

Avant-Garde Technique to Design a GUI Model for Rectangular Patch Antenna

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Abstract— the goal of this paper to design and analysis the Microstrip Patch Antenna using different parameters. A series of parametric study were done to find that how the characteristics of the antenna depends on its various geometrical and other parameters. The various geometrical parameters of the antenna are the dimensions of the patch and ground planes and the separation between them and it also includes the dielectric constant of the substrate material. . The antenna should possess a band reject characteristic at interfering frequency bands. Then three compact UWB antenna designs with different notches for the various applications like WLAN, WIMAX downlink, X band satellite communication and INSAT.

Keywords— UWB, Rectangular Patch Antenna, Wireless LAN

I. INTRODUCTION

In now day's the wireless system has become a part of human life. Most of the electrical and electronics equipment around are using the wireless system. An antenna is an essential element of the wireless system. Antenna is an electrical device which transmits the electromagnetic waves into the space by converting the electric power given at the input into the radio waves and at the receiver side the antenna intercepts these radio waves and converts them back into the electrical power. There are so many systems that uses antenna such as remote controlled television, cellular phones, satellite communications, spacecraft, radars, wireless phones and wireless computer networks. Day by day new wireless devices are introducing which increasing demands of compact antennas. Increase in the satellite communication and use of antennas in the aircraft and spacecraft has also increased the demands a low profile antenna that can provide a reliable communication. A microstrip antenna is one who offers low profile and light weight. It is a wide beam narrowband antenna can be manufactured easily by the printed circuit technology such as a metallic layers in a particular shape is bonded on a dielectric substrate which forms a radiating element and another continuous metallic layer on the other side of substrate as ground plane. not only the basic shapes any continuous shape can be used as the radiating patch. Instead of using dielectric substrate Some of the microstrip antennas use dielectric spacers which results in wider bandwidth but in the cost of less ruggedness. Microstrip antennas are low profile antenna and mechanical rugged and can be easily mounted on any planar and nonplanar surfaces. The size of microstrip antenna is related to the wavelength of operation generally $L/2$. The applications of microstrip antennas are above the microwave frequency because below these frequency the use of microstrip antenna doesn't make a sense because of the size of antenna. At frequencies lower than microwave, microstrip patches don't make sense

because of the sizes required. Now a day's microstrip antenna is used in commercial sectors due to its inexpensiveness and easy to manufacture benefit by advanced printed circuit technology. Due to the development and ongoing research in the area of microstrip antenna it is expected that in future after some time most of the conventional antenna will be replaced by microstrip antenna.

II. TYPES OF ANTENNA ACCORDING TO APPLICATION

Different types of application requires antenna with different parameters. Like for cellular mobile communication a circular polarized antenna is requires with high gain and for satellite communication in downlink a high directive antenna is required. The selection and the performance of an antenna is characterize on the basis of some parameters these are Bandwidth, Polarization, radiation, Pattern, Efficiency, Gain. These parameters are described in brief below

III. MICROSTRIP PATCH ANTENNA

A micro strip antenna generally consists of a dielectric substrate sandwiched between a radiating patch on the top and a ground plane on the other side as shown in Figure 1. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate.

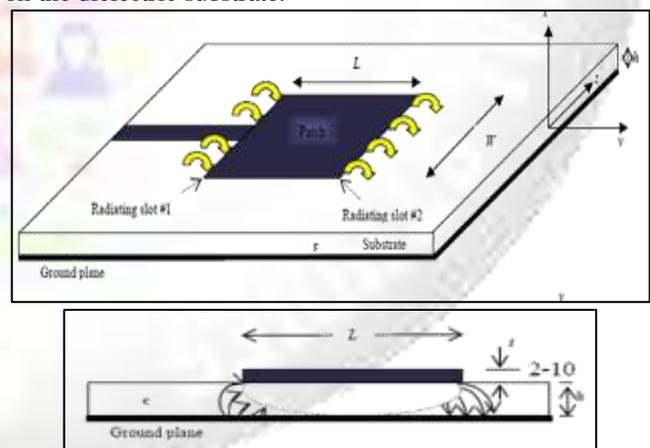


Fig. 1: Structure of rectangular Patch Antenna

For simplicity of analysis, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shape. For a rectangular patch, the length L of the patch is usually in the range of $0.3333 \lambda_0 < L < 0.5 \lambda_0$, where λ_0 is the free space wavelength. The patch is selected to be very thin substrate such that $t \ll \lambda_0$ (where t is the patch thickness). The height h of the substrate is usually $0.003 \lambda_0 \leq h \leq 0.05 \lambda_0$. The dielectric constant of the substrate ϵ_r is typically in the range.

IV. PROBLEM IDENTIFICATION

In previous work we have used feeding technique to design and analysis a micro strip patch antenna the position of feed point of the patch and impedance matching widely use in both single patch antenna and multi patch array antenna.

A. Limitation of Existing work

Through modeling and simulation, a wideband micro strip patch antenna was achieved. This design could be further optimized using ADS's optimization tools. Given more time, parameterization of each component dimension could be used to achieve better results. It is very important to take the feed technique the impedance and the substrate is main parameters into consideration. The proper position to terminate the Feed line also affects the performance of the antenna.

In future other different type of feed techniques can be used to calculate the overall performance of the antenna without missing the optimized parameters in the action. Resonant coupling between the feed structure, slot and middle patch is responsible for the first minimum seen in the S11 plot The Q of this valley can be adjusted by varying the substrate thicknesses, slot width or patch width. Each of these parameters was manually tuned to obtain lower resonant coupling and a lower center frequency with respect to the top patch resonant frequency. This was done in order to extend the lower frequency response. Optimization tools can be used to further optimize these parameters.

V. TRANSMISSION LINE MODEL

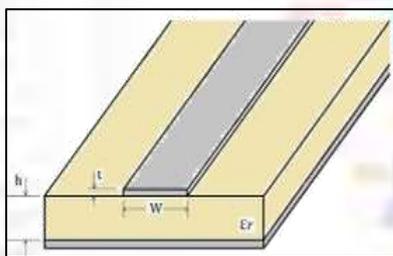


Fig. 2: Microstrip line

The transmission line method is the easiest way to study the microstrip antenna. In this method the transmission line model represents the microstrip patch antenna by two slots, separated by a low-impedance transmission line of length L. Results we get are not the best accurate compared with other methods but it is good enough to design the antenna.

To study the theory of microstrip transmission line we have two different cases:

- $W/h < 1$ (narrow strip line) and this is not what we are interesting with.
- The second case $w/h \gg 1$ and >1 (wider transmission line) this will help us to build a good picture to study the antenna se figure 3.

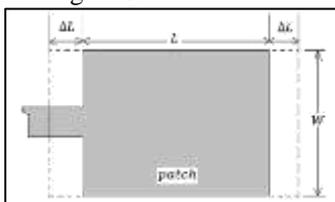


Fig. 3(a): A Physical and Effective Length of a Microstrip Patch



Fig. 3(b): Electric field lines

VI. MATLAB GUIDE ENVIRONMENT

GUIs (Graphical User Interface otherwise called graphical client interfaces or UIs) give control of interacting with programming applications, wiping out the need to take in a particular language or sort orders so as to execute the application.

MATLAB applications are independent MATLAB programs with GUI front end that automate an undertaking or figuring. The GUI ordinarily contains controls like menus, toolbars, catches, and sliders. Numerous MATLAB items like Curve Fitting Toolbox, Signal Processing Toolbox, and Control System Toolbox, incorporate applications with client specific interfaces. You can likewise make your own applications, including their relating GUIs, for others to work upon.

GUIDE (graphical client interface plan environment) gives instruments and helps in planning client interfaces for applications. A graphic plan of the UI can be made using the GUIDE Layout Editor. GUIDE then as a result generates the code in MATLAB for developing the UI, which you can alter to program the conduct of the intended application.

For more control over outline and improvement, you can likewise make MATLAB code characterizing each component. One can include dialog boxes, client interface controls, (for example, push tabs and sliders), and holders, (for example, radio buttons and push buttons).

VII. DESIGN ARCHITECTURE FOR MICROSTRIP PATCH CALCULATOR

Here we have worked on to create a GUI for patch antenna calculations. Such an app will help to ease the burden on the designer to repeatedly calculate the antenna parameters using the same standard formula for optimization purposes. The GUI was created using MATLAB R2012b GUIDE. The input parameters set here are frequency in GHz, dielectric constant and thickness in mils (1mil = 0.001 inch = 2.54 mm). The units are standardized in the backend and then using the standard formulae as in Chapter 1 for microstrip patch antenna, the various antenna parameters are calculated.



Fig. 4: Design Architecture of Patch Antenna Calculator

The output parameters defined with their dimensions are Length (mm), Width (mm), Rad resistance (ohm), efficiency, Gain, Characteristic impedance (ohm). The radiation plot of the E-plane and H-plane patterns plots is displayed. The surface power and total power is calculated using standard equations. Various callback functions and handles have been used to calculate and display the desired results.

VIII. EXECUTION STEPS

The Matlab GUIDE is opened and a new *.fig file is created. The GUI is made by using several active elements in the Property Inspector toolbar. The *.m file is generated from the *.fig file execution. At this stage the GUI is ready to run, but actions are not performed. The Callbacks are then integrated in the *.m file that issue the call of action to the active properties on clicking in the GUI. Then one needs to update the Handles data structure for each function with the following line being executed in each updation.

function pushbutton1_Callback(hObject, eventdata, handles)

Next the String is converted to double for input and further processing. Now when we click the pushbutton in the GUI, the corresponding callback function is executed and thus results are displayed accordingly.

IX. MATLAB PROGRAM

The program which is generated by MATLAB can be decoded as given below. Moreover we need to enter the required calculative formulas in the proper location in the code to undertake the necessary calculations. The following steps depict the algorithm involved.

- 1) Initialization Code before begging of any function
- 2) Opening Function before GUI is visible (Creation of Object)
- 3) Output returned to command line in variables to further process it to display on UI
- 4) Create Edit functions and Set Background Color (default color set as white).
- 5) Set Call back for edit functions i.e. the backend formulations.
- 6) Execution on push button1 execution i.e. the calculate button to initialize the calculations.
- 7) Formulation for single variable parameters.
- 8) Formulation for angle varying parameters.
- 9) Set output handles for final output display.

X. GRAPHICAL USER INTERFACE

The graphical user interface is made up of three inputs and seven outputs. Six of the outputs are in the form of numerical String while the one output is diagrammatic the calculations have to be done based on the matrix multiplication with the sine and cosine functions. There is an action button in form of the push button which enables the user to check for output after giving input for all values. Double precision is maintained for all calculations. The lines for radiation of electric and magnetic field are in different colours i.e. E-plane in Red and H-plane in Blue. To run the GUI Matlab must be functioning in the backend.

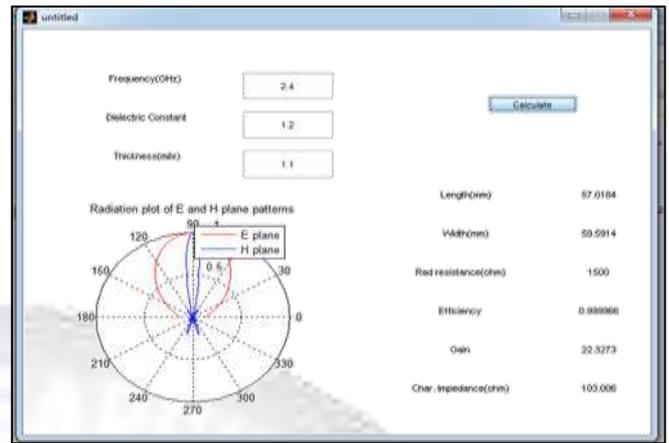


Fig. 5: GUI Window after giving output data

XI. FLOWCHART FOR ANTENNA DESIGN

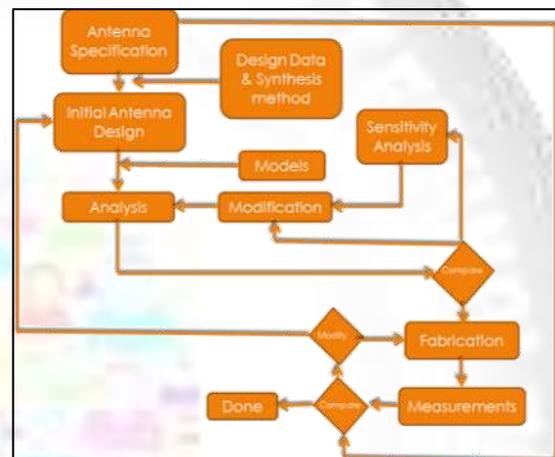


Fig. 6: Generalized flowchart for antenna design and fabrication

In the above figure 6, we can see a detailed diagram of how the antenna fabrication process is being followed at an industrial level. The MATLAB Code which has been developed functions in the first part of the flowchart i.e. during the initial design when the design data is available and the synthesis method needs to be chosen.

The program developed can be extended to implement all the compare stages and to fully automate the processes in which simple linear comparison is required. This will ease the designer job further on comparing the designed antenna specifications with the actual fabricated antenna and thus save a lot of time.

XII. CONCLUSION AND FUTURE SCOPE

In this thesis work, the focus was mostly on study of methods that help in optimization of the antenna designs. A MATLAB based GUI was developed for easy to use User Interface System for calculations of basic parameters of microstrip patch antenna. The GUI will be a useful tool in visualizing the antenna parameters without involving the complicated equations, since that part will be handled in the backend.

In future more analysis could be done on different type of antenna and how they can be better than other antennas that are conventional in nature. The aim must be to find the suitable design for particular application so that

there is no spurious radiation or bandwidth wastage. A catalog for such application based antennas can be made which can reduce time-to-market in various portable electronics devices for various applications.

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