AN EXPERIMENTAL STUDY ON OPTIMIZATION & METHODS OF MICROSTRIP PATCH ANTENNA

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ABSTRACT

The design of a microstrip patch (MP) antenna using the Moth-Flame Optimization (MFO) algorithm for UWB applications is presented in this article. MP antennas are designed to operate in dual- and multi-band applications as it has the following advantages such as low cost, light weight and easy installation. In order to reduce the microstrip patch cross-polarized radiation and achieve the required radiation parameters, the MP antenna is designed with a faulty ground structure. The substrate of liquid crystal polymer is used here to reduce the material cost and the applied geometry parameters are used to improve the antenna performance. The MFO Optimized Antenna 50mm ×50mm represents the compact size, which improves the performance of the antenna. However, the simulation process is performed by MATLAB tools with a high frequency structure simulator for parameter optimization and performance analysis respectively. The antenna has an operational bandwidth of 3.1 GHz and a return loss of -20 dB which covers UWB (3.1–10.6 GHz) applications. The simulation results demonstrate good impedance bandwidth, radiation pattern, directivity and relatively constant gain over the entire band of frequency compared to earlier methods. In conclusion, the proposed system may be a better choice for the design of microstrip antennae in communication system to cover Bluetooth operation, Wi-Fi, Wi-Max, telemedicine and UWB applications.

Keywords: UWB, GHz, MATLAB, Bandwidth etc.

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1. METHODS OF ANALYSIS OF MICROSTRIP PATCH ANTENNAS

Several models and methods of microstrip antenna research are used, but the transmission line model and cavity model listed below are the standard techniques for microstrip patch antennas research:

2. TRANSMISSION LINE MODEL

Compared to other systems, the transmission line system is the simplest. The model line gives simple physical perspective but is less reliable and harder to model coupling. Because of its precision and numerical efficiency, the transmission line model is used to predict the input feature of rectangle antennas. In modelling arrays, it also plays an important role. Its biggest drawback is the failure to predict features outside the simple resonance. A part of the transmission line within the transmission line model is the inner field of the patch antenna. The rectangular patch radiator is known by the transmission line model as a strip line resonator with no cross-field variation and expects radiation from the two transverse open sides.

It is also determined that transverse electrical magnetic mode (EME) with negligible difference in the cross-direction of the field is the main method of propagation within the strip line. The Model transmission line is an antenna with two W-and h-width slots separated by an L-length transmission line. Figure2 indicates that most lines remain in the substratum of electrical fields and parts of some airlines.

The transmission line therefore cannot endorse the TE mode. Therefore, for the fringing and wave propagation in the transmission line, an efficient dielectric constant (Čreff) is obtained. The value of ририит is significantly lower than нии due to the fringing fields. Fringing fields on the edge of the patch are also spread in the air rather than confined to the dielectric substratum.

Figure1.1Electric field lines expression

For ε_{reff} is given as:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{3/2}$$

Where,

ε_{reff} =effective dielectric constant

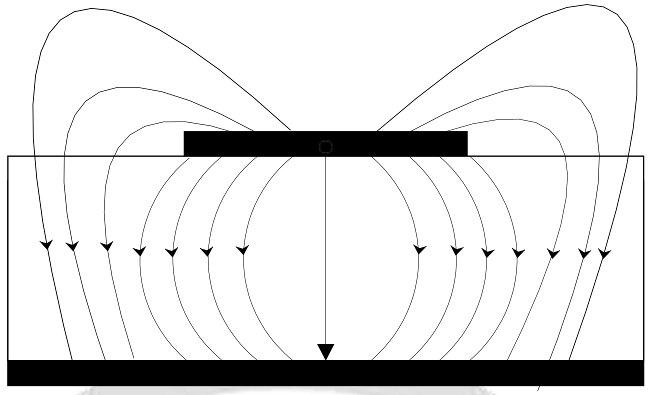

Fig-1: Electric field lines expression

ε_r =dielectric constant of the sub start
h=height of the dielectric
W=width of the patch

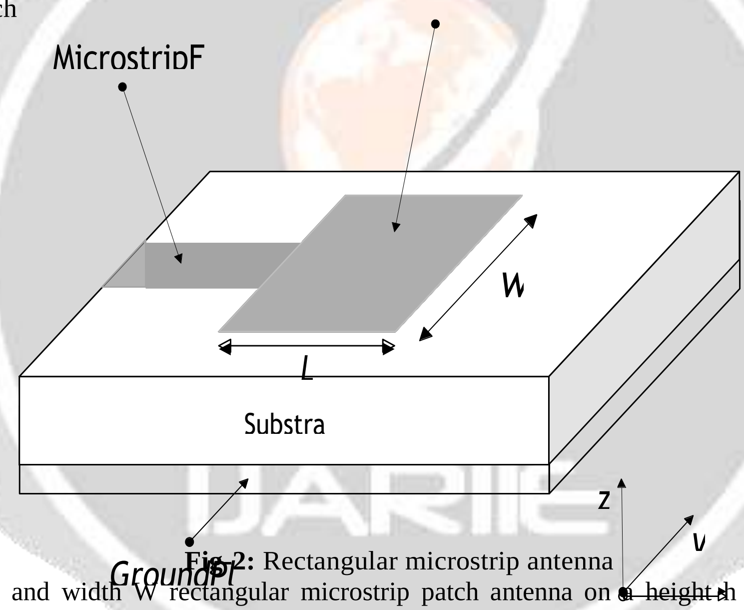

Fig-2: Rectangular microstrip antenna

Consider a length L and width W rectangular microstrip patch antenna on a height h substratum as defined in Figure1.2. The patch length is x, the width is y direction and the height is z. The patch length is z.

In the simple mode, i.e. mode TM10, the patch length is less than λ/2 when the dielectric media is equal where the free space wavelength is.TM10 means that the field only differs along the patch length and does not vary along the patch width.

$$\frac{\Delta L}{h} = 0.412\ \frac{(\varepsilon_{reff} + 0.3)\left[\frac{W}{h} + 0.264\right]}{(\varepsilon_{reff} - \ 0.258)\left[\frac{W}{h} + 0.8\right]}$$

The effective patch duration is

$$L_{eff} = L + 2\Delta L$$

The effective duration is for a resonance frequency f_0,

$$L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{reff}}}$$

The resonance frequency for any mode TM_{mn} is given for a rectangular microstrip patch antenna as:

$$f_r = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{L}\right)^2\right]^{1/2}$$

Where m and n are respectively the modes L and W. The patch width is determined as:

$$W = \frac{c}{2f_0\sqrt{\frac{\varepsilon_{reff}+1}{2}}}$$

3 CAVITY MODEL

The previous versions are easy to use but have some disadvantages. For patches that are rectangular in shape, the transmission line model is used and does not recognize the variations in the field along the radiating borders but there are no such disadvantages in the cavity model.

The model cavity is a general patch model that imposes open terms on the lateral corners of the patch. The patch is defined as a dielectric cavity with electric and magnetic walls.

The interior of the dielectric substratum of this model is modelled by a cavity bounded on top and bottom of the cavity by the electrical walls and magnetic fields around the cavity. A load distribution is produced at the top and bottom surfaces of the patch and on the surface of the floor, as seen on Figure 2.3.

The distribution of charges relies on an attractive system of repulsion. The requested mechanism is between contrary load at the bottom of the patch and repulsive mechanism at the bottom of the patch between the same loads. The motion of these loads induces the respective current J band J t densities on the top and bottom of the patch.

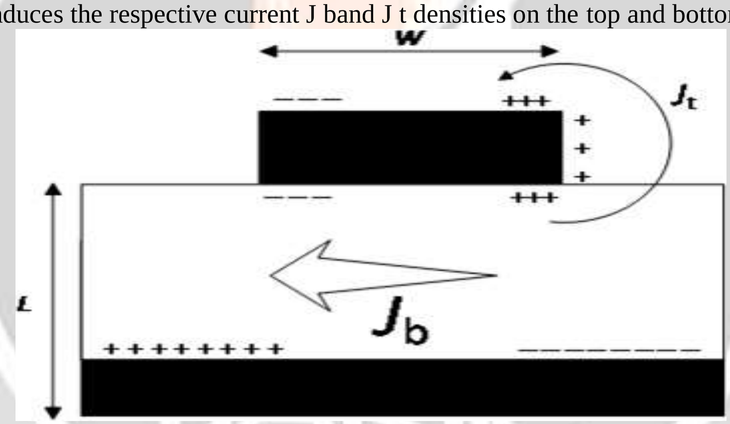

Fig-3: Charge distribution microstrip patch antenna.

When the microstrip patch antenna is seen as the cavity, it cannot indicate the radiation because it doesn't radiate the perfect loss-free cavity. For radiation, an effective loss tangent is added to the loss mechanism, δ_{eff}..

Thickness of the antenna substratum of the microstrip is very small, and so waves on the edge of the patch are produced within the dielectric substratum. A small volume of energy is thus radiated. As the height of the substrate, where 5-007 is the dielectric wavelength (h), is ridiculously small and it will change constantly in the field. Also very small are the fringing fields around the margins. Therefore, only the TM field configurations inside the cavity are considered.

4 FINITE ELEMENT METHOD

An extraordinarily flexible methodology is the Finite Element Method (FEM), which facilitates research into complex structures. It is used for many issues, including wave guides, transmission lines, cavities, etc. In this approach discretization of structures into well-defined small parts. The FEM approach is suitable for 3-dimensional structures. This approach is particularly important for researchers in antennas and other electromagnetic wave fields. In this way, according to the planar or volumetric structures to be analyzed the area of concern is divided in many finite surfaces or volume components.

These little, divided units are usually called finite elements such as two-dimensional triangles and rectangles and three-dimensional tetra hederal elements.

By decomposing the problem into limit values problems, wave equation within homogeneous boundary conditions is resolved. This approach extends to standardized forms as well.

5. CONCLUSION

The design of a microstrip patch (MP) antenna using the Moth-Flame Optimization (MFO) algorithm for UWB applications Particle swarm optimization has been successfully used as a heuristic approach to minimize the combined cost function and calculate optimized values of the geometric dimensions of all antennas. The promising results provide a framework for the future in designing any shape of antenna for any range of frequency. Ultra-Wideband (UWB) systems are best suited for high data rate wireless transmission with low power consumption. However, antenna design for UWB has been a challenging task. Furthermore, it is always desirable to have more freedom by designing different sized antennas with similar characteristics so that they can be used at the transmitter or receiver depending on other physical constraints such as area. To tackle these issues, in this paper, we have investigated the joint optimization of three different shape-printed monopole antennas, namely printed square monopole antenna, printed circular monopole antenna and printed hexagonal monopole antenna, for UWB applications. More specifically, we have obtained the optimized geometric parameters of these antennas by reducing the mean-square-error to the desired lower band edge frequency, quality factor and bandwidth. The antenna has an operational bandwidth of 3.1 GHz and a return loss of -20 dB which covers UWB (3.1–10.6 GHz) applications.

6. REFERENCES

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