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Gain Enhancement of Microstrip Patch Antenna using Array Configuration - A survey

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Abstract: Minimizing return losses and maximizing gain are important issues in the design of microstrip patch antenna. High gain microstrip patches antenna find an optimal arrangement of patches in order to improve antenna performance. For example, in long distance applications, only an optimal microstrip patch antenna that fully covers the monitored area can be applied. In this paper, we address the optimal planning of patch arrangement on dielectric substrate. We seek an technology that maximizes radiations from patch while ensuring simultaneously full power transmission. First, we design a microstrip patch antenna using HFSS (high frequency structure simulator). Then, we implement a array structure, increasing the size of antenna .Experimental results show that the proposed antenna provides low return losses and VSWR.

Keywords: Wireless Local Area Networks (WLAN), Array, Feed Network, Return Losses, Gain, Directivity, Polar Plot, Radiation Pattern.

INTRODUCTION

Wireless Local Area Networks (WLAN) consist of a large number of limited capabilities (Power and Processing). Micro Electro Mechanical Systems (MEMS) capable of measuring and reporting physical variables related to their environment. In communication applications, patch antennas are deployed in a certain field to transmit and receive radio waves and report events like return losses, gain, directivity, VSWR[1]. As depicted in Fig. 1,a micro strip patch antenna is simply a radiating patch on one side of a dielectric substrate and a ground plane on other side. The load attaches to a micro strip to its ground plane. Microstrip patch antenna radiate due to fringing fields created between the patch and the ground plane and resonate according to the dimensions of the radiating patch.[1]

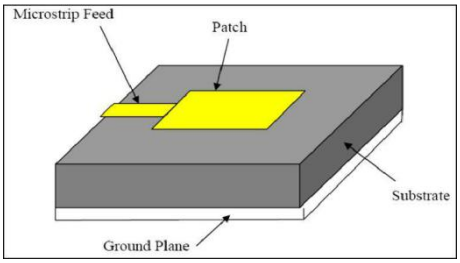

Fig 1 Elements of microstrip patch antenna[1]

We address the global problem of maximizing gain under the array configuration technique. We consider a network of patches that is deployed under certain frequency band to monitor some given events. The transmission line is used to transfer RF power from source to patch. Series feed or corporate feed transmission line is used to transfer of RF power [9]. Due to surface wave excitations, microstrip patch antenna usually have a limited gain characteristics. Narrow bandwidth and low gain in microstrip patch antenna is critical problem and has been improved by:

1.Patch with different shapes
2. Partial substrate removal technique
3Using Meta material cover
4 Array configuration Technique

The scope of this paper includes enhancement of gain using array configuration and using rectangular shape micro strip patch antenna. We consider a micro strip patch antenna that is deployed in 2.5 – 4 ghz frequency range to monitor some given parameters like gain, return losses, radiation pattern etc. Micro strip patch antennas are small in size. But gain can be improved by increasing the size of patch antenna[4]. One general method to enhance the size of micro Strip patch antenna use more than single patch. Physical and electrical arrangement of patches forms an array. Increasing the size of antenna, s parameters and gain of patch antenna can be improved[2].

As depicted in fig 1. RF energy fed to patches through transmission line The patches, micro strip transmission line , and ground plane are made of high conductivity metal. It has been observed that the width of micro strip antenna controls the input impedance[5]. Larger width also can increase the bandwidth.

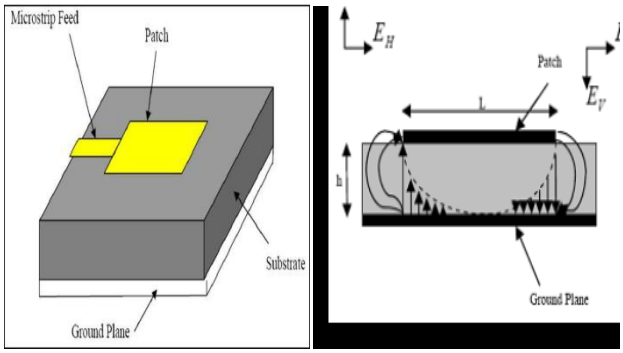

Fig 2.(a) basic elements of patch antenna[1] fig 2.(b) side view of antenna[1]

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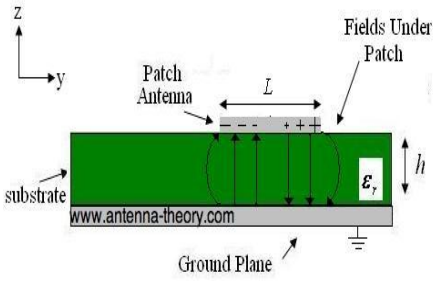

fig 2.(c) side view of antenna resembles field underneath the patch [1]

The fringing field around the antenna can help explain why the micro strip antenna radiates (fig b) . Consider the side view of patch antenna fig 2(b). Current at the end of patch is zero(open circuit end) and maximum at the center of the patch. Since the patch antenna can be viewed as an open circuited transmission line the voltage reflection coefficient will be 1. When this occurs, the voltage and current are out of phase. At the end of patch the voltage is maximum. At the start of patch antenna (a half wavelength away) the voltage must be at minimum. Hence the fields underneath the patch will resemble that of fig2(c) which displays the fringing of fields around the edges. It is the fringing fields that are responsible for the radiation. The fringing E- fields on the edge of the micro strip antenna add up in phase and produce the radiation of the micro strip antenna. The micro strip antenna's radiation arises from the fringing field, which are due to the advantageous voltage distribution; hence the radiation arises due to the voltage and not the current[1].Array configuration allows patches to be arranged in two different manners i.e. linear array configuration and phase order array configuration. In linear order, patches are arranged in a series manner while in phase order, each radiating element(patch) provided with a phase sift of theta. Beams are formed after phase shift of theta through each radiating element. Many papers addressed separately micro strip patch antenna, feeding techniques, radiation pattern, gain characteristics. Many other works addressed the integrated problem of maintaining gap between patches, dimensions of antenna, location of feed line but only on linear array configuration not phase. To the best of our knowledge, the problem of maximizing gain and reduction in losses has not been addressed within the same global optimization process. In this paper, we address the optimal planning of arrangement of metallic radiating element on dielectric substrate. In our design, antenna parameters has improved using linear array configuration.

The problem of maintaining both design considerations and arrangement of patches has been extensively addressed in the literature and many configurations were proposed to enhance the gain of antenna. For example A. D et al.[3] proposed inset feed linearly polarized rectangular micro strip patch antenna array with sixteen elements. Initially antenna with a single patch is designed and after evaluating the outcomes of antenna features; operation frequency, radiation patterns, reflected loss, efficiency and antenna gain, we transformed it to a 2x1 array. Finally, analyzed the 2×2 array, then 4×2 array and finally 4 × 4 array to increase directivity, gain, efficiency and have better radiation patterns. Author Kuldeep Kumar Singh [5] designed antennas with 2,4,8 and 16 elements. It has been observed that with increasing number of patches ,performance of patches improved. It has been observed by designers that shape of patch affect the parameters. Rampal Kushwaha[4] provides E shaped micro strip patch antenna. They presents bandwidth radiated microstrip patch with enhanced gain has been designed with centre frequency of 2GHz. This paper presents gain enhancement by cutting rectangular hole on another inserted layer. A symmetrical hole on inserted layer is used in simulation at 2GHz which is the key frequency in modern wireless communication era. The gain enhancement of approximate 10dB is achieved at 2GHz by inserting another symmetrical rectangular layer. Similarly Miss Junnarkar Priyanka[6] proposed Triangular Microstrip Patch Antenna. Thus proposed system uses FR4 as a dielectric substrate(€r=4.4).The antenna has been designed to operate on the range of 5.5GHz.Therefore the proposed antenna is highly suitable for communication system. Although microstrip antennas generally used with single patch but for better results and improved characteristics array of patches introduced. AminRida[13] proposed a low cost microstrip antenna array for mm–wave applications. Microstrip patch array antenna is developed in the millimeter-wave band for large gain applications. A simple edge feeding is used for a sub-array of 16x1 elements, and finally a matching network or power divider/splitter is designed for a 32x16 elements with a gain of27dBi for the design frequency of 79GHz and 26dBi at 80GHz. A method to reduce the slightly high "shoulder" radiation due to the feed network is introduced through a shielded feed.

A microstrip patch antenna is very simple in the construction using a conventional fabrication technique. The patch can take any shape but rectangular and circular configurations are the most commonly used configurations. Yahya S. H. Khraisat [9]proposed an 4 Elements Rectangular Microstrip Patch Antenna with High Gain for 2.4 GHz Applications. They designed an inset feed linearly polarized rectangular microstrip patch antenna with four element array. Controlled Microstrip antennas have a wide beam that make it suitable in building antenna. Linearly polarized micro strip patch antennas suffers from low gain due to positive refractive index. The fact is that the resolution below the diffraction limit does not possible. Meta materials are artificial materials that provide negative refractive index. some designers used meta material cover to enhance the performance of micro strip patch antenna. For example, Amer Basim Shaalanet . al .[12]proposed Fractal Shape Antenna using Meta material Cover. Meta materials allow the propagation of wave in reverse direction. When negative refractive index applies , resolution below the diffraction limit is possible .This process is called sub wavelength imaging. They described the fractal shape antenna is proposed and covered by new design of ring resonator to get enhancement in gain. The calculated result shows an enhancement in efficiency, gain, directivity and far field shapes. Generally rectangular shape patches are used to designed micro strip patch antenna. Rectangular

patches then arrange to form an array. It is also very convenient to use patches of different shape and then arrange them into array. Deepti Saxena[10] et.al. proposed E-Shaped Microstrip Patch Antenna Array for WLAN . The array is mounted on a low-cost FR4 substrate and is fed by a standard 50 Ohm coaxial feed. The array is designed using a full wave solver based on the moment method. A special combined series and corporate feeding network is incorporated directly in the array. Operating frequency of this design is suitable for S band and C-band application. Another author Subodh Kumar Tripathi[1], proposed E-Shaped Slotted Microstrip Antenna with for Wireless Communication. Designed antenna can be operated in dual frequencies such as 5.1GHz and 7.5GHz with return loss of -22db and -12db respectively. Maximum achieved gain of the designed antenna is 11.5 dbi.

There are four feeding techniques to transfer the RF power to patches. Microstrip feed line is most commonly used. There are further two ways to apply micro strip feed line .Series feed network and corporate feed network are used to fed RF to patches in array configuration. Yash Rawatet. al. [7] represented different feeding techniques for Rectangular Microstrip Patch Antenna. In this paper, a comparative study between inset feed, microstrip feed and co-axial feed, on a rectangular microstrip patch antenna are done on the basis of S parameter, Reflection gain, VSWR and Radiation Pattern using Hyper lynx 3D EM software. Different feeding techniques have different impact when applying on microstrip patch antenna. Author H. Errifiet. al.[8] proposed Patch Array Antennas with Series, Corporate and Series-Corporate Feed Network. Different feeding techniques applied on single patch antenna .It has been observed that performance of micro strip patch antenna varies with changes in feed network. Series feed network is not generally used due to some limitations also. In series feed network ,a minor change in single radiating element causes change in others. Thus effect on performance of patch antenna. Corporate feed method is thus used. Coupling of RF power to micro strip patch antenna and feed line is responsible for radiations from patches .More the number of patches, larger the amount of radiations and hence improved gain can be achieved. S. M. Mahfuz Alam and Md. Anwarul Abed in [15], described radiation pattern of microstrip patch antenna having a number of radiating elements. The fringing field created on patch antenna depends on the dielectric constant of patch element. The desired directivity of the antenna has been achieved by the proper design of the patch antenna array. In this paper the generalized equations of electric and magnetic field for n element patch antenna array are analyzed.

CONCLUSION

Theoretical survey on micro strip patch antenna array has done in this paper. While designing the antenna the things which we have to consider is substrate which we are going to use, feeding type, dielectric constant of the substrate and its height and width. When we use the substrate from the ceramic family it gives the low microwave loss and also good insulation at high temperature. Particular micro strip patch antenna can be designed for specific applications. And it is believed that, this small size antenna will continue to benefit the human race for future years.

REFERENCES

[1] " Antenna Patch Theory", Design book
[2] Mohit Joshi, UtkarshShah.,"Gain Enhancement of Micro strip Patch Antenna For WLAN application using Array configration" ,International Journal of Engineering Research and Development,Vol-2,Issue 2,Feb-2013.
[3] A. De, C. K. Chosh and A. K Bhattacherjee, "Design and Performance Analysis of Micro strip Patch Array Antennas with different configurations", International Journal of Future Generation Communication and Networking Vol. 9, No. 3 ,2016
[4] RampalKushwaha, " Design and analysis of gain for rectangular microstrip patch antenna using symmetrical cuts" , International Journal of Advance Technology & Engineering Research (IJATER), Vol. 1, Issue 1, November 2011
[5]. Kuldeep Kumar Singh, "Review and Analysis of Microstrip Patch Array Antenna with different configurations", International Journal of Scientific & Engineering Research, Volume 4, Issue 2,2013.
[6] Miss JunnarkarPriyanka, " Communication With Triangular Micro strip Patch Antenna Array" , IJARIIE ,Vol-1 Issue-5 2015,ISSN(O)-2395-4396
[7] H. Errifi, A. Baghdad, A. Badri, and A. Sahel, "Design and Analysis of Directive Micro strip Patch Array Antennas with Series, Corporate and Series-Corporate Feed Network", International Journal of Electronics and Electrical Engineering Vol. 3, No. 6, December 2015
[8] .Yahya S. H. Khraisat, "Design of 4 Elements Rectangular Micro strip Patch Antenna with High Gain for 2.4 GHz Applications", IEEE Transaction On Antenna And Propagation, Vol. 6, No. 1,2012
[9]. .DeeptiSaxena, SwetaAgarwal, SumitSrivastava, "Low Cost E-Shaped Micro strip Patch Antenna Array for WLAN" ,International Journal of Advanced Research in Electrical ,Electronics and Instrumentation Engineering ,Vol-1,Vol. 3, Issue 4, April 2014
[10] AmerBasimShaalan , AmmarNadalShareef "Gain Enhancement of Fractal Shape Antenna using Metamaterial Cover ", International Journal of Advanced Research (2014), Vol 2, Issue 11, pp.880- 887
[11]. AminRida and Manos Tentzeris, "Design of Low Cost Microstrip Antenna Arrays for mm Wave Applications",IEEE Transactions And Propagation,Vol.AA,No.B,2011.
[12]. S. M. MahfuzAlam, Md. AnwarulAbedin, " Radiation Pattern Investigation of n Element Micro strip Patch Antenna Array", IEEE Transactions And Wireless Propagation Letters, Vol. 1, Issue 3, June 2012.