Optimization Bow-Tie Antenna and Its Parameters

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Abstract: In this paper two proposed methods of input impedance calculation for Bow-Tie antenna are introduced. The proposed methods show input impedance calculation with high accuracy. Also, design Curves for input impedance values were developed depending on the geometry of antenna**.** The proposed design curves are used to design a Bow-Tie type RFID tag antenna. Recently the Bacterial foraging optimization algorithm (BFA) has attracted a lot of attention as a high-performance optimizer. This paper presents a hybrid approach involving Bacterial Swarm Optimization (BSO) and Nelder-Mead (NM) algorithm. The proposed algorithm is used to design a bow-tie antenna for 2.45 GHz Radio Frequency Identi¯cation (RFID) readers. The antenna is analyzed completely using Method of Moments (MoM), then the MoM code is coupled with the BSO-NM algorithm to optimize the antenna. The simulated antenna and the optimization algorithm programs were implemented using MATLAB version 7.4. To verify the validity of numerical simulations, the results are compared with those obtained using COMSOL Software Suite 4.3.

Keywords — Bow-tie Antenna, Underwater Communications, Wireless Fidelity, Wireless LAN.

INTRODUCTION

Antenna are a very important component of communication system. By definition, an antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space. Antennas demonstrate a property known as reciprocity, which means that an antenna will maintain the same characteristics regardless if it is transmitting or receiving. Most antennas are resonant devices, which operate efficiently over relatively narrow frequency band.

An antenna must be tuned to the same frequency band of the radio system to which it is connected, otherwise the reception and the transmission will be impaired. When a signal is fed into an antenna, the antenna will emit radiation distributed in space in a certain way. A graphical representation of the relative distribution of the radiated power in space is called a radiation pattern.

A bow-tie antenna patterned on a dielectric substrate is optimized by changing the length of the arms and the flare angle to reduce the magnitude of S11, the reflection coefficient. The two geometric dimensions that are used as design variables directly control the size and shape of the antenna, and also affect the dimensions of the dielectric substrate. The gradient-free Nelder-Mead optimization method is used to improve the objective function.

The model of the bow-tie antenna consists of a rectangular dielectric substrate with two triangular faces on top representing a metal pattern, as shown in Figure 1. The flare angle and height of the arms define the antenna's shape. It is desirable to keep the size of the substrate as small as possible, so it is defined to extend a distance of 2 mm around the outline of the pattern. A lumped port excitation applied to a small rectangular face between the antenna arms mimics a 50 ohms transmission line feed.

The two design variables, flare angle and arm height, control a total of four dimensions in the model. The height and width of the rectangular dielectric substrate are defined to be slightly larger than the profile of the antenna. Thus, the two design variables

Explicitly control two other geometric dimensions in the model which directly affect the antenna characteristics. The reflection coefficient, |S11|, is minimized by using the gradient-free optimization method. Because the objective function is non-analytic, it is not possible to analytically compute the derivatives with respect to the design variables.

Furthermore, the design parameters will introduce significant geometric changes to the domains. Both of these reasons motivate the use of the gradient-free optimization method, which numerically approximates the gradients of the objective function. Using this approximate gradient information, the objective function is iteratively improved until the design variables are converged within the desired tolerance.

ISSUES OF PROJECT

The 2.4 GHz has long been a standard around the world, while the usage of many channels within the 5 GHz band is prohibited in some countries, like China. One reason to use the lower frequency band is because the waves of the 2.4 GHz band have a better propagation behavior through obstacles than that of the 5 GHz band waves and thus provides better coverage. On the other hand, the main reason to use the 5 GHz band is that it is not used as widely as the 2.4 GHz band so there is less interference from neighboring Wi-Fi signals. Also, the higher the frequency is kept, the smaller the size of the antenna should be, meaning that 5 GHz waves need cheaper (in general terms) antennas which can be designed and built easier.

2.1 OBJECTIVE OF BOW-TIE ANTENNA

- The optimization goal was to maximize the electric field strength at a chosen depth (50 mm).
- In which corresponds to a stronger output signal of the radiometer for the same source and, as a result, a greater volume, from which power is collected at the constant receiver sensitivity.
- Another aim was to obtain the minimum possible reflection coefficient S_{11} at the operating frequency band in order to minimize the mismatch between the antenna and feed line, which impedance was chosen to be 50 Ω.

PROPOSED SYSTEM

RECONFIGURABLE RF-MEMS Antenna systems were first introduced in 1998 by E. R. Brown and since then have been studied by several research groups. An emphasis has been given in reconfigurable aperture (recap) and micro strip antenna structures, in order to achieve multiple octave tenability. However, the integration of RF-MEMS with the antenna has not been fully demonstrated. Furthermore, in the majority of publications, ideal models for the switches have been used while the effect of the bias lines on the antenna performance has been largely neglected.

The radiation patterns of an antenna are inherently related to the distributions of the currents on its surface. Predetermination of these current paths, allows one to define the antenna's radiation

Patterns at its various frequencies of operation.Thefeature of self-similarity of a fractal antenna can provide a basis for the design of multiple-frequency antennas. These antennas have the advantage that they radiate similar patterns in a variety of frequency bands. The major predecessor is the widely studied Sierpinski gasket. In an ideal case, the Sierpinski gasket is described by an infinite number of iterations resulting in a very complex antenna structure with an infinite number of frequency bands.

In reality though, technological limitations reduce the number of iterations for such a structure to a finite one, usually less than 6 (pre-fractal). Moreover, for the purposes of this paper, only 1iteration was found necessary to obtain the desired reconfigurability but more complex designs will be examined in the future. So far, the Sierpinski gasket has been modified in several ways to give desirable frequency spacing low pass filters were applied between the triangle interconnections to suppress any side lobes that may exist after the 1st resonance.

The great majority of research regarding Sierpinski gasket antennas has been done for a structure etched on thin dielectric materials with low relative permittivity, thus approximating the free-space environment. In a previous work, preliminary results on a similar antenna fabricated on silicon were reported. The current paper examines several issues that appear before, during, and after the antenna integration. These are with respect to its design, feed, and performance as well as with the structure and the biasing network of the used RF-MEMS switches. The main idea is to demonstrate the function of a new type of RF-MEMS reconfigurable multiband antenna based on a self-similar design. Such an antenna enhances the performance of a conventional Sierpinski gasket by adding to it one frequency band. An analytical procedure used to design the antenna is also introduced. Finally, simulated and measured results demonstrating the antenna's functionality for the different states of its RF-MEMS switches are presented and discussed.

METHODOLOGY

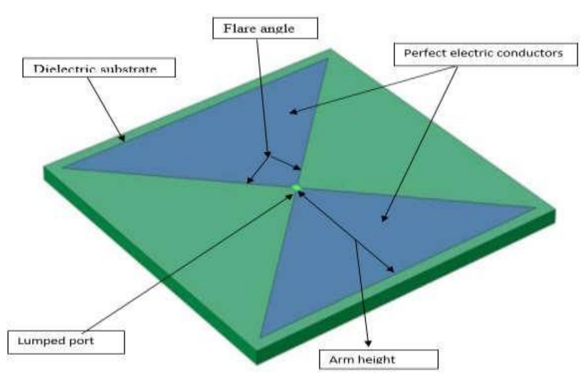
4.1 MEMS TECHONOLOGY

Micromechanical system can be combined with microelectronics, photonics or wireless capabilities new generation of microsystem can be developed which will offer far reaching efficiency regarding space, accuracy, precision and so forth. Micromechanical system (MEMS) technology can be used fabricate both application specific devices. The associated micro packaging system that will allow for the integration of devices or circuits, made with non-compatible technology, with a system-on-chip environment. The MEMS technology is described with the help of a hearing instrument application and related micro packaging. Technology can be used for permanent, semi-permanent or temporary interconnection of devices using MEMS encompass the process-based technologies used to fabricate tiny integrated devices and system that integrate functionalities from different physical domains into one device.

4.2 Tools Used

- Operating System :Windows 10 /Unix /Linux
- Application Software's :COMSOL, Multiphysics, Coventor ware

Antenna Layout



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RESULT ANALYSIS

The model is solved for a single frequency, 2.45 GHz, and the optimizer adjusts the flare angle and height of the arms such that the reflection coefficient is reduced. For the initial, optimized, design |S11| = 0.62, while |S11| = 0.20 for the optimized design. The presence of the variably-sized dielectric substrate would make it quite difficult to use any analytic relationships to achieve this optimized design. The optimized values for the height and flare angle are 17.02 mm and 51.84□, respectively.

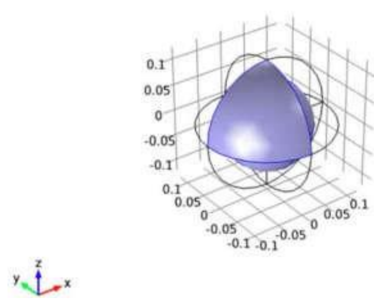
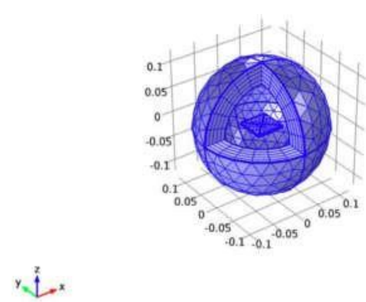


Fig: set up the Electromagnetic Waves physics.



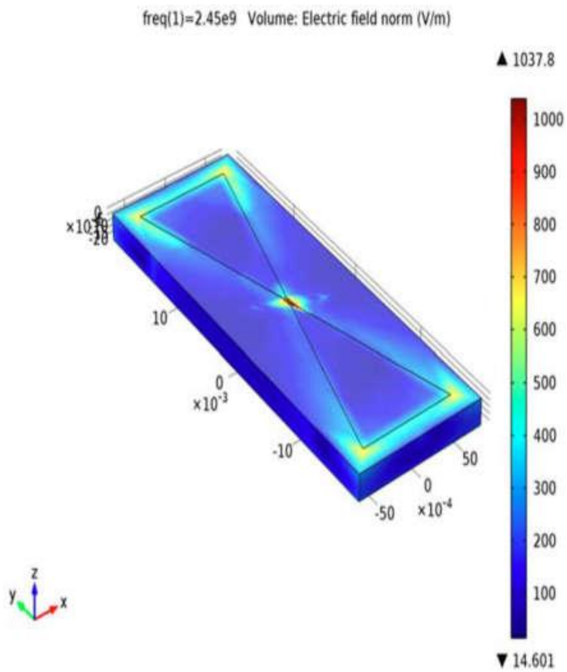


Fig: The electric field norm in an optimized antenna layout

APPLICATION

- Underwater Wireless Sensor Networks (WSN) are sensors used to monitor environmental or physical phenomena in order to cooperatively disseminate.
- The data through the network of sensors to a shore access point Coastline protection, off-shore oil/gas field monitoring, oceanographic data collection, autonomous.
- Researchers deploy WSN'sin unconventional environments for further studies which are stationed underground or underwater.
- Another possible application is the real-time guidance of an autonomous underwater vehicle (AUV) when approaching an underwater docking station and subsequent high-speed data transfer between the AUV and the dock.

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