Miniaturization Design of Beidou Navigation Terminal Antenna

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Abstract. Based on the theory of microstrip antenna, we design a microstrip antenna for application in Beidou navigation terminal. The designed antenna is a miniature circularly polarized antenna. The main radiation unit is a microstrip rectangular path that is cut a few corners and opened a groove. Cutting corners and opening a groove are to achieve the circular polarization and meet the requirements of miniaturization, respectively. The software HFSS are employed to simulate and analyze the properties of the designed antenna. Numerical results show that the designed antenna can satisfy the application requirements of Beidou navigation terminal antenna.

Introduction

Navigation positioning system has begun to play an indispensable role in our life [1]. This system has developed rapidly in recent years, and constantly developing and perfecting the technology, all over the world are ubiquitous positioning today, the system is gaining momentum, with all kinds of navigation devices for people who play the most important role in the middle. The most used of these devices is the microstrip antenna [2]. We are in the process of developing an antenna suitable for the Beidou navigation system terminal [3]. Today, as Beidou continues to be applied in various industries, Navigation equipment requirements are also becoming more and more easy to carry, short and pithy in the field of antenna design, circular polarization antenna and miniaturized antenna design to meet the current navigation terminal requirements of users today's navigation system is developing rapidly, the more developed More quickly, there will be more new problems. New challenges are raised. More and more experts and scholars come forward to solve these problems. People from all walks of life are contributing their own part to the navigation system of the motherland [4]. The current technology level under the premise of this paper in the research process is mainly used in the microstrip antenna on the basis of a groove on the surface. The frequency band involved in the research is mainly the IF frequency band, and no research is done on the HF and microwave frequency bands. In this paper, the optimization software mainly includes Anosoft's HFSS and Agilent's ADS software [5]. Antenna, as a commonly used analog-to-electromagnetic converter, works by transmitting the lead wave to the antenna after passing through the transmission line, converting it into an electromagnetic wave and transmitting the electromagnetic wave in the air, or converting the electromagnetic wave transmitted in the air into a guide traveling waves to the transmission line to complete the communication.

In the signal generated place, after the hardware circuit will generate analog signals, transmitted through the wire to the antenna transmission, and then by the antenna for energy conversion, and then the converted electromagnetic waves emitted. After receiving the signal, the antenna will emit electromagnetic waves into the surrounding space. The polarization direction of the antenna is the same as that of the electric field. As a kind of antenna, the microstrip antenna is widely used at present. Its main structure is to add a piece of non-thick metal plate by engineering means on the dielectric substrate, and the other side is made into a patch by technical means. The most important part of the microstrip antenna is the feed section [6]. When the microstrip feeder and the microstrip patch are located in the same plane, the feed structure that we make is called the microstrip feed. The structure of this feature will make our production process more concise [7]. However, due to the
defect of the microstrip antenna itself, the radiation emitted by it will have an influence on the pattern of the antenna analysis result and greatly reduce the gain of the component. There are other cases, because this shape of the line must be added to the additional capacitance, but the addition of additional capacitance will increase the reactance rate, to further reduce the working bandwidth of the antenna into [8].

**Antenna Structure**

The design process is as follows. In the modeling of the antenna, the center of the general model is located at the origin of the coordinates. The designed circularly polarized Beidou terminal receiving antenna has a center frequency of 1.561 ± 0.01 GHz and a circularly polarized wave axis ratio of less than 2.0 dB. Media substrate set to square, and the material used FR4 is the thickness of 1.6 mm. Figure 1 show the top view of the model.

![Figure 1. Top view of the model.](image)

**Simulation Results**

After the optimization simulation is completed, as shown in Figure 2. The port return loss of the antenna can be analyzed by S11. From the return loss we can see the impedance matching, in the case of a certain frequency, the smaller the value of S11, the better match. The optimum frequency of the antenna is 1.5640GHz, which is close to 1.561GHz. This means that the designed antenna meets the requirements.

![Figure 2. Return loss S11.](image)

The input impedance varies with the location of the feed point. The closer to the edge of the microstrip patch, the greater the input impedance is. The position of the feed point can determine the
impedance value. The input impedance for the designed antenna is given in Figure 3. It can be seen from Figure 3 that the input impedance is \((52.31 + 7.99i) \Omega\) at the center frequency 1.561 GHz.

![Figure 3. Input impedance.](image)

The axial ratio sweep result of the designed antenna is depicted in Figure 4. According to the results in the Figure 4, the minimum value of axial ratio is exactly at 1.561GHz, and the value is 0.98dB, which is less than 3dB. In general engineering design, the requirement that the axial ratio is less than 3dB is demanded.

![Figure 4. Axial Ratio.](image)

Figure 5 and Figure 6 are two-dimensional and three-dimensional plots of the antenna's gain diagram, respectively. Maximum radiation direction of the antenna is at phi = 0° and theta = 0°. The biggest gain for the antenna is 2.47 dB.

![Figure 5. Two-dimensional antenna gain pattern.](image)
Figure 6. Three-dimensional gain pattern.

Figure 7 illustrates the Right-hand circular polarization gain and total gain. It is easy to see that $\theta$ is within the range of $-50^\circ$ to $50^\circ$, and the right-hand circularly polarized wave gain pattern and the total gain pattern are close together. This means that the designed antenna is mainly a right-hand circular polarization.

Summary

We have designed a microstrip patch antenna with the characteristics of Right-hand circular polarization and miniaturization. The techniques of cutting corners and opening grooves are employed to achieve circular polarization and miniaturization, respectively. The simulation software HFSS is used to optimize the performance of the antenna. Numerical results obtained by HFSS show that the performance indexes for the designed antenna meet the requirements of engineering applications.

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References


