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# Rectangular Microstrip Patch Antenna Design Using Metamaterial: A Comprehensive Review

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***Abstract***

*Due to their small size, low cost, ease of manufacturing, etc., microstrip patch antennas are used for cell phone applications. Thanks to its many advantages, the MSA has proved to be an exceptional radiator for many applications, but it also has some drawbacks. The main disadvantages of a patch antenna are lower gain and tight bandwidth. In this paper, a survey is presented on the current solutions for the same, built over several years and an emerging metamaterial of technology. Metamaterials are artificial materials distinguished by parameters that are normally not present but can be engineered in nature. Due to the property of having negative permeability as well as permittivity, they vary from other materials. In order to produce negative permeability and thin wire elements to generate negative permittivity, the metamaterial structure consists of Split Ring Resonators (SRRs).*

***Keywords:*** *Microstrip Antenna; Microstrip Patch Antennas; Slotted Microstrip Antennas; Transmitter.*

## I. INTRODUCTION

The world of the antennas requires the comprehension of the meaning, feature, parameter, and shape of the antennas. An antenna can be defined as an electromechanical device capable of transmitting electromagnetic waves or receiving them. In other words, a set of elevated conductors may be said to be an antenna that pairs or matches free space with the transmitter or receiver [1]. Electromagnetic waves are forced into free space by a transmitting antenna connected to a transmitter and then fly at the speed of light in space [2]. Similarly, a transmitting antenna connected to a radio receiver receives or intercepts a portion of electromagnetic space-based waves. Figure 1 shows the rectangular structure of a microstrip patch antenna.

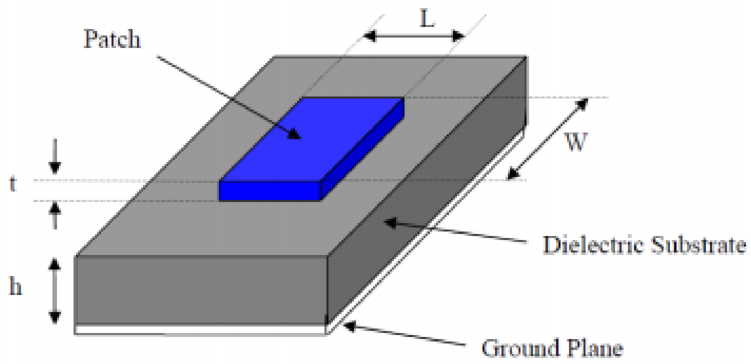


Fig. 1 Shows the rectangular structure of a microstrip patch antenna [3].

The most basic feeding technique used is Microstrip Line Feed. The patch is attached to a Microstrip line with an impedance of 50 Ohms, and the port is connected to the other end of the additional Microstrip line introduced [4]. The additional Microstrip line serves as a feeding point for the rectangular antennas of the Microstrip patch. Figure 2 illustrates the Metamaterial based microstrip patch antenna.

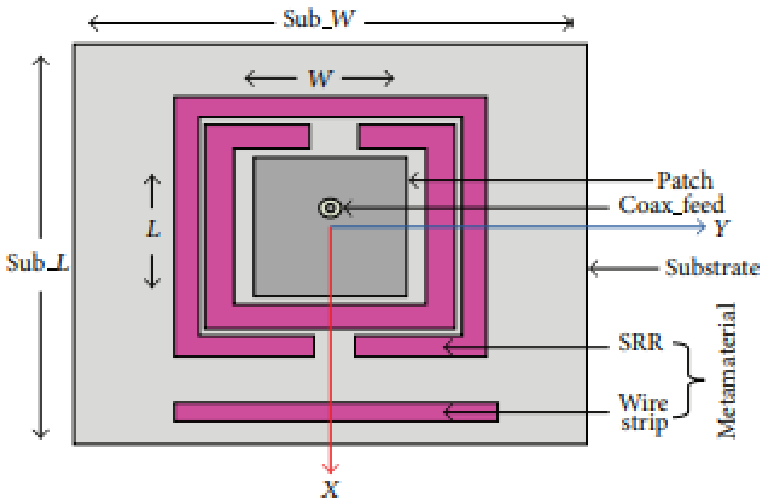


Fig. 2 Illustrates the Metamaterial based microstrip patch antenna [3].

Microstrip Inset Feed is the advancement of the previously introduced Microstrip feed line. In this feeding technique, a feed point is measured somewhere on the surface of the rectangular patch where the impedance of the patch matches with the impedance of Microstrip feed line that is 50 ohms. Figure 3 illustrates the conventional microstrip antenna.

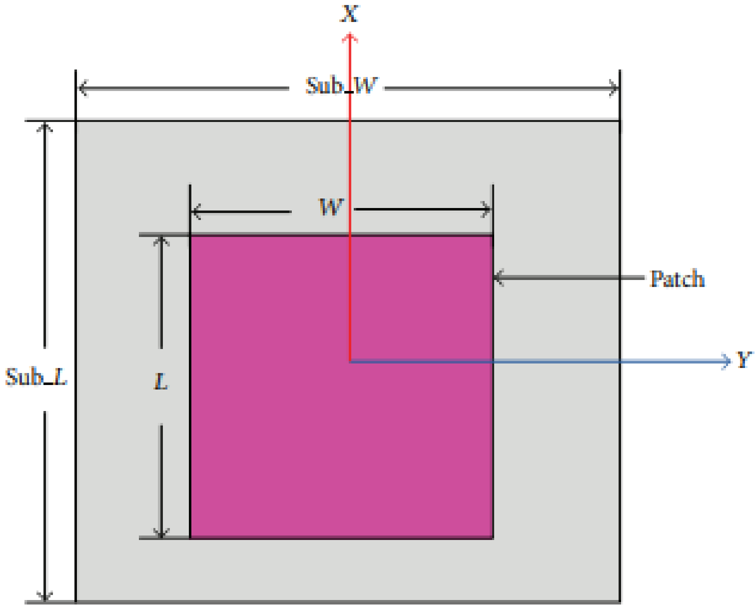


Fig. 3 Illustrates the Conventional microstrip antenna [3].

The width W of the DRA antenna can be determined by utilizing the following equation.

$$w = \frac{c}{2\, f_r \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where
$f_r$ denotes the resonant frequency, and
r represents substrate dielectric constant

The effective dielectric constant ($\varepsilon_{reff}$) of DRA antenna is derived by using the following equations.

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\sqrt{\left(1 + 12\frac{h}{W}\right)}$$

Where h denotes the height of the antenna and W denotes the width.

The length of the antenna may be measured by applying the following equation.

$$L = \frac{c}{2\, f_r \sqrt{\varepsilon_{reff}}}$$

The antenna length extension is calculated by applying the equation below.

$$\Delta L = 0.412\, h\, \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.246\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

Here W represents the width and h denotes the height.

The real length ($L_{eff}$) of the antenna can be calculated by using the following formula.

$$L_{eff} = L + 2\Delta L$$

## II. LITERATURE REVIEW

An analysis was carried out on the circularly polarised microstrip patch antenna by Kumar et al. A triple-frequency single-feed S-shaped circularly polarised microstrip antenna with a minimal frequency ratio has been proposed for mobile communication and GPS applications. An S-shaped slot is removed in the centre of a square patch of 84.5 to 84.5 mm2 for multi-band service. A single microstrip line with an aperture-coupled feeding structure consists of the proposed antenna geometry. The simulation results show that the proposed antenna can be used for multiband antennas at 1.193 GHz, 1.454 GHz and 1.615 GHz, respectively, with a reasonable return loss of -34.34 dB, -18.23 dB and -24.75 dB [5].

## III. DISCUSSION AND CONCLUSION

In antenna theory and design, microstrip antennas have been one of the most innovative subjects for many years, and are increasingly being used in a wide variety of modern microwave systems. As any other device or technology in this world so far, among its various benefits, microstrip patch antennas still have certain limitations. Several experiments are going on to improve the patch antenna gain and bandwidth. The problems of spurious radiation and high complexity are the product of current solutions. A new approach called metamaterial has emerged from the studies. Due to their fascinating and unusual properties, metamaterials have played a major role in antenna design. It is evident from this survey that antennas using metamaterials can be used to boost the efficiency of microstrip antennas. By reactively loading the metamaterial structure above the substrate, a metamaterial antenna is formed. Various kinds of metamaterial substrates exist. Any modification of the metamaterial substrate will result in changes in the antenna parameters.

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