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Microstrip Patch Antenna Functioning with Various Shapes of Metamaterial – A Survey

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ABSTRACT

Nowadays, Communication devices need a low profile antenna that can assist various applications and provides a wide range of frequency up to optical frequencies. Microstrip patch antennas are using metamaterials that support to enhance gain and directivity with compact size. Metamaterials are unnatural materials that cannot be found in nature but can be engineered. Metamaterials must have negative permittivity and permeability. The objective of this paper is to analytically review the different shapes of metamaterial unit cells employed in microstrip patch antenna to obtain improved gain, directivity, efficiency and bandwidth.

Index Terms: Microstrip Patch Antennas, Metamaterials, Negative permittivity and Permeability.

1. INTRODUCTION

Microstrip antennas have low profile, light weight, compactness and good reliability. Among those advantages, the microstrip antennas can be easily fabricated. Microstrip antennas are recently used in antenna design with a combination of metamaterials, either as a cover or a substrate [1]. Microstrip patch antennas require to reduce their size further and improve its various parameters such as bandwidth, gain and directivity. Hence metamaterial behaves as a superstrate which is used in Microstrip patch antennas to overcome its drawbacks of narrow bandwidth, low gain and low power handling capability [2-3]. Researchers took advantages of using metamaterials to increase the efficiency of the wireless communication systems. They either combine the metamaterial block with antennas or they designed metamaterial inspired antennas [4-10]. Types of Metamaterials are given in figure 1.

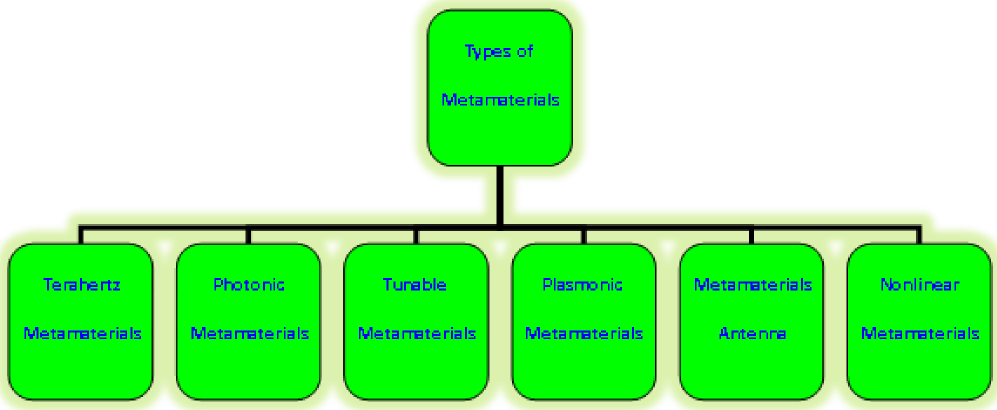

Figure 1. Types of Metamaterials

Metamaterials are integrated in microstrip patch antennas to improve various parameters. The metamaterials can be characterized into different types such as, Split Ring Resonator, Symmetrical Ring Structure, Omega Structure, Pentagon Structure, U-Structure, E-Structure, S-Structure etc. Apart from these structures, the symmetrical ring structures are fabricated easily and give better directional beamwidth [11-15]. Therefore it can be reviewed that the metamaterials used in microstrip patch antennas improves performance of various parameters and also it give low profile design.

2. VARIOUS TYPES OF METAMATERIAL STRUCTURES

2.1. Patch Antenna with Hexagon Shaped Metamaterial

A Hexagon shaped metamaterial loaded patch antenna is operated in K_u-band. It is reviewed that the design achieved better efficiency, high gain and high directivity [16].

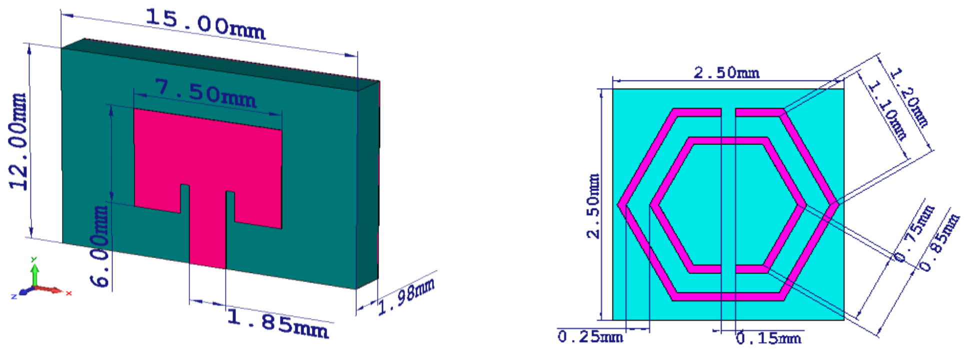

Figure 2. Microstrip Patch Antenna with Hexagon Shaped Metamaterial [16]

2.2. Patch Antenna with Square Shapes Metamaterial

Microstrip patch antenna with square shapes metamaterial is operated in the frequencies of 2.925 GHz and 1.965 GHz [17]. According to the survey, that the use of square shapes metamaterial reduced the return loss and increased the bandwidth.

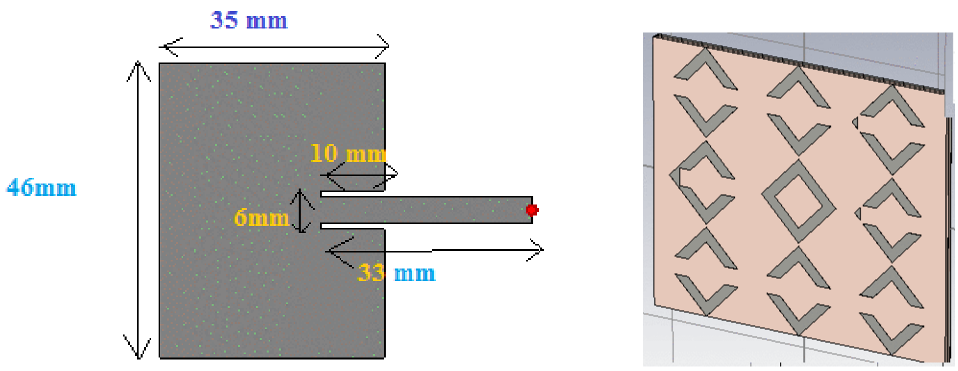

Figure 3. Microstrip Patch Antenna with Square Shapes Metamaterial [17]

2.3. Patch Antenna with Split Ring Resonator

Split ring resonator with patch antenna is operated at the working frequency of 5.725 GHz. An analysis made on return loss behaviour related to the operation frequency, gain and feature impedance [18] . It is viewed that the return loss is reduced.

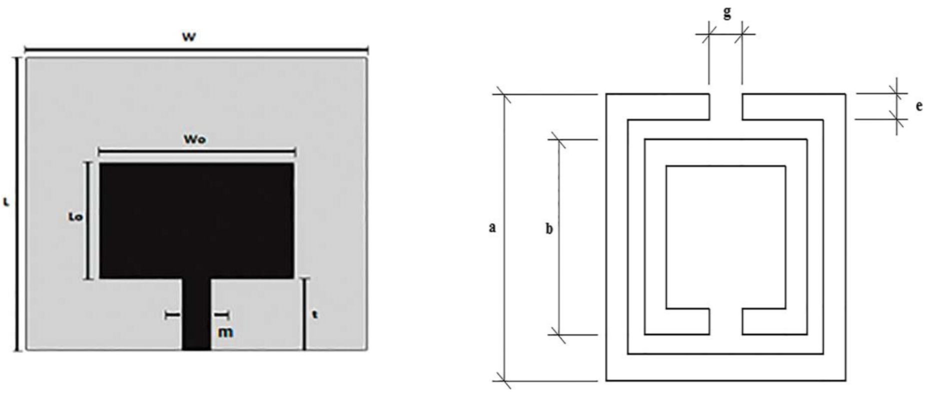

Figure 4. Microstrip Patch Antenna with Split Ring Resonator [18]

2.4. Criss - Cross Metamaterial based Microstrip Patch Antenna

The design of criss-cross metamaterial based patch antenna was providing improved gain, bandwidth and multiple frequency operations [19]. It is observed that the design proved negative response of μ and □.

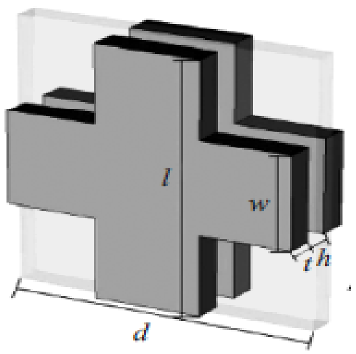

Figure 5. Criss Cross Metamaterial [19]

2.5. Patch Antenna with Omega Shaped Metamaterial

Omega shaped metamaterial with patch antenna is designed to operate in the frequency of 12 GHz. It is reviewed [20] that the design is used to improving the gain and directivity for satellite based communication systems.

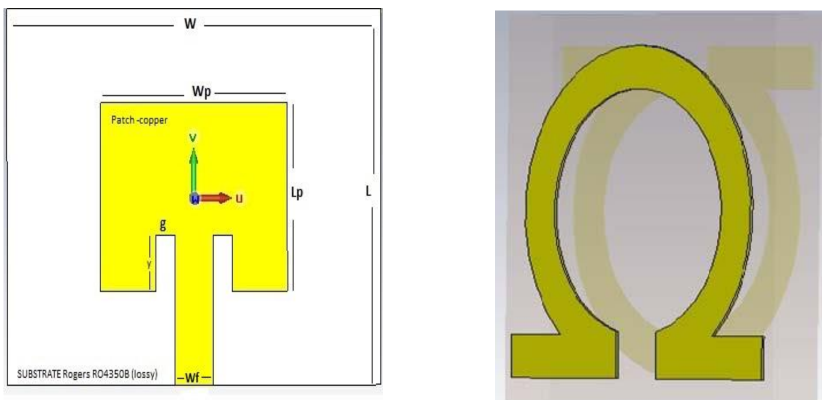

Figure 6. Microstrip Patch Antenna with Omega Shaped Metamaterial [20]

2.6. Microstrip Patch Antenna Loaded with Shapes of Triangle and Circle Metamaterial

The design reported that the patch antenna is incorporated with shapes of triangle and circle metamaterial structure to improve the bandwidth at dual band operation [21].

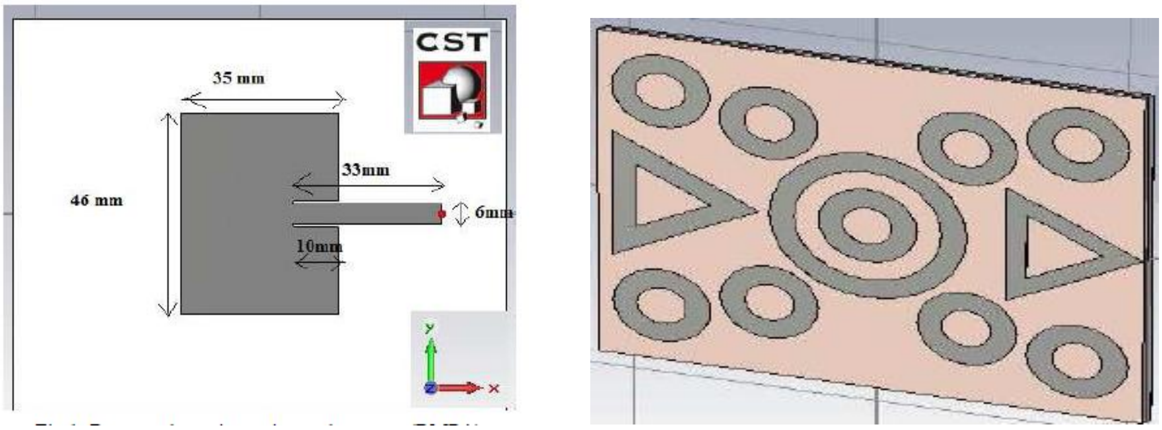

Figure 7. Microstrip Patch Antenna with Shapes of Triangle and Circle Metamaterial [21]

2.7. Patch Antenna with U-Shape Split Ring Resonator

It is examined that the rectangular patch antenna with U- shape split ring resonator is used to improve the return loss and bandwidth of patch antenna [22].

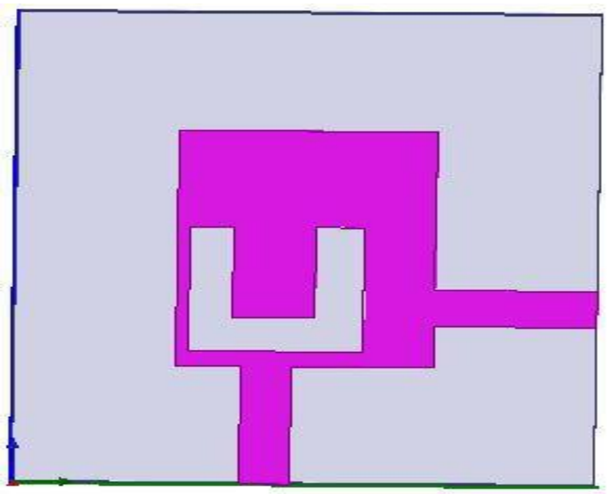

Figure 8. U–Shape SRR [22]

2.8 Patch Antenna with Pi Shape Metamaterial

The design of patch antenna with Pi shape metamaterial is operated in the frequency of C band. It is reported that the design reduced return loss value as -40.1766 dB [23].

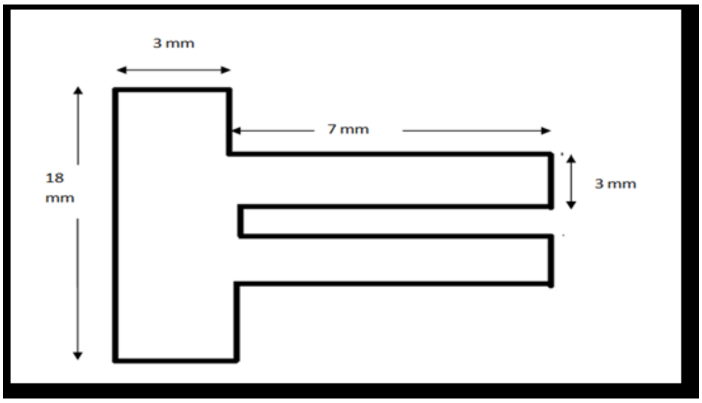

Figure 9. Pi – Shape Metamaterial [23]

3. CONCLUSION

It is concluded that the paper presents survey on various metamaterial structure employed with Microstrip patch antenna. A review shows, by implementing metamaterial structure with patch antenna can reduce return loss, miniaturize the size of an antenna, increase band width, increase efficiency, improves gain, directivity and all other parameters such as radiation pattern and VSWR. Because of these advantages, the research is going on in plenty of applications in the civilian worlds.

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