strip widths = 2.4mm

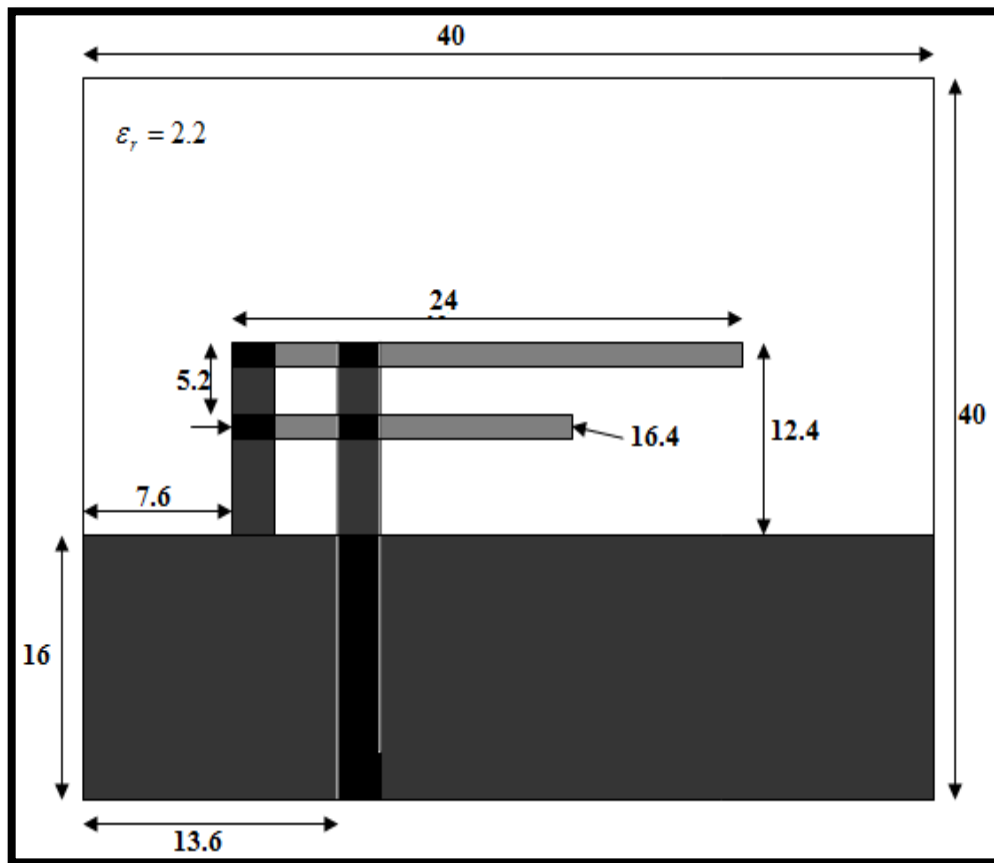


Figure 1.1 : The design for a planar inverted F antenna (Top view)

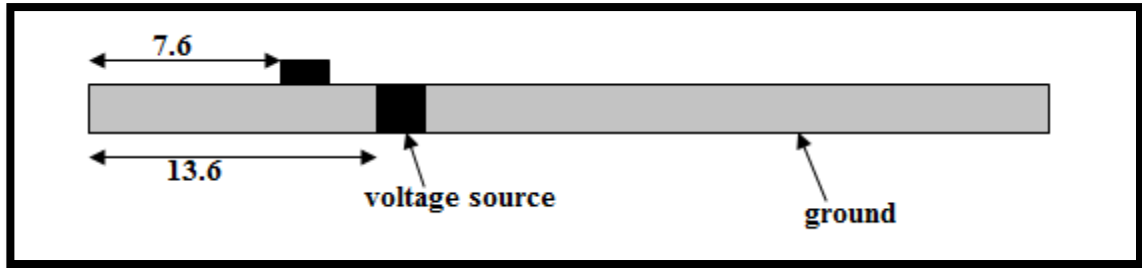


Figure 1.2 : The design for a planar inverted F antenna Side view

1.4.4 Developed Graphical User Interfaces (GUI)

In this project, Graphical User Interface is used. In computing, a graphical user interface is a type of user interface that allows users to interact with electronic devices using images rather than text commands. A Graphical User Interface (GUI) represents the information and actions available to a user through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation. The actions are usually performed through direct manipulation of the graphical elements.

There are several compelling arguments for using MATLAB as a GUI development tool. The important to develop Graphical User Interface (GUI) in MATLAB is:

1) High-Level Script Based Development

MATLAB scripts do not require compilation, do not require rigorous instantiation of variables, and do not require low-level memory management. Therefore, code development time can be much shorter and often the complexity of code is much simpler. Graphical User Interface (GUI) application development can be a daunting task for scientists and engineers who do not have a strong background in software engineering.

2) Seamless Integration with Existing MATLAB Computational Power

May already be a committed MATLAB user and have libraries of functions and scripts for solving specific problems related to field or perhaps have acquired scripts and functions through the science and engineering community. Building Graphical User Interface (GUI) using MATLAB means that all the code have developed to solve complex problems may be directly used within GUI.

3) Operating System Independent GUI Applications

MATLAB currently supports operating systems such as Solaris (UNIX), MS Windows, Linux, and Mac OS-X and this allows considerable flexibility for code development. Since M-file scripts are not compiled, they may be executed using MATLAB that runs on any operating system supported. This is also true for GUI application development with a few exceptions for some properties.

4) User Interactivity and Real-time Measurements

Although M-file scripts and functions are excellent for solving many problems, there are often situations where user interactivity with the application is integral for understanding or solving a particular problem. Some examples of where a GUI interface can help the user interact efficiently with an application are listed below:

- Video applications
- Audio Signal Processing
- Communications Signal Processing
- Simulation of Complex Systems
- Animation of 2D or 3D Graphical Data

1.4.5 Simulate using FDTD

CHAPTER II

LITERATURE REVIEW

This chapter contains the literature review theoretical concept that applied in this project. It contains the information gathering of the project in order to complete whole project. The main source is book and other sources, which is journals and articles obtained from internet.

2.1 FINITE-DIFFERENCE TIME-DOMAIN (FDTD)

Finite-Difference Time-Domain (FDTD) is one of the primary available computational electrodynamics modeling technique. Since it is a time-domain method,