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A Review on Antenna Application of Metamaterials

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Abstract:- *Metamaterials are a recent area of research that are important in a wide range of applications such as antenna, cloaking devices(invisibility), observer of light, super-lens, invisible submarine. This has attracted researchers both from industry and academia from the last few decades. The literature presents quality work that has been done in this direction. The paper presents a review of how metamaterials can be used as an energy storage device and can be used if needed in future. It proves to be an edge over the existing conventional techniques.*

Index Terms: - *Metamaterials, Negative Refractive Index (NRI), Left handed materials (LHM)*

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I. Introduction

The word “Meta”, which is taken from the Greek, whose meaning is "beyond” metamaterials naturally occurring substances besides exotic properties. These are the materials that are out of their properties from their structure rather than material, which they are composed of the first and one of the most significant contributions have been made to this topic 1968 V. G. Veselago who said that the materials, both theoretically possible negative permittivity and negative permeability[1]. In 1999, John Pendry of left-handed metamaterials practical way to identify (LHM), which does not follow the conventional right hand rule [2]. He offered his design organizes Thin Wire (TW) structure, which depicts the negative value of the effective permittivity [3]. It showed that the structure of the plasma frequency lower than the microwave wavelength regime. Because of its low plasma frequency, the structure can produce negative effective permittivity at microwave frequencies. It was also shown that the negative magnetic permeability can be achieved by using an array of split-ring resonators [4]. Later, then, Smith will demonstrate the new LHM simultaneously negative permittivity and permeability shows a microwave and carried out experiments to test its rare properties in 2000[5]. Shelby et al demonstrated experimentally for the first time using metamaterials with negative refraction repeating unit cell split ring resonators and copper strips [6-7].

Metamaterials are used in antennas to enhance performance miniaturized antenna systems [8-9]. These metamaterials antennas can be used to increase the gain of the antenna, since it has unique features and a band gap of periodic structures [10]. Most conventional small antennas wave reflects the signal back to the source. But these metamaterials antenna structure stores energy and re-radiates that makes its size is small, and behaves as a large antenna. The use of artificial materials and surfaces, properly engineered to enhance certain features defined antenna impedance matching, gain bandwidth, efficiency, front-to-back ratio, etc [11-12]. Metamaterials are also being utilized to increase the beam scanning range of antenna arrays. These antennas also find applications that support monitoring sensors, communication links, navigation systems, and command and control systems [13]. In this paper, we discussed the antenna application of metamaterials.

II. Related Work

Mohit Anand proposed novel applications of metamaterials in antenna engineering [14]. Compared to traditional materials, metamaterials displays some features that are not found in conventional materials. Some of the unique applications of the composite structures of an antenna substrate, superstrate, feed networks, phased array antennas, ground planes, antenna radomes and struts invisibility discussed.

Rakhi Rani *et al.* proposed an overview of metamaterials and its application, later then application of metamaterials in micro strip patch antennas over the last 13-15years. Atul Kumar *et al.* proposed how we can increase the performance of the patch antenna by using metamaterials or how we can improve the gain & bandwidth. Bimal Garg *et al*. describe Both micro strip patch antenna and micro strip patch antenna with array of rectangular split resonator at 3.2mm are simulated using IE3d Electromagnetic simulator of Zeland software incorporation.

III. Metamaterials Surface Antenna Technology

Metamaterials Surface Antenna Technology (M-SAT), an invention which uses metamaterials to accurate and maintains a consistent broadband radio frequency beam locked on a satellite platform is in motion or stationary. Gimbals and engines are replaced by arrays of metamaterials in a different configuration. In addition, this new technology Phase Shifters are not required, as with phased array technology. The desired effect is accomplished by varying the pattern of activated metamaterial elements as needed. The metamaterial Cloaking technology is the practical application of theory. The antenna is approximately the size of a laptop computer.

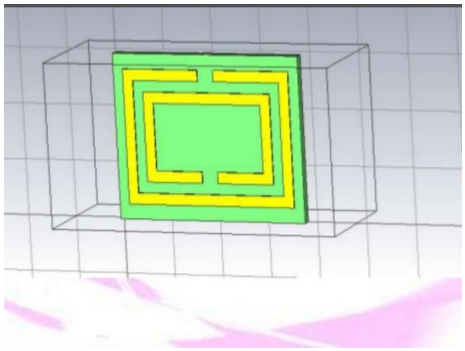

Fig.1

IV. M/Icrostrip Patch Antennas

Micro strip patch antennas are the most widely used today; in particular, this is an advantage of up to 6 GHz frequency range. Deschamps first proposed the concept of Micro strip antenna (MSA) in 1953. Micro strip antennas are also known as micro strip patch antennas, or just patch antennas. Radiating elements and are typically photo etched on the feed lines. Dielectric substrate. The micro strip antenna radiates a relatively broad beam from the side of the plane of the substrate. Thus, micro strip antenna has a very low profile, and so it can be fabricated using printed circuit (photolithographic) technology [15] .That radiating patch can be square, rectangular, thin layer (dipole), circular, elliptical, triangular or any other configuration.

V. Parameters Of Patch Antennas Which Can Improve By Using Mtm

By using metamaterial as a substrate or cover can increase profits and we can increase throughput and orientation of the patch antennas [16]. MSA has a narrow band width, which is a major limiting factor for wide application So Increased bandwidth MSA is an important research today. By increasing the substrate height and reduce the dielectric constant [17]. By using MTM as a cover up we can also advance the bandwidth [18-19]. When we use left-handed metamaterials as a plate, the use of left-handed metamaterials can increase directionality. The lens will focus on energy and radiation energy concentration. When the negative permeability of ultra-material, the micro strip patch antenna used in the reflection surface gain of about 6.91dbi.This is because the SRR eliminates substrate surface waves and radiant energy concentration [20]. So main problem in the patch antennas is substrate surface wave which can be remove by using SRR [21]. The micro strip patch antenna size can be reduced by using a metamaterial structure. With expand structure composite material Right / left hand transmission line (CRLH-TL) metamaterial, 61.12% size can be reduced [22]. In addition, broadband can be obtained by reducing the ground plane of the antenna. Compact UWB (UWB) The antenna can be designed using a meta-material structure. The antenna has a bandwidth of 189%.By placing multiple metamaterial unit cells, the bandwidth of a single patch antenna can be increased [19].

VI. Metamaterials Advantages

A. Directivity Enhancement

Metamaterials has a characteristic property that controls the direction of the electromagnetic energy originated to collect a small angular range around the normal to the surface [23]. A DNG Directive enhances the material properties of the antenna.

B. Bandwidth Enhancement

Metamaterials antenna to increase bandwidth compared conventional patch antenna [24]. This is achieved by use of a conventional antenna or load a LHM superstrate towards metamaterial

C. radiated Power Enhancement

A small antenna can increase the power radiated by using DNG metamaterials [25]. A small dipole antenna attached DNG metamaterials to use to increase radiated power compared to conventional antenna much.

D. Beam width and side lobes

It metamaterials antennas reduce beam width and side lobe ratio and thus raise and lower the return loss of the antenna directivity [26].

VII. Conclusion

Micro strip antenna is one of the most innovative topics in antenna theory and design and is used in modern microwave system. In today's world, micro strip patch antennas also have some advantages. Some studies are ongoing Patch antenna gain and bandwidth. Existing solutions lead to spurious radiation and high complexity problems. This new the method proposes a new solution called metamaterials. Due to the celestial design, metamaterials play an important role in antenna design Fun and unusual attributes. Through this review metamaterials can be used for performance improvement Micro strip patch antenna. The ultra-material antenna is made by loading a metamaterial structure on a substrate. Have Different types of metamaterial substrates. If changing the metamaterial substrate will change the parameters of the antenna. Get one the patch antenna increases the value by 1.5 dB to 7 dB by adding a metamaterial structure. Miniaturization is the main metamaterial function. Of all the works mentioned here, the use of metamaterials resulted in a reduction in size of about 50% of the patch antenna. Narrow bandwidth and low gain are two major drawbacks of micro strip patch antennas. By using we can overcome these problems.

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