Super Wide Band Microstrip Patch Antenna for High Frequency Applications

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Abstract: As the research is going on the most of the application of antenna shifting towards the high frequency range, that is important because most of the lower band upto 4GHz is occupied by many applications. The technique in which similar structure developed again and again called fractal antenna. By increasing same structure multiple times the electrical length will enhanced as well as bandwidth may be increased. By fractal many objective excellently achieve. Size reduction also called miniaturization can also achieved by modified fractal approach. This paper represents a unique rectangular patch with defected ground. The meaning of defected is modified or slotted. Three rectangle are added to the top layer of the antenna by which radiation can be enhanced. In this paper combination of fractal and defected ground is used for bandwidth enhancement. In this work bandwidth enhancement is done, simulation is done by HFSS software. Antenna is useful for 3GHz to 14GHz, which represent bandwidth of 11GHz. In this range many wireless application can be shifted. In the given range, VSWR is also achieved less than two, and return loss is also less than -10db. Mathematical analysis is done by considering the center frequency as 4.5GHz and than antenna is analyzed, simulated and optimized to achieve the super wideband. In the proposed design microstrip feed line is used for utilization of its advantages. Practically easily available substrate that is FR4 is used for simulation with the thickness 1.6mm and dielectric constant 4.4.

Keywords: Super Wideband, fractal micro-strip patch-antenna, return loss, VSWR, radiation pattern

I. INTRODUCTION

Here the fractal technique and the parameter variation with fractal and different fractal geometries are explained. The detail of HFSS simulation software tool is used for analysis and study. In the beginning term 'fractal' was invented by the mathematician B.B. Mandelbrot, he belongs from France, invent fractal in 1970. A fractal is discontinuous structure which is split into multiple parts in which increase the current length and size reduction can also be done by fractal technique. When single shape is repeated multiple times called iteration produces fractal antenna. This iteration can go on without break multiple times can be infinitely, but practically infinite is not possible so huge length and boundary is developed. In now days in many field of science and engineering fractal term is used. Antenna is the field in which fractal term is used for bandwidth enhancement. For many communication system antenna are used and development is going on day by day. Many features can be developed and improved by fractal technique; size deduction and bandwidth enhancement are of them. The most common and important property of fractal are similarity and filling of space. The similarity produced the increment in number of resonant bands in the antenna called multiband antenna. By fractal the super wide band antenna can be designed and developed; which is used for wide band transmitter and receiver. Because of multiband behavior of the fractal. By fractal and its other properties size reduction is very easy, some example are Hilbert curve, Sierpinski Gasket etc.[4] Some of the famous fractal technique is called sierpinski gasket shows repetitive triangle inside the triangle. So many other shapes can also be used for designing of fractal antenna. When one of geometry introduced inside the other again and again these are called iterations, by these iteration size reduction and band. The repetitive fractal shape reduces size of antenna. In the field of wireless communication many communication systems have to design with different resonant frequency for this need of different antenna is there. So the solution of this problem is to use multiple antennas for single device or use a wideband antenna. The first solution is costly and complex. Size reduction is also a huge challenge in the antenna designing which can be achieved with fractal optimization. Some other technique is also available like defected ground and thickness of dielectric material etc.

II. EXISTING GEOMETRIES

For excellent performance of the antenna we needed to increase the electrical length so that radiation by the antenna is increases and gain, directivity VSWR enhanced. By this size might be reduced. As shown in figure1 three existing geometry are given, but the hardware implementation is difficult, if antenna like this is designed so the durability is not up to the mark. These are not having bandwidth more than 5GHz. Due to this problem a simple fractal should be designed with less number of iteration. If an antenna is capable of achieve 10GHz than most of the application can be covered. By this single antenna can be used for multiple applications.

![Figure 1: (a) Sierpinski gasket (b) Sierpinski monopole (c) Sierpinski dipole](image)

Figure one shows three unique geometries with triangle iteration, hardware implementation of these are very difficult so we have to design the antenna which can be easily fabricated and used for wideband. The rectangular is better option as compare to triangular.

IV. ANTENNA RESULT

HFSS simulation software is used for the designing and analysis of the antenna. The graph between return loss and frequency is demonstrated in the figure (5). It show the bandwidth close to 11GHz, which comes in the category of super wide band antenna.
Koch curve shown in figure two consist of modified sharp edge with three iteration, this is also not durable because of the very small thickness of these edges can’t be practically implemented.

### III. ANTENNA DESIGN

As shown in figure 3 the fusion of two technologies is given, in which semi-fractal and defected ground is used and designed a modified rectangular antenna. In proposed design three notched rectangular are introduced with a base rectangle, it also consist of two elements in the shape of rectangle parallel to the feed line. This geometry increased the electrical length by doing these modifications in the base structure. By this design super wide band can be achieved and used for many applications by single device.

- **Figure 3: Front View of Proposed compact super wideband antenna**

This different fractal shown in figure 3 is demonstrated and microstrip feeding is used for simple implementation of hardware. Figure four shows the modified ground structure on the rectangle in which 6.25mm thick and 26.2mm long ground is available. Remaining portion is uncovered. Due to this bandwidth can be further enhanced.

- **Figure 4: Back side view of Proposed compact super wideband antenna**

Modified ground is shown in figure four which is useful for enhancement of bandwidth and boost up other parameter also.

- **Figure 5: $S_{11}$ Versus Frequency Plot of super wideband Antenna**

The most useful and important parameter of the antenna is called return loss. It show the value reflection of energy from the load. More mismatch shows more reflection gives higher loss of energy. The value of return loss is -30db at resonance frequency of 4.5GHz. Figure number six shows the graph of frequency and VSWR, Which is achieved less than two. If character impedance of the transmission line is equal to the
load impedance that is antenna than maximum power will be transferred to the antenna and enhanced radiation is achieved. The practical value for VSWR is between one and two but ideal is One which can’t be achieved. VSWR is one for perfect matching which is practically not possible.

**Figure 8: Radiation pattern in 3D of Super Wideband Antenna**

Figure eight demonstrate the three dimensional radiation for super wideband patch with legend of color which shows the intensity of the radiation in different direction. Red shows highest radiation on the other end blue shows minimum strength of the signal.

**V. CONCLUSION**

The super wideband patch antenna has been designed and simulated which achieved 11GHz of bandwidth. In this many wireless application can be run with single antenna. rectangular patch of size 26.2*24.7 has been designed with FR-4 substrate with dielectric constant 4.4 is used.

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