UWB Technique for 2-D Meshed Planner Waveguide Communication Sheet

Tianyi Liu
University of Electric Science and Technology of China
Chengdu, China
Email: 201621020211@std.uestc.edu.cn

Feng Yang
University of Electric Science and Technology of China
Chengdu, China
Email: yangf@uestc.edu.cn

***Abstract*—in this paper, we propose a new ultra-wideband technique (UWB) for two-dimensional waveguide communication sheet. It uses fractal based meshed structure to support an ultra-wide band operation. The two-dimensional meshed structure sheet was mounted on grounded substrate. The UWB signal is transmitted to the sheet structure using a coaxial port at the bottom. Moreover, another coaxial port is connected using an energy coupler at the top of the sheet. As compared with previous works that only supports single frequency band, the new proposed technique, can provide an ultra-wideband operation. Furthermore, the proposed meshed structure covers an ultra-wide band spectrum ranging from 2GHz to 6GHz in the simulation environment.**

Keywords—two-dimensional communication; sheet structure; ultra-wideband

I. INTRODUCTION

Recently, the Internet of Things (IoT) has been emerging in various applications such as smart cities, health monitoring, smart vehicles and smart environment sensing. These applications require energy harvesting for modal sensors in the space. The two-dimensional waveguide communication sheet (WCS) is one of promising structure to support the energy harvesting for a large number of multi-modal sensors in the space. Furthermore, the Two-dimensional communication sheet inspired by [1]. However, the signal connection and energy supply for large amounts of multi-modal sensors in the space was still a challenge.

Traditional WCS [2-5] uses rectangular metal mesh structure on the top layer, the spectrum band is about 2GHz to 3GHz, while in this paper, we provide a fractal metal mesh structure to allow frequency band extended as four times as the previous.

Fractal structure first proposed in 1975 by French Mathematician Benoit Mandelbrot, and defined, as the part components in some manners were similar to the entirety. The primary features of fractal structure are self-similarity and space filling. In the 1980s, the relations between electromagnetic wave and fractal structure drives the development of fractal electrodynamics. Among them, fractal UWB techniques are the most significant research directions, by using the fractal structure, boundaries of microwave system could streamline to fit not only the low frequency band, but also the higher operating frequency.

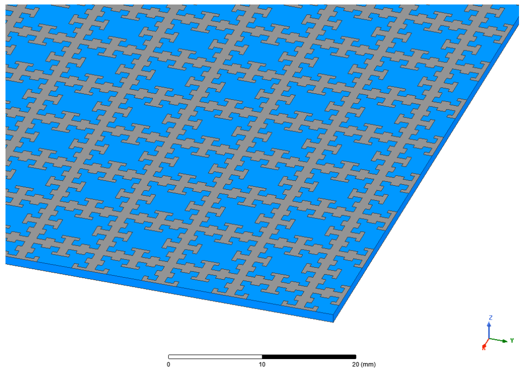


Fig. 1. T-square mesh structure in UWB two-dimensional communication sheet

Ultra-wideband technique is one of the most important issues in the microwave area; it expected to be suitable for short-range high-speed communications. The wide spectrum range from 2GHz to 6GHz enables sufficiently large channel capacity.

Therefore, in this paper, a novel sheet structure is proposed to establish the signal connection and energy supply. As a sheet structure, which can support surface electromagnetic field, it provides free location of sensors on its surface. Moreover, it provides an advantage over the traditional microwave transmission lines that can only establish a kind of one-dimensional connection between spot and spot. Meanwhile, the attenuation of EM wave along the surface is much smaller than the wave propagating in the three-dimensional free space. With these two merits, it provides a feasible solution for the signal connection and energy supply of the sensors in the intelligent space. Due to its differences with one-dimensional connection and three-dimensional connection, it names 2DCS, which means Two-Dimensional Communication Sheet. Moreover, by using T-square fractal in the mesh structure could expand the spectrum band to 3 times frequency multiplication.

II. FUNDAMENTAL SYSTEM DESCRIPTION

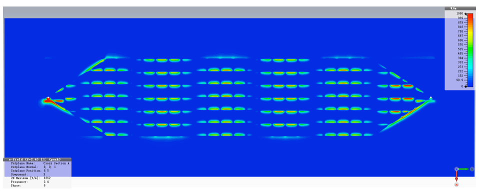
A. UWB 2-D Communication Sheet

The Structure of 2-D Waveguide Communication Sheet (WCS) is shown in Fig. 1. It has three layers, the bottom layer is conductor, and it works as a ground plane. The middle layer is dielectric substrate, electromagnetic wave propagates through it, and the top layer is meshed metal structure. The period of the mesh is sufficiently smaller than half of the guided wave length in order to restrict EM waves in the dielectric layer without leakage through the top surface. Moreover, as compare with previous literature investigation, the proposed meshed structure uses T-square fractal model to streamline the boundary conditions of the metal conductor. Furthermore, the boundary conditions of proposed meshed structure can support higher frequencies up to 6 GHz.

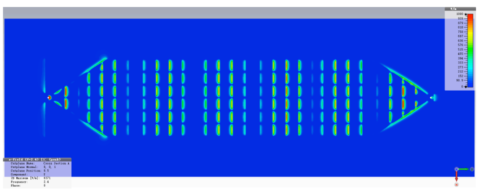
B. Fundamental Guided Wave Mode

The electric and magnetic field components of 2-D WCS are shown in Fig. 2. Considering the one-dimensional case, the waves propagate in +Y direction. The longitudinal electric field component is E_y , it results due to the transverse direction period of the meshed structure. While, the transverse field components include E_x and E_z .The electric field component E_x , magnetic field components H_y , and H_z are also generated by periodic meshed structure. However. The core field components are E_z and H_x , satisfying the right-hand rule of EM wave propagation theory. The guided waves through the structure consists of multiple TE and TM modes, however, the longitudinal field components get sufficiently smaller than the transverse field components, so the entire waveguide system illustrates a quasi-TEM wave mode.

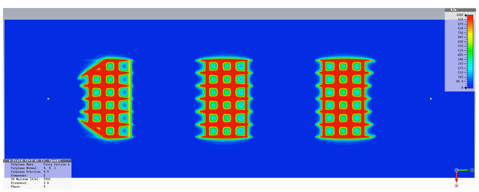
To verify this point, we simulated the meshed structure with guided wave length as depicted in Fig. 2(c). The simulated result shows the guided wave length along the structure is about 80mm. Therefore, the guided wave length is near the length of plane wave. Hence, the meshed structure is exhibiting a quasi-TEM mode. Furthermore, the dielectric constant is of



(a)



(b)



(c)

Fig. 2. Electromagnetic wave travel along Y direction and electric field components in all directions. (a) X direction (b) Y direction (c) Z direction

substrate 2.2, and operating frequency is 2.4GHz. Normally, the wavelength of plane wave traveling in the dielectric substrate is about 84mm, which is very close to the simulated guided wave length.

III. SIMULATIONS AND RESULTS

In this section, we provide a full wave simulation using CST-Microwave Studio, the time domain solver based on FITD is skilled at UWB problems. As shown in Fig. 3. The structure using T-Square fractal model mesh conductor, whose spectrum extended from 2GHz to 7GHz, reach a great progress in the capacity of the signal frequency band.

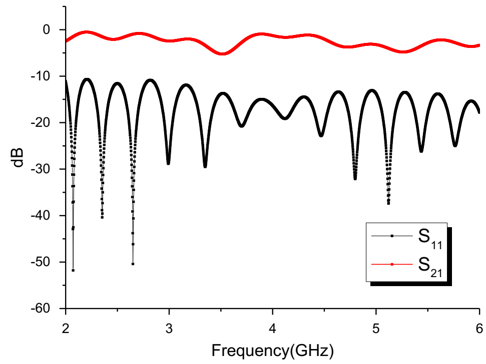


Fig. 3. Using a one-dimensional model to simulate the S Parameters of 2-D communication sheet. Define the spectrum by the S11 parameter lower than -10dB.

IV. CONCLUSIONS

In this paper, we propose a UWB 2-D communication sheet based on the fractal techniques. In the proposed system, the spectrum bandwidth is about 5GHz, cover from 2GHz to 7GHz, the return loss less than -10dB during the band. Then we simulated the entire structure using full wave simulations, the result we gain from the simulations support our UWB contributions in two-dimensional communication.

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