

Performance and Improvement of Various Antennas in Modern Wireless Communication System

Samba Siva Nayak R¹, Dr. R. P. Singh² and Samba Siva Nayak R³

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Abstract

Today, the importance of wireless communication is known around the world. To achieve better communication, many techniques and methods have been introduced. Among these techniques, intelligent / adaptive antennas are a hot topic in the field of research. Smart antennas consist of several antenna arrays and are able to optimize the radiation and reception of dynamically desired signals. In order to avoid or mitigate interference, smart antennas may also introduce zero values towards the receivers by adaptively updating the weights associated with each antenna element. Smart antennas can also improve reception quality and reduce missed calls. The various existing surveys are also discussed to identify the research deficit for the scope of future research.

Index terms— wireless communication system, micro strip antenna, single-input, single-output, antenna diversity, multiple-input, multiple-output, multi-com with mu

1 Introduction

In the era of modern wireless communication systems, antennas capable of operating at broad frequency band range are increasingly demanded. Various antenna design which enable antennas with low profile, light weight, enhanced dual or wideband frequency capabilities have been developed and presented in the literature. However, such antennas mostly need a large size of ground plane or a via hole connection for feeding the signal which increases manufacturing difficulty and cost. Antennas are useful mode of communication in different fields; antennas are used to communicate in form of audio, video, graphically. As their importance in communication antennas are develop time to time according to the need. Antennas are design for different application of different materials, structures for better communication. They are design for radio, television, satellite, broadcasting, and cellular system etc., communications. It also considered essential in discovering the properties of the system where antennas are used. Different systems have different kinds of antennas employed to them. In some systems directional properties of the antennas are designed around by operational characteristics of the system, whereas the antennas are simply used to transmit electromagnetic energy in omnidirectional in some other systems or in some systems it could be used for point to point communication where increase gain and lessened wave impedance are require.

2 II. Performance and Improvement of Various Antennas

Much of the success or failure of a wireless product depends on the performance of the antenna. Too often, the antenna tends to be an afterthought and is added on towards the end of the design phase. A monopole antenna is a class of radio antenna consisting of a straight rod-shaped conductor, often mounted perpendicularly over some type of conductive surface, called a ground plane. The driving signal from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the lower end of the monopole and the ground plane. One side of the antenna feedline is attached to the lower end of the monopole, and the other side

5 MULTIPLE-INPUT, MULTIPLE-OUTPUT (MIMO):

is attached to the ground plane, which is often the Earth. This contrasts with a dipole antenna which consists of two identical rod conductors, with the signal from the transmitter applied between the two halves of the antenna.

In terms of antenna performance, fractal shaped geometries are believed to result in multi-band characteristics and reduction of antenna size. Although the utility of different fractal geometries varies in these aspects, nevertheless they are primary motives for fractal antenna design. For example, monopole and dipole antennas using fractal Sierpinski gaskets have been widely reported and their multiband characteristics have been associated with the self-similarity of the geometry. However this qualitative explanation may not always be realized, especially with other fractal geometries. A quantitative link between multiband characteristics of the antenna and a mathematically expressible feature of the fractal geometry is needed for design optimization. To explore this, a Koch curve is chosen as a candidate geometry, primarily because its similarity dimension can be varied from 1 to 2 by changing a geometrical parameter (indentation angle).

Extensive numerical simulations presented here indicate that this variation has a direct impact on the primary resonant frequency of the antenna, its input resistance at this frequency, and the ratio of the first two resonant frequencies. In other words, these antenna features can now be quantitatively linked to the fractal dimension of the geometry. This finding can lead to increased flexibility in designing antennas using these geometries.

3 III. Micro Strip Antenna

Rectangular micro strip antenna is designed with a centre frequency of 2.4 GHz and using FR4 glass epoxy substrate of dielectric constant 4.4. A rectangular slot defective ground structure is then inserted into the ground plane and the simulation is carried out by varying the length of the slot with a fixed width of 2mm. The simulation is carried out using HFSS. HFSS is a finite element method solver for electromagnetic structures. The performance of both the rectangular microstrip antenna and the rectangular microstrip patch antenna with defective ground structures are investigated. Depending on the relative permittivity, operating frequency, the width and length of the patch are determined. The substrate used is FR4 with a relative permittivity of 4.4 and the height of the substrate is 1.6 mm. The desired length and width can be found out by using following equations obtained from the transmission model analysis.

Sensitivity to board size is an important factor when choosing an antenna. For example, a monopole antenna is an antenna working with an ideal, relatively large ground which is considered part of the antenna. This makes the monopole antenna sensitive to ground size and shape, meaning that the ground can greatly affect the antenna's performance. Inverted-F antennas, also called PIFA antennas, have an arrangement that makes them less sensitive to ground. Lastly there are dipole or sleeve antennas. These antennas have a positive current on one side and negative current on the other, thus establishing their own ground reference. Of the three antenna types listed here, the dipole is least sensitive to ground. All antennas require some amount of space for placement. When deciding on antenna placement, the surrounding materials must be considered, particularly conductive materials, as they affect the performance of the antenna. Antenna selection also depends on the system in which the antenna will be used. Here is a list of systems and their ideal antenna numbers and placement: Single-Input, Single-Output (SISO): This system uses only one antenna. SISO systems are usually quite sensitive to location. Performance is easily affected by the multipath effect. In a SISO system, some locations generate what is called a constructive effect and other locations generate a destructive effect. For example, a car's FM radio is usually a single antenna system. As the car moves along the road, you may receive a clear signal one location and static noise in another. SISO systems with a single antenna are the easiest to design and are inexpensive.

4 SISO with antenna diversity:

In this configuration, the system has two antennas. A SISO system with a single antenna can only receive a signal at one point in space with no redundancy. However, a SISO system with antenna diversity support has two antennas, either one of which can be used at any point in time. This allows the system to switch antennas if the performance of one antenna is lacking. The system always switches to the best antenna to overcome the multipath problem. If your system supports antenna diversity, it is better to use two antennas. The rule of thumb is to place the antennas at least a quarter of a wavelength apart. As a rough estimate, a quarter of a wavelength is three centimeters in the 2.4 GHz band and 1.5 centimeters in the 5 GHz band.

5 Multiple-input, multiple-output (MIMO):

These systems use multiple antennas to receive and transmit concurrently. For example, if you are using a 2X2 MIMO system, you need two antennas; this configuration is called a two data stream system. MIMO systems must have adequate isolation between each antenna. Typically, approximately 25dBm isolation gives you better signal quality and thus better throughput. How can you achieve higher isolation? The first and easiest method is to increase the distance between the antennas. Move the antennas as far away from each other as possible. Longer antenna distance provides better antenna isolation. The second method is to adjust the antenna polarization. For example, if you have two dipole antennas, you can adjust them so that they form a 90-degree angle, one in the horizontal polarization and the other in the vertical polarization. This way, even at very short ranges, you can still achieve 25dBm isolation.

Multi-com with multiple antennas: Multi-com systems use two different standards, such as Wi-Fi and Bluetooth, in one product. Multi-com systems require multiple antennas. Wi-Fi and Bluetooth operate at the same frequencies so adequate isolation between the antennas helps avoid interference and makes for better multi-com coexistence. For example, Wi-Fi products can handle a maximum of -20 dBm input signal and a maximum transmit power (TX) of approximately +20 dBm. Normally, Bluetooth can receive a maximum input signal of -10 dBm and TX power is typically limited to approximately 4 dBm. Therefore, you need approximately 25~30 dBm isolation between Wi-Fi antennas and Bluetooth antennas. This provides increased performance when Wi-Fi and Bluetooth operate concurrently.

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7 IV. Conclusion and Further Study

A wideband antenna that covers all Wi-Fi and WiMAX frequency bands has been designed and implemented on FR4 substrate successfully. The wideband antenna characteristic covers the frequency of 2.3 -6 GHz. Wideband characteristic is produced by modifying a basic circular patch with square ground plane by truncating the patch and by adjusting the square ground plane to widen the bandwidth at the higher frequency band. The antenna gain shows an almost linearly increase with the frequency from 0 dB at 2.3GHz to around 4.5 dB at 6 GHz. Antenna radiation pattern is bidirectional. Antenna measurement shows a good agreement with simulation results. Our further study is to investigate a more challenging antenna design using a multiband approach. Multiband antenna can provide a filtering capability at RF level, so as to improve interference to other system.^{1 2}

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