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CONFIGURATION AND OPTIMIZATION OF A MICRO STRIP PATCH ANTENNA FOR INCREASED BANDWIDTH

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ABSTRACT

The development of numerous frameworks, it is imperative to plan broadband receiving wires to cover a wide recurrence range. The point of this paper is to plan a broadband patch reception apparatus, utilizing the three methods of opening; including specifically coupled parasitic components, and fractal EBG structures. The transmission capacity is enhanced from 9.32% to 23.77%. A wideband running from 4.15 GHz to 5.27 GHz is gotten. Additionally a relative investigation of installing EBG structures at various statures is likewise done. The composite impact of coordinating these systems in the configuration gives a straightforward and productive strategy for acquiring low profile, broadband, high pick up reception apparatus. By the expansion of parasitic components the data transfer capacity was expanded to just 18.04%. Later on by implanting EBG structures the data transmission was expanded up to 23.77%. The outline is appropriate for assortment of remote applications like WLAN and Radar Applications.

KEYWORDS: Bandwidth, broadband, EBG structures, parasitic elements and Slotting.

INTRODUCTION

The Small scale strip Patch radio wires have been planned and described widely over the past numerous years as a result of their position of safety structures, light weights, and minimal effort in creation [1],[8] where different outline strategies and quick solvers have been produced to improve radiation execution, (for example, data transfer capacity and increase). These position of safety reception apparatuses are helpful in flying machine, satellite and rocket applications where size, weight, cost, execution, simplicity of establishment and streamlined profiles are strict limitations. Disregarding numerous points of interest, these receiving wires experience the ill effects of some drawbacks which incorporate their low proficiency, low power, high Q, spurious food radiation and exceptionally limit data transfer capacity [9],[14]. There have been extensive endeavors made by specialists from everywhere throughout the world towards expanding its data transmission. A conceivable path for expanding the transmission capacity is to either build the tallness of the dielectric or diminishing the dielectric steady. However the main methodology would make it unacceptable for low profile structures while the last approach will make the coordinating circuit to the patch troublesome because of unreasonably wide bolstering lines. Different strategies [15], [17] have been proposed to expand the data transfer capacity of a patch radio wire. Transmission capacity of little size micro strip reception apparatuses has been enhanced by the utilization of U opening and L test [15], stacked micro strip patch radio wire, gap coupled, and impedance coordinating system utilizing channel plan methods [16], lopsided structures [17].

Another method for expanding the transfer speed of the MPA is the utilization of extra resonators [18] either specifically coupled or in a roundabout way coupled to the patch reception apparatus. Utilization of EBG structures for enhancing the qualities of MPA, for example, enhancing their radiation designs, upgrading their increase, and minimizing the side and back projection levels, and so on has pulled in much consideration among specialists in the microwave and reception apparatus groups [19]. Different EBG structures have been proposed and they have discovered numerous applications in the microwave area [20]. As of late EBG structure on the food line has additionally been contemplated to enhance execution of a triple band space radio wire.

The principle goal of this paper is to display another reception apparatus arrangement with joined impact of opening, utilization of straightforwardly coupled parasitic components and fractal EBG structures to plan a basic low profile broadband receiving wire. Firstly opening was finished by presenting four openings on all the four sides of a rectangular molded patch reception apparatus as appeared in Fig. 1. At that point four distinctive emanating components associated together and straightforwardly coupled to the opened reception apparatus as appeared in Fig. 2 were included which indicates change in data transfer capacity from 9.32% to 18.04%. Later on by installing fractal EBG structures in the same receiving wire it was being watched that the data transmission was expanded up to 23.77%. A relative examination was likewise done at various statures of fractal EBG structures. The material utilized as the substrate is FR4 (glass epoxy, er= 4.4) and the sort of food utilized is coaxial test encourage. The reenactment is done utilizing HFSS which depends on Finite Element Method.

ANTENNA DESIGN

Slotted Rectangular Microstrip Patch Antenna: In this section a slotted patch antenna is designed. Fig. 1 depicts the geometry of the proposed patch antenna with its dimensions 36mm×28mm. The four slits as shown in Fig. 1 are created in its shape. The FR4 material is used as the substrate whose thickness is 3.2mm (h1). The dimensions of the slits along the length are L1=4mm and W1=10mm and along the width are W2=4mm and L2=12mm. The feed is positioned 0.6mm along the x-axis and 4.3mm along the Y axis from the centre of the rectangular patch. The ground plane size is 100mm×100mm. The proposed antenna is simulated using HFSS which is based on FEM. Fig. 7 shows the simulated impedance bandwidth. The impedance bandwidth is found to be 9.32% ranging from 4.2GHz to 4.61GHz. It has been observed that by introducing the slits in the patch antenna the surface current path is increased leading to a broader bandwidth of 9.32% whereas the bandwidth of a normal patch antenna is generally about only 1%.

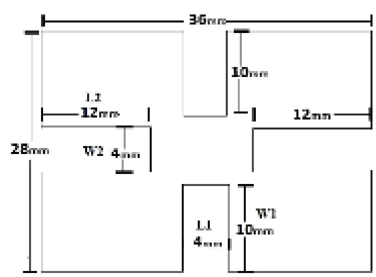

Fig. 1 Top view of Slotted Patch Antenna

Bandwidth Improvement by the use of Directly Coupled Parasitic Elements: The antenna designed in Section A still has narrow bandwidth by seeing the demand for overgrowing need of wireless communication. The second technique employed here to increase its bandwidth is the use of directly coupled parasitic elements. Fig. 2 shows the geometry of the proposed new modified slotted patch antenna with parasitic patches. These additional resonators generate the modes very close to the fundamental resonant frequency of the main patch resulting in broad bandwidth. As shown in the figure additional parasitic elements are directly coupled and inserted in the slits of the slotted patch antenna. All the dimensions of the parasitic elements are shown in the figure. This new antenna with parasitic elements has bandwidth of 18.04% which is twice that of the slotted patch antenna. This antenna operates in the range of 3.53GHz to 4.23GHz. The length and width of each element of these parasitic elements are optimized to get the broad bandwidth. The optimized feed location is found to be at 0.62mm along the x-axis and 4.3mm along the y-axis from the centre of the rectangular patch. The results are shown in Fig. 8.

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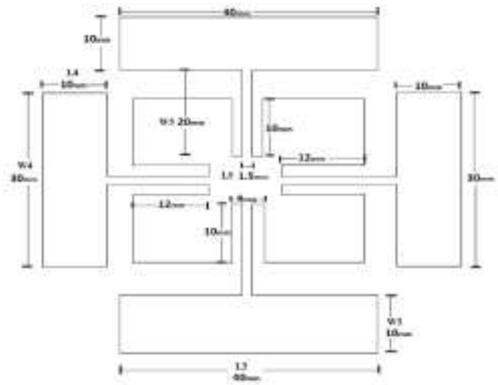

Fig. 2 Top view of Slotted Patch Antenna with directly coupled parasitic elements

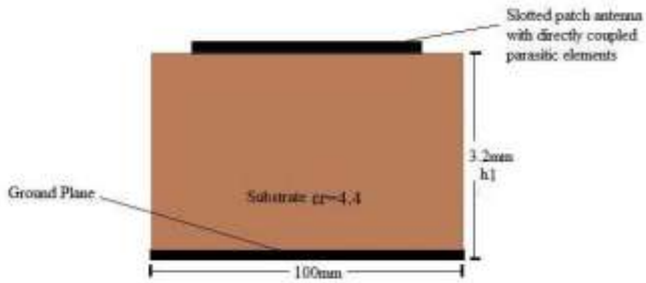

Fig. 3 Side view of Slotted Patch Antenna with directly coupled parasitic elements

New Modified Antenna Design using Fractal EBG Structures for Wide Bandwidth: In this section a third technique is employed to further improve the bandwidth of the antenna designed in Section B. By the use of EBG structures the characteristics of the patch antenna can further be enhanced. An EBG structure is a periodic structure that forbids the propagation of all Electromagnetic waves within a particular frequency band called the band gap. The performance improvement occurs due to the stop bands of these periodic structures. These structures provide a simple and effective solution to surface and leaky waves. Several types of micro strip based EBG structures have been analyzed for variety of applications.

Fig. 4 shows the geometry of the single element of the EBG structures. An array of 6×6 EBG structures is embedded at a height of 1.6mm (h2) as shown in Fig. 5. Each single array element has dimensions of L7=12mm and W7=12mm as shown in figure. The gap between the array elements, L5=4mm and W5=4mm is also shown in the figure. This new modified antenna design using EBG structures has a wide bandwidth of 23.77% ranging from 4.15GHz to 5.27GHz as shown in Fig. 9 in comparison to 18.04% of the antenna designed in Section B. The antenna is found to resonate at the frequency of 4.17GHz with -38.60dB return loss.

The side view of the new modified antenna design is shown in Fig. 6. The EBG structures were embedded at the height of 1.6mm (h2) from the ground plane in the antenna designed in section B. The modified feed location is found to be at 0.6mm along the x-axis and 4.6mm along the y-axis from the centre of the rectangular patch.

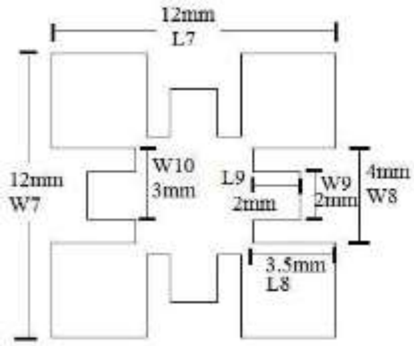

Fig. 4 Single Element of EBG Structures

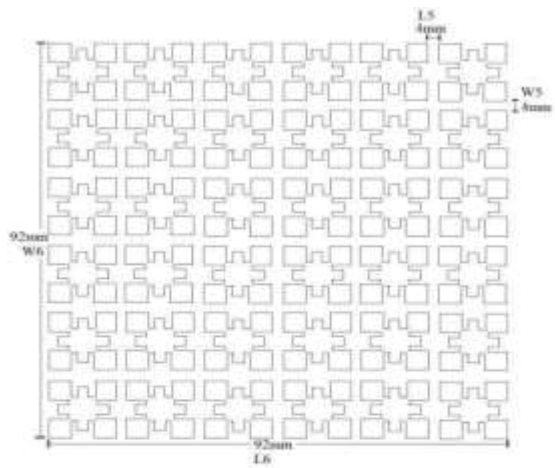

Fig. 5 6×6 array of EBG structures

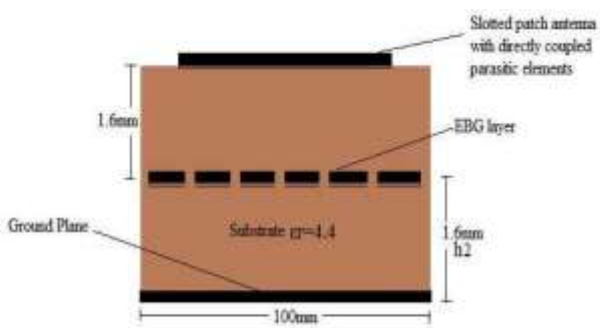

Fig. 6 Side view of the new modified antenna design with EBG structures

SIMULATED RESULTS AND DISCUSSION

Slotted Patch Antenna: Fig. 7 shows the return loss curve for the antenna designed in section A. The simulated results show that the resonant frequency locates at about 4.31GHz with the maximum return loss of -33.55dB. The -10dB impedance bandwidth is found to be 9.32% ranging from 4.2GHz to 4.61GHz which is comparable more than the normal rectangular shaped patch antenna having only 1% bandwidth.

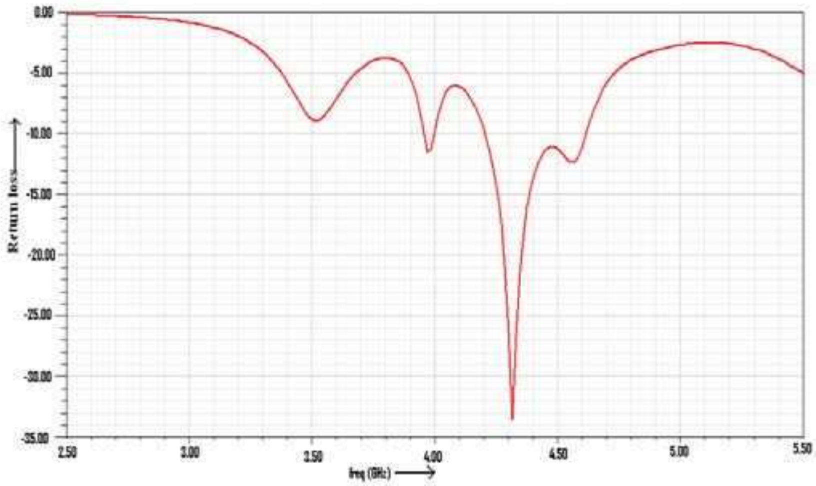

Fig. 7 Return Loss (in dB) vs freq (in GHz) for slotted patch antenna

Slotted Patch Antenna with Directly Coupled Parasitic Elements: The result in Section A shows only the limited bandwidth. To further enhance the bandwidth of the patch antenna designed in section A, the use of parasitic elements is made which increased the bandwidth to 18.04% ranging from 3.53GHz to 4.23GHz. Fig. 8 shows the return loss curve for the antenna designed in section B. The maximum return loss is found to be -29.12 dB located at the resonant frequency of 3.63GHz.

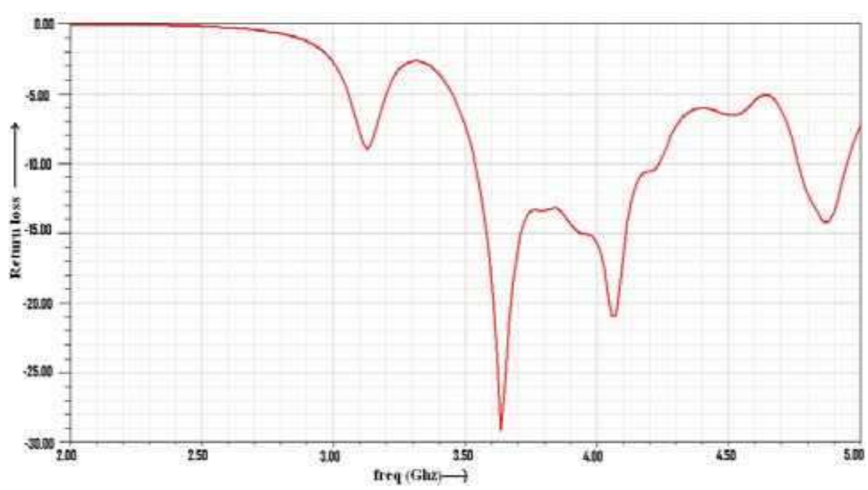

Fig. 8 Return Loss (in dB) vs. freq (in GHz) for slotted patch antenna with directly coupled parasitic elements

New Modified Antenna with Embedded Fractal EBG Structures: Fig. 9 shows the return loss curve for the antenna designed in section C. By embedding the fractal EBG structures the bandwidth was further improved to 23.77% ranging from 4.15GHz to 5.27GHz. It is being observed from the figure that by embedding EBG structures the bandwidth is drastically improved.

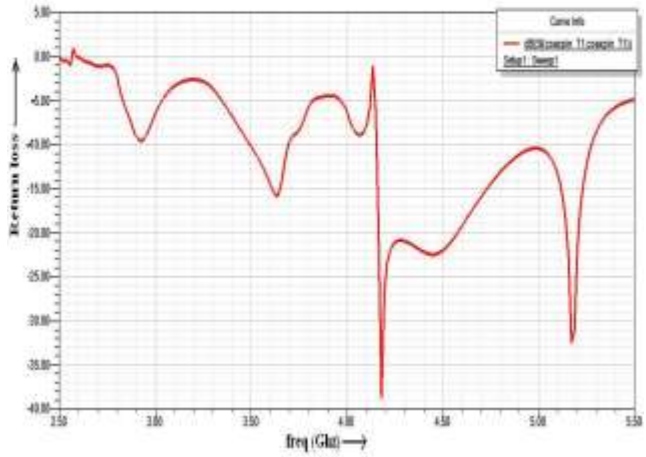

Fig. 9 Return Loss (in dB) vs. freq (in GHz) for slotted patch antenna with directly coupled parasitic elements and embedded fractal EBG

Effect of Embedding Fractal EBG Structures at Different Heights from Ground Plane: Fig. 10 shows the return loss curve of the new proposed antenna with EBG structures at different heights. The height from the ground plane of the EBG structures is optimized to get the broad bandwidth. The optimum result is found at height h2=1.6mm from the ground plane as can be seen from Fig. 6.

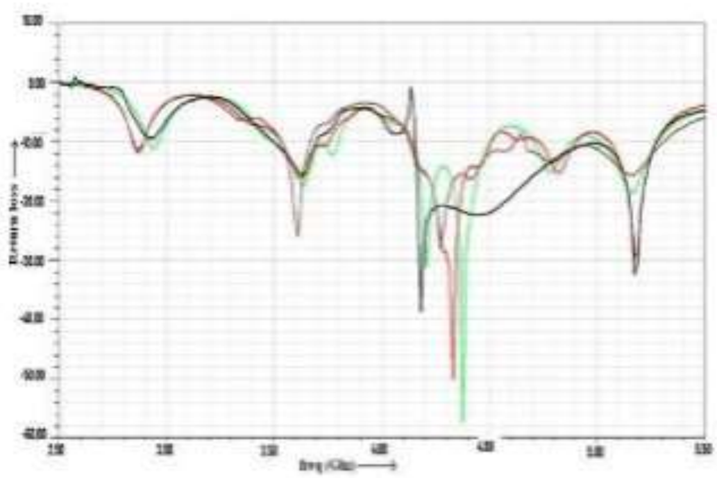

Fig. 10 Effect of fractal EBG structures at different heights from ground plane

CONCLUSION

In this paper an exceptionally wideband patch reception apparatus is outlined, utilizing the three strategies of opening, including specifically coupled parasitic components and inserting fractal EBG structures. From the recreation result it is being watched that by including openings in the ordinary rectangular formed patch radio wire the transmission capacity is expanded from 1% to 9.32% .This transfer speed is further enhanced to 18.04% by including specifically coupled parasitic components which is only twice to that of the opened receiving wire. To further build the transfer speed the third component is fused that is the utilization of 6×6 fractal EBG structures. These EBG structures are implanted in the adjusted patch to expand the data transfer capacity up to 23.77%. This radio wire can be utilized to give the wide band operation to WLAN and radar applications.

REFERENCES

[1] Zhao, W.-J., J. L.-W. Li, and K. Xiao, "Analysis of radiation characteristics of conformal microstrip arrays using adaptive integral method," IEEE Transactions on Antennas and Propagation, Vol. 60, No. 2, 1176-1181, 2012.
[2] Li, J. L.-W., Y.-N. Li, T.-S. Yeo, J. R. Mosig, and O. J. F. Martin, "Addendum: 'A broadband and high-gain met material microstrip antenna' [Appl. Phys. Lett. 96, 164101(2010)]," Applied Physics Letters, Vol. 99, 159901, Nov. 2011.
[3] Li, L.-W., Y.-N. Li, T.-S. Yeo, J. R. Mosig, and O. J. F. Martin, "A broadband and high-gain met material microstrip antenna, "Applied Physics Letters, Vol. 96, No. 6, 164101, Apr. 2010.
[4] Zhao, W.-J., L.-W. Li, and K. Xiao, "Analysis of electromagnetic scattering and radiation from finite microstrip structures using an EFIEPMCHWT formulation," IEEE Transactions on Antennas and Propagation, Vol. 58, No. 7, 2468-2473, Jul. 2010.
[5] Yuan, N., T. S. Yeo, X. C. Nie, Y. B. Gan, and L.-W. Li, "Analysis of probe-fed conformal microstrip antennas on finite ground plane and substrate," IEEE Transactions on Antennas and Propagation, Vol. 54, No. 2, 554-563, Feb. 2006.
[6] Yin, W.-Y., X.-T. Dong, J. F. Mao, and L.-W. Li, "Average power handling capability of finite-ground thin film microstrip lines over ultra wide frequency ranges," IEEE Microwave and Wireless Components Letters, Vol. 15, No. 10, 715-717, Oct. 2005.
[7] Gao, S.-C., L.-W. Li, T.-S. Yeo, and M.-S. Leong, "A broad-band dual polarized microstrip patch antenna with aperture coupling," IEEE Transactions on Antennas and Propagation, Vol. 51, No. 4, 898-900, Apr. 2003.
[8] Yuan, N., T.-S. Yeo, X. C. Nie, and L.-W. Li, "A fast analysis of scattering and radiation of large microstrip antenna arrays," IEEE Transactions on Antennas and Propagation, Vol. 51, No. 9, 2218-2226, Sep. 2003. A correction is also made here (appearing in IEEE T-AP, Vol. 52, No. 7, 1921, Jul. 2004).
[9] Moradi, K. and S. Nikmehr, "A dual-band dual-polarized microstrip array antenna for base stations," Progress In Electromagnetics Research, Vol. 123, 527-541, 2012.
[10] Monavar, F. M. and N. Komjani, "Bandwidth enhancement of microstrip patch antenna using jerusalem cross-shaped frequency selective surfaces by invasive weed optimization approach," Progress In Electromagnetics Research, Vol. 121, 103-120, 2011.
[11] Pergol, M. and W. Zieniutycz, "Rectangular microstrip resonator illuminated by normal-incident plane wave," Progress In Electromagnetics Research, Vol. 120, 83-97, 2011.
[12] Rezaee, P., M. Tayarani, and R. KnÄochel, "Active learning method for the determination of coupling factor and external Q in microstrip filter design," Progress In Electromagnetics Research, Vol. 120, 459-479, 2011.
[13] Tiang, J.-J., M. T. Islam, N. Misran, and J. S. Mandeep, "Circular microstrip slot antenna for dual-frequency RFID application," Progress In Electromagnetics Research, Vol. 120, 499-512, 2011.
[14] Asimakis, N. P., I. S. Karanasiou, and N. K. Uzunoglu, "Non-invasive microwave radiometric system for intracranial applications: A study using the conformal L-notch microstrip patch antenna," Progress In Electromagnetics Research, Vol. 117, 83-101, 2011.
[15] Shakelford, A., K. F. Lee, D. Chatterjee, Y. X. Guo, K. M. Luk, and R. Chair, "Small-size wide-bandwidth microstrip patch antennas," Digest of 2001 IEEE AP-S International Symposium on Antennas and Propagation, Vol. 1, 86-89, Jul. 2001.
[16] Slavova, A., A. Abdel Rahman, and A. S. Omar, "Broadband bandwidth enhancement of an Aperture coupled microstrip patch antenna," Digest of 2004 IEEE AP-S International Symposium on Antennas and Propagation, Vol. 4, 3737-3740, Jun. 2004.
[17] Li, J. Y., Z.-Z. Ooa, and L.-W. Li, "Improvement of characteristics of microstrip antennas using unbalanced structures," IEEE Antennas and Wireless Propagat. Lett., Vol. 1, 71-73, 2002.
[18] A. A. Abdelaziz, "Bandwidth Enhancement of Microstrip Antenna," Progress In Electromagnetics Research, PIER 63, 311-317, 2006.
[19] Yang, F. and R.-S. Y, "Applications of electromagnetic band-gap (EBG) structures in microwave antenna designs," Microwave and Millimeter Wave Technology, 528-531, Aug. 2002.
[20] Yang, L., M. Y. Fan, F. L. Chen, J. Z. She, and Z. H. Feng, "A novel compact electromagnetic bandgap structure and its applications for microwave circuits," IEEE Trans. on Microwave Theory and Techniques, Vol. 53, No. 1, 183-190, Jan. 2005.

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