Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 2, February : 2024

THE DESIGN AND DEVELOPMENT OF METAMATERIAL BASED ANTENNA FOR BIOMEDICAL APPLICATIONS

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Abstract
The metamaterial antenna is having different types of antennas based on the application the antenna is designed specifically. The meta material antenna uses various range frequencies according to the applications [1]. In printed antenna the demerit is which effects on human tissue were located on the human head and electric field strength leakages, respectively. In Minkowski fractal antenna which is used for medical based, its performance and selectivity is so poor to sense the cancer cells [2]. The biocompatible antenna is a coplanar waveguide-fed antenna it requires large area, size and shape is cannot be changed in real-time application, it has a low gain and narrow bandwidth [3]. Hence, proposed the 3D printed antenna, it is a method of creating structure by stacking layers on top of each other. The 3D printed antenna were used in wide area network of technologies, with in the w-band frequency range (27 - 31GHz) [4]. The fabrication process is cheaper, faster and flexible manner.

Keywords: Minkowski defective ground structure · Metamaterial · Biosensor · Split ring resonator,SAR; flexible antenna; wearable; MTM

INTRODUCTION

The meta material antenna introduced by the Russian theorist V.G. Veselago, in 1968.The meta material antenna has a composite structure, and it has electromagnetic properties [4] specifically which are not observed in the electrical permittivity and magnetic permeability are commonly not visible in the nature [6]. There are some antennas basically applicable on wireless networks and biomedical purposes. Each antenna has its own property which are applicable in real-time actions and they are printed antenna, Makowski fractal antenna, w-band biocompatible antenna and modern antennas [7]. In printed antenna itself describes the flexible and wearable, but while fabricating the antenna directly it effects on the efficiency and bandwidth of the antenna as well as it shows side effects on human body. But proposed 3D printed antenna were works in the range of w-band frequency and it is less in weight and it gives a large bandwidth [8]. The Makowski fractal antenna used for the medical purpose and it describes the how the cancer cells are detected by the sensors and its selectivity, performance is poor because its asses only three cancer cells to the cancer cell lines [2]. The selectivity and performance are based on the dielectric constant, resonance frequency and electrical characteristics, in 3D printed antenna the losses and noise can be reduced, the selectivity and performance are increased. The Biocompatible antenna is applicable for the body implantable and it is tested by the muscle mimicking liquid, the drawbacks of the antenna is narrow bandwidth, low gain, impedance matching and polarization losses [9], the proposed 3D printed antenna were increase the gain, bandwidth and impedance matching [10]. The modern antennas are not applicable for microwave application and it gives narrow bandwidth, in proposed method the drawbacks are overcomes by the 3D printed antenna, it is applicable for the microwave applications [11].
The proposed 3D printed antenna were works in the range of ka-band frequency(27-31GHz) and it is applied for the wireless area network, it is low power consumption device, it gives a large bandwidth [12], when placed on the human body the frequency shifted to down till 3.5GHz. it has radiation pattern, dielectric constant and resonance frequency, the antenna is designed based on the specific applications [14]. The radiation pattern is how radiates the power in the form of energy i.e., electromagnetic waves.

LITERATURE SURVEY

The meta material antenna was introduced in 1968, the antenna designs were changed rapidly according to the technology and their applications. Mainly the antennas applicable for different sectors and fields, because according the application the antenna was designed in certain range of frequencies [1]. In 2023 the paper was published through Applied physics a material science and processing; the paper describes about fractal antenna [2]. In 2021 the printed antenna was designed ant it was published through MDPI [4]. In 2022 the Modern antennas was introduced. In 2018 the biocompatible antenna was invented and it was published through the IET Journals. The fractal antenna used in the medical field for testing of breast cancer, before testing the cancer cells, the imaging tests involved [6]. By collecting the human body fluids and to assess the amount of Harmon's. To test the tumours or cancer cells we need to examine under the microscope, the cells are increasing rapidly and never die[2]. In fractal antenna uses the SRR and DGS are the two circuits to avoid the reflection effects, the SRR is split ring resonator were used as sensor it is used at the top region, when Makowski curve occurs at third iteration it acts as DGS defected ground structure it used for ground regions [7]. This dielectric property is much greater than the normal cells. The dielectric property increases due to water level content in the breast layers [9]. The reflection coefficient, conductivity, and characterization are the methods, the frequency method is better than the reflection coefficient method, the drawback of the fractal antenna is selectivity and performance, antenna sensor can accept only three cancer cell lines to test. The frequency range of the antenna is 2.0 to 2.6GHz [10].

The printed antenna used in the Biomedical application and it operates between 0.5 to 3.0 GHz [11]. It is a wireless device and always monitor the patience movement. The antenna printed on the polymer substrate, by silver nanoparticle ink [13]. The printed antenna is flexible and wearable device, it is a self-operating device, generally the behaviour of human tissue has high permittivity [2]. When the human body absorbs an electromagnetic wave, radiated from the antenna, the human body will take lot of energy due to this the parameters of antenna will decrease, while using the wearable antenna [4]. In wearable antenna the MTM, CPM and unit cell is introduced to decrease the reflection effects [15]. In wearable antenna has a disadvantage while fabricating the antenna directly effects on efficiency and bandwidth.

The Biocompatible antenna use for the medical purpose, the antenna works in the range of 402 - 405 GHz. The operating frequency is 2.15GHz (1.35 – 3.0GHz) [17]. The antenna is used for medical implantation is MICS and ISM bands. The applications of the antenna are surveillance sensors, control systems, etc., to design the antenna the parameters required dimension, width bandwidth, CSRR, sensors, radars, peak gain, efficiency and patch antenna, etc., to identify the dielectric parameters of an antenna the Cole - Cole method [18] is used in the Biocompatible antenna, the antenna is tested by the muscles mimicking liquid. It is a omnidirectional antenna The drawbacks of antenna are more complexity, narrow bandwidth and low gain [19]. The modern's antenna is applicable for the communication, wireless technology, mainly the modern's antennas describe about various types of antennas [13], earlier the antenna was designed with the copper, its dependence upon the choice of substrate. The first found antennas are split ring resonators and CLL loaded loops it uses mainly forward and backward waves. To design an antenna the required parameters are radiation pattern, dielectric parameters, resonance frequency, characterization and efficiency, etc., [14] the drawbacks of the antenna is narrow bandwidth, low gain.

EXISTING METHOD

The existing method considered from the different antennas like modern's antenna, fractal antenna, biocompatible antenna and wearable antenna. Basically, the antenna is designed by the radiation centre and the average terrain and

antenna parameters [1]. The modern's antenna has described about different types of antennas, firstly the SSR, CSRR and CLL was implemented, by these antennas the refraction of negative index occurs, by making the combination of copper wires and cells [2]. The CLRH resonator or unit cell introduced to avoid the effects of right and left materials and it can use for the infinity wavelength and without dimensions [3]. The modern antenna is used for only liquids, not for other applications. The frequency range of the modern antenna is LTE band, X band and WiMax band The modern antenna is not applicable for microwave applications [4]. Now about the fractal antenna, it was applicable at the biomedical field, the fractal antenna is a sensor and used for imaging process of breast cancer [5]. In the fractal antenna the selectivity and performance are so poor, the cancer cell lines the approach depends upon the electrical characteristics [6]. The resonance frequency is15.42GHz. The drawback of an antenna is noise is high, losses and sensitivity [7]. The biocompatible antenna used for implantable applications. It directly effects on the efficiency and bandwidth while fabricating the antenna. In this antenna the CPW- fed antenna is proposed to avoid the wide impedance bandwidth [9], the multi-layer phantom model and single layer muscle model used in the biocompatible antenna [10]. The required frequency to operate is 8.8 to11.9 GHz. The wearable antenna is used for the self-monitoring of the human body, specifically placed at the top of head, the human body absorbs the electromagnetic waves the body consumes lot of energy [12], due to this it effects on human tissue, the electrical characterization and dielectric properties will affect or changes. It is denoted by the k, given by

$$K = EO / E \quad \text{----------(1)}$$

The drawback is it is not flexible and size cannot be reduced, etc., The four-antenna used in the communication technology and biomedical applications [13]. In each antenna each problem was raised as explain in the above content. So, to reduce or to overcome the antenna demerits 3D printed antenna is introduced [15]. It used for a wide area network application.

CONCLUSION

In this project, 3D printed antenna is proposed with the metamaterial antenna. The results of the antenna are significantly reducing the area and delay, it also increases the perfection with the selectivity and performance. The 3D printed antenna is applicable for the 5G communication technology and biomedical applications. The antenna basically used at the wide area networks with the frequency ka-band its range around 27 – 31GHz. There are some antennas which are designed specifically for specific application, the fractal antenna uses for breast cancer which may affect on human tissues and it can be reduced by the 3D printed antenna, as well as each antenna has each drawback. To overcome the all drawbacks the 3D printed antenna has designed by facing challenges.

REFERENCE:

1. R. J. Barker and E. Schamiloglu, High-power Microwave Sources and technologies, Wiley-IEEE Press, Hoboken, NJ, USA, pp. 3–14, June 2001.
2. E. Schamiloglu, "High power microwave sources and applications," in Proceedings of the 2004 IEEE MTT-S International Microwave Symposium DigestIEEE Cat. No. 04CH37535, vol. 2, IEEE, Fort Worth, TX, USA, 2004.
3. J. Benford, J. A. Swegle, and E. Schamiloglu, High Power microwaves, CRC Press, Boca Raton, FL, USA, pp. 5–20, 2007.
4. S. Li, Z. Duan, H. Huang, and Z. H. F. Z. Y. Liu, "Extended interaction oversized coaxial relativistic klystron amplifier with gigawatt-level output at Ka band," Physics of Plasmas, vol. 25, no. 4, Article ID 043116, 2018.
5. S. N. Vlasov and I. M. Orlova, "Quasioptical transformer which transforms the waves in a waveguide having a circular cross section into a highly directional wave beam," Radiophysics and Quantum Electronics, vol. 17, no. 1, pp. 115–119, 1974.
6. C. C. Courtney, D. E. Voss, C. E. Baum, and W. R. Prather, "A description and the

measured performance of three coaxial beam-rotating antenna prototypes," IEEE Antennas and Propagation Magazine, vol. 44, no. 3, pp. 30–47, 2002.
7. C. C. Courtney, "Design and numerical simulation of coaxial beam-rotating antenna lens," Electronics Letters, vol. 38, no. 11, pp. 496–498, 2002.
8. Y. Rahmat-Samii, D.-W. Duan, and D. V. L. F. Giri, "Canonical examples of reflector antennas for high-power microwave applications," IEEE Transactions on Electromagnetic Compatibility, vol. 34, no. 3, pp. 197–205, 1992.
9. L. Tie-zhu and H. Wen-huaS. Hao, W. Kang-yi, L. Jia-wei, and H. Hui-jun, ""Design and near field characteristic of high power microwave dual-reflector antenna," in Proceedings of the 2012 International Conference on Microwave and Millimeter Wave Technology (ICMMT), vol. 5, IEEE, Shenzhen, China, May 2012.
10. C.-W. Yuan, S.-R. Peng, T. Shu, and Z.-Q. H. Li, "Designs and experiments of a novel radial line slot antenna for high-power microwave application," IEEE Transactions on Antennas and Propagation, vol. 61, no. 10, pp. 4940–4946, 2013.
11. L. Yu, C. Yuan, J. He, X. L. Zhao, Y. Sun, and C. Shen, "Design of a slot-coupled radial line helical array antenna for high power microwave applications," AIP Advances, vol. 7, 2017.
12. X. L. Zhao, C. W. Yuan, L. Liu, S. Peng, Q. Zhang, and H. Zhou, "All-metal transmit-array for circular polarization design using rotated cross-slot elements for high power microwave applications," IEEE Transactions on Antennas and Propagation, vol. 65, no. 6, pp. 3253–3256, 2017.
13. X. L. Zhao, C. W. Yuan, L. Liu, S. Peng, Q. Zhang, and H. Zhou, "All-metal beam steering lens antenna for high power microwave applications," IEEE Transactions on Antennas and Propagation, vol. 65, no. 12, pp. 7340–7344, 2017.
14. Y. Sun, J. He, C. Yuan, and Q. Zhang, "Design and experimental demonstration of a circularly polarized mode converter for high-power microwave applications," Review of Scientific Instruments, vol. 89, no. 8, Article ID 084701, 2018.
15. Y. Sun, J. He, C. Yuan, and Q. X. L. Zhang, "Ku-band radial-line continuous transverse stub antenna with transmit-array lens for high-power microwave application," IEEE Transactions on Antennas and Propagation, vol. 68, no. 3, pp. 2050–2059, 2020.
16. X. Zhao, C. Yuan, and J. ZhangQ. Zhang, ""Design of a beam scanning metamaterial antenna with polarization transform for high-power microwave application," Microwave and Optical Technology Letters, vol. 62, October 2020.
17. B. Liu, W. Hong, Z. Kuai, and X. G. J. H. K. Yin, "Substrate integrated waveguide (SIW) monopulse slot antenna array," IEEE Transactions on Antennas and Propagation, vol. 57, no. 1, pp. 275–279, 2009.
18. T. Y. Tian Yang Yang, W. Wei Hong, and Y. Yan Zhang, "Wideband millimeter-wave substrate integrated waveguide cavity-backed rectangular patch antenna," IEEE Antennas and Wireless Propagation Letters, vol. 13, pp. 205–208, 2014.
19. X. Jiang, F. Jia, and Y. P. J. X. Huang, "Ka-band 8 × 8 low-sidelobe slot antenna array using a 1-to-64 high-efficiency network designed by new printed RGW technology," IEEE Antennas and Wireless Propagation Letters, vol. 18, no. 6, pp. 1248–1252, 2019.