Literature Survey on Compact Microstrip Patch Antennas for Wireless Application

E. Kanniga and S. Sindhuja

Abstract--- *The increasing growth of wireless system requires miniaturized antenna.Truly isotropic antennas do not exist. The most straight forward adaptive solution is to propose an antenna radiating as stable as possible in all directions. Recently antennas with quasi isotropic coverage are of increasing interest for researchers. Microstrip patch array antenna for X-band application is to be designed using any EDA Tool (ADS or HFSS). Miniaturization is possible and we just have to maintain minimum of 0.3mm line width for fabrication of the antenna. Metamaterial based miniaturization needs to be realized once the substrate is identified accordingly.*

Keywords--- *Microstrip Patch Antenna, Miniaturization, ADS, HFSS.*

I. INTRODUCTION

Wireless systems are present everywhere and also use of wireless systems is increasing rapidly. These systems include AM and FM radios, Global Positioning Systems (GPS), RFID etc. performances ofthese devices are defined by the characteristics of the antennas used. So that the designing of antenna is most important part for designing any wireless system. Nowadays printed antennas are most popular for compact electronics and thewireless systems designing because of their low profile nature and ease of integration. Most commonly used printed antennas are microstrip patch antennas (MPA).Although most of the parts of communication systems have seen considerable reduction in size by using fabrication technology. Still size reduction of the antennas is very difficult task. Conventional antennas have dimensions of half wavelength of the operating frequency. Antenna performance is very important part to be considered while reducing the size of antenna. Number of study published on the topic of antenna performances. All theories concluded that size reduction can be achieved on the expense of the antenna bandwidth and gain. These [1] theories shows the limit of Q-factor on the antenna performances. Nowadays design of electrically small antennas is interest of many research groups and many novel antenna structures has appeared in the miniaturized form. These include microstrip patch, slot antennas and others.

II. LITERATURE SURVEY

The paper titled “A review on miniaturization techniques for microstrip patch antenna” by Amit A. Rakholiya. Namrata V. Langhnoja deals with the various miniaturization techniques which includes use of high permittivity ξr materials, use of meta materials, Sierpinski carpet fractal method, use of shorting pins between ground and patch plane, introducing slots in the patch.The basis of patch antennas, transmission line model analysis, major features and drawbacks of these techniques are presented in this paper. [1]

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The paper titled "A Compact Microstrip Patch Antenna using Metamaterial" by Nikhil Kulkarni and G. B.Lohiya a metamaterial based compact multiband microstrip antenna is proposed which can give high gain and directivity. Metamaterial are periodic structures and have been intensively investigated due to the particular features such as ultra-refraction phenomenon and negative permittivity and/or permeability.The proposed microstrip antenna patch antenna with metamaterial gives a multiband operation, covering the frequency range of L, S and C bands. While using metamaterial different types of loading helps in getting multiband operation and further the size of the antenna is reduced. [2]The paper titled "Design of Compact Microstrip Patch Antenna by Using Metamaterial and its Applications" Sunayana and Misha ThakurParticle Swarm optimization (PSO) technique is discussed which gave straightforward calculation within the style of Microstrip patch antenna and analysis the result of assorted style parameter. Metamaterials are termed as Double terrible (DNG) materials due to the property of negative ε and μ. Metamaterial is the synthetic substrate that did no longer exist in the actual nature. [3]

The paper titled "Design of 8 - Shaped DNG Metamaterial for GSM 1.8 GHz Applications" by Ruchika Sharma and Harbinder Singh an 8-shaped DNG (double negative) metamaterial for GSM 1.8 GHz applications has been represented in this.This metamaterial structure is designed on low cost FR4 substrate. To calculate the complex values of permittivity and permeability Nicolson-Ross-Weir (NRW) approach is used with the help of MATLAB. The challenging tasks of designing and simulating the matematerial are carried out using CST Microwave studio 2010. [4]

The paper titled "Left Handed Metamaterial antenna design for GSM 1.8 GHz applications" by Ruchika Sharma and Harbinder Singh presents the ideas about the use of metamaterials in innovative antenna designs from an engineering perspective. In the previous work, an eight shaped left handed metamaterial was designed with the help of FR4 substrate having ξr = -4 and μr = -2 at 1.8 GHz.By adding left-handed metamaterial return loss has been improved and the effective volume of the rectangular microstrip patch antenna is also shortened by 71% and 47% reduction was applied to the base substrate of the patch antenna. [5]

The paper titled "Design of an X-band microstrip patch antenna with Enhanced bandwidth" by M. M. Islam, M. T. Islam, M. R. I. Faruque, and W. Hueyshin summarizes the miniaturization of antenna and improvement inbandwidth can be obtained by adjusting to cut the slot inground and patch of microstrip antenna of proper length and width. X band technology has been broadly used invarious applications because of its high data transmission rate,large bandwidth and short-range features. Designing X bandantennas has tempted the interest of many researchers and isstill a major challenge to equalize these applications. [6]

The paper titled "Study the various Feeding Techniques of Microstrip Antenna Using Design and Simulation Using CST Microwave Studio" by Sourabh Bisht, Shweta Saini, Dr. Ved Prakash; BhaskarNautiyal explains various feeding methods for Microstrip patch antennas. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The various feeding techniques to microstrip patch antenna are microstrip line feed, coaxial feed, Aperture coupled feed and proximity coupled feed. [7]

The paper titled "Microstrip Patch Array Antenna for X-Band Applications" by Nivetha K and Monica A deals with antenna array which consists of 12square patches which are identical to each other and functions at a center frequency of 8.2 GHz and has a bandwidth of 100MHz.The square patches are arranged in such a fashion that there are four arms,each of which have 3 elements and is series fed.The main application of x-band is radar. Hence in order to avoid sea clutter reflectivity Horizontal polarization is used because it can produce less sea clutter reflectivity when compared with vertical polarization.Therefore inorder to increase the current flow to aid horizontal polarization, a slit was carved on each patch. [8]

The paper titled "A Printed Microstrip Antenna for RADAR Communication" by Bipa Datta, Arnab Das, Samiran Chatterjee, Moumita Mukherjee and Santosh Kumar Chowdhury explains about the proposed antenna (substrate with $\xi r = 4.4$) has a gain of 3.98 dBi and presents a size reduction of 48.11% when compared to a conventional microstrip patch (10mm X 6mm). The simulation has been carried out by IE3D [11] software which uses the MOM method. Due to the small size, lowcost and low weight this antenna is a good entrant for the application of XBand microwave communication and Ku-Band RADAR communication. The X band and Ku-Band defined by an IEEE standard for radio waves and radar engineering with frequencies that ranges from 8.0 to 12.0 GHz and 12.0 to 18.0 GHz respectively. The X band is used for short range tracking, missile guidance, marine, radar and air bone intercept. Especially it is used for radar communication ranges roughly from 8.29 GHz to 11.4 GHz. The Ku band is used for high resolution mapping and satellite altimetry. Especially, Ku Band is used for tracking the satellite within the ranges roughly from 12.87 GHz to 14.43 GHz. [9]

The paper titled "Microstrip Antenna Designs for Radar Applications" by K.S. Beenamole explains about Microstrip antennas and arrays which are used as an alternative for the bulky and heavy weight reflector/slotted waveguide array antennas. For radars which demand a low profile, light weight antenna subsystem, the microstrip antennas are an ideal choice. The fabrication technology based on photolithography enables the bulk production of microstrip antenna with repeatable performance at a lower cost in a lesser time frame as compared to the conventional antennas. This technology has been developed and successfully established in LRDE for X-band, L-band and S-band radar applications. The reliability and the yield of microstrip antennas are very high because the antennas and arrays can be analyzed using 3D EM analysis tools based on Method of Moments (MoM), Finite Element method (FEM) and Finite Difference Time Domain (FDTD) before fabrication. [10]

The paper titled "A Positive Future for Double-Negative Metamaterials"by Nader Engheta, and Richard W. Ziolkowski gives an overview of some of the unusual characteristics of DNG MTMs is provided and some of their exciting potential applications are reviewed.While the physics of MTMs appears to be much better understood now through analysis and numerical simulations, there are significant challenges ahead in the areas of fabrication and measurements. There have been several successful microwave realizations of the volumetric MTMs that have demonstrated the unusual properties discussed here. [11]

The paper titled "Design, Fabrication, and Testing of Double Negative Metamaterials" by Richard W. Ziolkowski presents design, fabrication, and testing of several metamaterials that exhibit double negative (DNG) medium properties at X band frequencies are reported. DNG media are materials in which the permittivity and permeability are both negative. Simulation and experimental results are given that demonstrate the realization of DNG metamaterials matched to free-space. The extraction of the effective permittivity and permeability for these metamaterials from reflection and transmission data at normal incidence is treated. It is shown that the metamaterials studied exhibit DNG properties in the frequency range of interest. [12]

The paper titled “Application of Double Negative Materials to Increase the Power Radiated by Electrically Small Antennas” by Richard W. Ziolkowskiand and Allison D. Kipple.The problem of an infinitesimal electric dipole embedded in a homogeneous DNG medium is treated; its analytical solution shows that this electrically small antenna acts inductively rather than capacitively as it would in free space. It is then shown that a properly designed dipole-DNG shell combination increases the real power radiated by more than an order of magnitude over the corresponding free space case. The reactance of the antenna is shown to have a corresponding decrease. Analysis of the reactive power within this dipole-DNG shell system indicates that the DNG shell acts as a natural matching network for the dipole. [13]

The paper titled “Radar Absorbing Applications of Metamaterials” by Vasundara V. Varadan, explains Radar Absorbing Materials (RAM) is used tocamouflage or shield highly reflective surfaces such metallicsurfaces from incident electromagnetic (EM) waves. In thispaper, we explore the applications of metamaterials asconformal RAM coatings for controlling the reflection of EMwaves from metal surfaces. Metamaterials are engineeredmaterials with specially designed metallic resonant structuresthat are much smaller than the wavelength of incidentmicrowaves (MW) and effectively such materials may negativepermittivity and/or permeability. For the first time, we alsoexplore the experimental use of metamaterials as conformal Frequency Selective Surfaces (FSS). Using a specially designedfree space focused microwave beam automated scanningsystem, the reflection reduction properties of metamaterialsare demonstrated for oblique angles of incidence and fororthogonal polarizations.[14]

The paper titled “Antenna Miniaturization and Bandwidth Enhancement Using a Reactive Impedance Substrate”by HosseinMosallaeiand and Kamal Sarabandi explains the concept of a novel reactive impedance surface (RIS) as a substrate for planar antennas, that can miniaturize the size and significantly enhance both the bandwidth and the radiation characteristics of an antenna is introduced. Using the exact image formulation for the fields of elementary sources above impedance surfaces, it is shown that a purely reactive impedance plane with a specific surface reactance can minimize the interaction between the elementary source and its image in the RIS substrate. [15]

III. CONCLUSION

This paper presented theoretical survey on compact antennas used in wireless applications. After study of the literature survey, we can conclude that increase in bandwidth; gain and improved radiation pattern can be obtained by adding the slots in the geometry of antenna, using different material of antenna, by changing the feeding technique. Also by using metamaterial inspired antennas improved antenna parameters can be obtained.

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