Performance Analysis of Rectangular Microstrip Wearable Textile Antenna with Series of Slots

A. Rajesh[1], R. Vani[2], and B. Rama Rao[3]
[1] SRM Institute of Science and Technology, Ramapuram, Chennai, India
[2] Department of ECE, SRM Institute of Science and Technology, Ramapuram, Chennai, India
[3] Department of ECE, Aditya Institute of Technology and Management Tekkali, India
Email: ab3126@srmist.edu.in; vanir@srmist.edu.in; 07ramusri@gmail.com

Abstract—In this paper the design of a wearable antenna for industrial, scientific, and medical (ISM band) applications at 2.4 - 2.45 GHz and 5.7 - 5.85 GHz is discussed. The rectangular microstrio patch antenna is considered and two series of slots are implemented with same length and different length. The conductive and ground planes are made from copper and cloth, respectively. Copper serves as a conductor in this case, while textile material serves as a barrier between the human body and the antenna. Micro strip feeding is supplied here to improve the antenna's reliability. The performance of the antenna will be evaluated using the simulation and practical as well, the reflection coefficient, VSWR, gain and radiation pattern of Microstrip textile antennas is obtained which used in a variety of ISM band applications.

Index Terms—Textile antenna, ISM band, reflectioncoefficient

I. Introduction

Wearable antennas appear to be playing an increasingly prominate role in the shrinking of wireless equipment. Wearable antennas are in enormously demanded due to their use in smart clothing for wireless communications. In the future, the garments will not only protect the human body against the extremes of nature, but also provide information about the state of user's health and environment [1]. For this, the persons likely to carry a range of devices and sensors, including medical sensors that constantly communicate with each other and the outside world [2]-[5]. There is an increasing interest in this subject in both civil and military domains. In the civil domain there is a move towards ubiquitous computing that requires diverse electronic devices, typically communication elements for transfer of entertainment media, information sources and social interaction [6].

Wearable antennas must have a planar structure and flexible construction materials, as well as be lightweight and wearable. Low-cost and easy-to-integrate. Portable electronic appliances have become an integral aspect of modern life. In this modern highly technological world, every human individual is habituated to carry the mobile phones without intervals in their daily life, and they can be used for more than just making phone conversations; they can also be used for internet access, multimedia, a personal digital assistance e-learning, digital library, digital transactions and GPS navigation.

Several composite materials are discussed in existing wearable antennas for textile applications and in terms of high conductivity, high tensile strength, with different sheet resistance, efficiency, bandwidth [11]-[13]. Wearable electronics and antennas are a critical technology for achieving this goal. The 2.45 GHz and 5.8 GHz ISM unlicensed bands are used for the development of wearable antennas due to their near-global availability. The ISM unlicensed bands of 2.45 GHz and 5.8 GHz are being used to construct the wearable antennas. The wearable antennas must be concealed and have a low profile for the user's comfort. This necessitates the antenna elements' probable integration into daily apparel. Because it can be made conformal for integration into clothes, the micro strip patch is a good contender for any wearable application [14]-[18]. When using a readily accessible flexible textile as a dielectric material, the antennas' cost drops dramatically. In addition, the advancement of planar technology has stimulated study in his field. Micro strip antennas have a low profile, and are easily conformal to the object. As a result, they are the best candidates for developing wearable antennas.

II. Important Characteristics of Textile Materials in Wearable Antenna Design

Planar fibrous materials are the Fabrics whose properties are found with the help of structure of the fiber and with the help of component of the fiber. Fabrics are porous in texture whose air volume, size and density which give the actual behavior of the material like its thermal resistance, permeability. Usually fabrics provide flexibility, compressibility, elasticity, thickness and the density of the material changes as pressure decreases. Fabrics are usually employed in exchanging the water molecule from the outside world due to which there may be some changes in texture and morphological feature. These effects of fiber are unavoidable therefore we need to find the techniques to control rather than avoiding it completely. They are widely applied in textile industry where we need to concentrate more on the properties and behavior of antenna to reduce the unavoidable effects. Additionally, some of the textile fabric has some effects on the performance of the antenna which is discussed in review.

Manuscript received September 22, 2021; revised April 15, 2022.
doi:10.12720/jcm.17.5.365-372

Imaginary and real gives the tangential component related to loss function which given by the formulae tan δ = ε''r / ε'r. Since the textile fabrics are anisotropic, the properties usually depend on the electric field. This anisotropic behaviour depends on the permittivity of the material. The relative permittivity of represents the actual behaviour of the material under varying electric fields and frequencies. The dielectric behaviour of textile materials depends on the characteristics of the fibre and polymer components and the bulk density of the fibres in the fibre material. However, textiles are rough, porous, and uneven, with air between the fibres, which makes it difficult to characterize them. Ordinary textile fabrics such as cotton with tan δ = 0.0400 polyester with tan δ= 0.0045 is obtained by the waveguide cavity process at 2.6 GHz surface wave loss, it is related to the propagation of guided waves in the substrate due to the low dielectric constant. Therefore, reducing the dielectric constant can improve the space wave, thereby improving the impedance bandwidth of the antenna. It is worth noting that the value of ε_r changes with the humidity of the substrate and also affects the antenna width.

A. Thickness of the Dielectric Fabrics

The substrate dielectric constant and thickness are the most important factors in determining the bandwidth and efficiency of a planar micro strip antenna. As mentioned earlier, changes in the dielectric constant can change the bandwidth of the antenna, but reducing the dielectric constant of the substrate can also increase the resonant frequency of the antenna. Because of permittivity in textile materials is very small, their thickness may have greater fluctuations, which determines the bandwidth of the antenna and its input impedance, and thus its resonant frequency. For, fixed εr, the substrate thickness, an important parameter for antenna design can be set to maximise the planar antenna's bandwidth for a fixed relative permittivity. This figure, however, may not be optimal for antenna efficiency. As a result, the thickness of the dielectric material chosen is a compromise between antenna efficiency and bandwidth. Equation 1, where Q is the antenna quality factor, can be used to illustrate the effect of thickness on the antenna's bandwidth (BW):

$$BW \approx 1/Q \quad (1)$$

The Q factor depends on space wave (Qrad) losses, the conduction ohmic (Qc) losses, the surface waves (Qsw)and dielectric(Qd)losses as shown in Equation 2

$$(1/Qt)=(1/Qrad)+(1/Qc)+(1/Qsw)+(1/Qd) \quad (2)$$

The quality factor related with radiation (Qrad) is usually the major component for thin substrates (h o) and is inversely proportional to the substrate height. As a result, raising the substrate's height lowers the Q factor (Qt). Furthermore, the antenna's geometric size is influenced by the thickness of the substrate. This indicates that a thick substrate with a low relative permittivity (value between 1 and 2) produces a large patch, whereas a thin substrate with the same dielectric properties produces a small patch. The patch is smaller when the dielectric constant is the same Furthermore, every technical data sheet will include nominal thickness values, allowing for careful material selection based on the needed thickness. A human body's curvature is made up of a series of bends in different directions. Textile fabrics respond well to these surfaces due to their excellent flexibility and elasticity. Indeed, the dielectric fabric's permittivity and thickness are affected by bending and elongation, which affects the antenna's resonance frequency and, in particular, the bandwidth. In addition, also affects its behavior and may change its resonant frequency

B. The Dimensions of This Patch is Calculated Using the Formulae Below

The antenna dimensions are calculated by using the Transaction-level modelling (TLM) Model. The width of the Microstrip Patch Antenna is given by [24]

$$w = \frac{c}{2f\sqrt{\frac{\epsilon_r + 1}{2}}} \quad (3)$$

The Effective Dielectric constant εreff is given by

for ≥ 1

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}} \quad (4)$$

for ≤ 1

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}} + 0.041\left[1 - \sqrt{\frac{w}{h}}\right] \quad (5)$$

The dimensions of the patch are extended to account the fringing effects. The extension is given by,

$$\Delta L = 0.412h\frac{\left(\epsilon_{reff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\epsilon_{reff} - 0.258\right)\left(\frac{w}{h} + 0.8\right)} \quad (6)$$

Since the length has been extended on each side of the patch, the effective length is given by,

$$L_{eff} = \frac{c}{2f\sqrt{\epsilon_{reff}}} \quad (7)$$

Patch resonant length L is given by,

$$L = L_{eff} - 2\Delta L \quad (8)$$

The inset width S is given by

$$S = (2*g) + Wo \quad (9)$$

The ground plane dimensions are calculated by using the following formulae

Length of the ground plane

$$Lg = 6h + L \tag{10}$$

Width of the ground plane

$$Wg = 6h + W \tag{11}$$

III. Performance of Different Textile Materials in Wearable Antennas

The various fabric materials used to construct the textile antenna are listed in Table I below:

TABLE I: COMPARISON OF VARIOUS PARAMETERS WITH DIFFERENT TEXTILE MATERIALS FOR THE DESIGN OF WEARABLE TEXTILE ANTENNAS

Reference	Dielectric material	Conductive material			Conductivematerial
	Material	**Thickness**	**r**	**tanδ**	
[21]	Unspecified textile material	0.236 mm	3.29	0.0004	-
[10]	Fleece fabric	3 mm	1.04		Knitted copperfabric
[22]	Cordura ®	0.5 mm	Between 1.1 and 1.7.	-	Copper tape
[8]	Polyamide spacerfabric	6 mm	1.14	negligible	Silver– copper– nickel platedwoven fabric
[8]	Woolenfelt	3.5 mm	1.45	0.02	Silver– copper–nickel platedwoven fabric
[20]	Fleece fabric	2,56 mm	1.25	-	*Flectron®*
[23]	Felt	1,1 mm	1.30	0,02	*Zelt®*
[1]	Foam	3.94 mm	1.52	0.012	Patch: *Zelt®*Ground plane: *Flectron®*

Table I describe about the comparison of various parameters with different textile materials used in the literature for the design of wearable textile antennas.

IV. Simulation

A series of slots are supplied on the Rectangular Micro strip wearable textile antenna. 100 percent wash cotton with a dielectric constant of 1.5 and a loss tangent of 0.01. The substrate and ground plane are 60 mm X 60 mm X 1 mm in size. The patch is rectangular in shape, with a length of 30 mm and a width of 40 mm, with a slot cut in the centre with dimensions of 10 mm X 10 mm. As illustrated in picture 1, the patch has a sequence of slot cuts on either side of the centre slot. The antenna can be broadcast at different frequencies by adjusting the position and dimensions of the slots. The proposed antenna uses the edge feeding approach, with a feed line length of 15mm and a width of 1mm.

A. Study Case 1

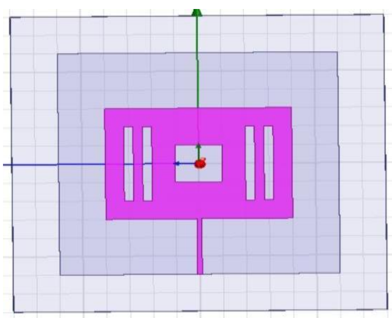


Fig. 1. Rectangular Micro strip wearable textile antenna with series of slots.

The distance between the centre slot and the immediate side slot is 5 millimeters, while the distance between the immediate side slot and the outermost slot is 2 millimeters. As seen in Fig. 1, the immediate side slot measures 20 mm X 2 mm, whereas the outermost slot measures 20 mm X 2 mm.In the 6 to 12.5 GHz range, the simulation was disabled. The results are displayed in Fig. 1 for a rectangular Micro strip wearable textile antenna.

The simulation was inhibited in the 6 to 12.5 GHz band. The results are noted for rectangular Micro strip wearable textile antenna which is shown in Fig. 1.

B. Study Case 2

A 5 mm distance exists between the centre slot and the immediate side slot, and a 2 mm distance exists between the immediate side slot and the outermost slot. As illustrated in Fig. 2, the immediate side slot measures 10 mm X 2 mm, while the outermost slot is 15 mm X 2 mm.

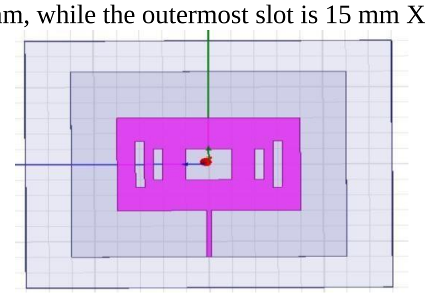


Fig. 2. Rectangular Micro strip wearable textile antenna with series of slots.

The simulation was inhibited in the 6 to 9 GHz band. The results are noted for rectangular Micro strip wearable textile antenna which is shown in Fig. 2.

V. Results

The results obtained for case 1 in which distance is 2mm are as follows:

A. 3D Gain

Fig. 3 shows the power transmitted per unit angle in term of 3D gain of the Rectangular Micro strip wearable textile antenna in HFSS. For any application, the gain of any antenna should be greater than 3dB. This antenna achieves a gain of 6.71 dB

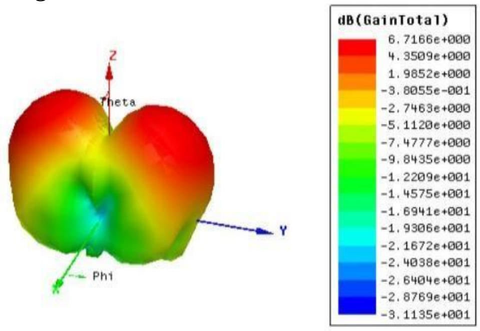


Fig. 3. 3D-gain plot

B. Smith Chart

The smith chart for Rectangular Micro strip wearable textile antenna is shown in Fig. 4.

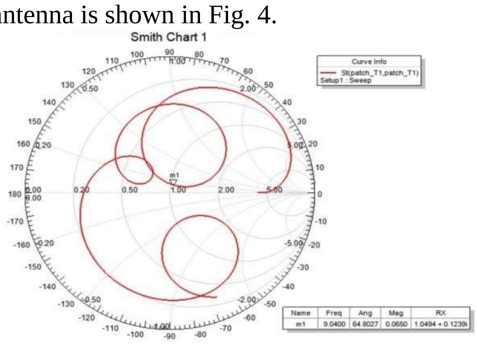


Fig. 4. Smith chart

C. Return Loss

Return loss is a parameter that describes how much power is lost in the load and does not return as a reflection. In Fig. 5b, from 6 to 12.5 GHz, the simulated results for the rectangular Microstrip wearable textile antenna were taken. Fig. 5 a shows the best return loss result found at 9.04 GHz, which is -23.74 dB.

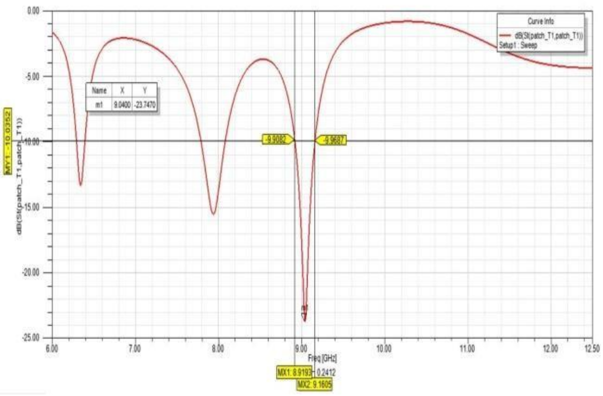


Fig. 5. Simulation return loss curve of proposed antenna

D. VSWR

The VSWR that corresponds to a perfect match is at a minimum of one. An antenna's VSWR ranges from 1 to infinity. It should be anywhere between 1 and 2 for practical purposes. Because we got the best simulated return loss result at 9.04 GHz, we took the VSWR value at 9.04 GHz, which is 1.13, as shown in Fig. 6.

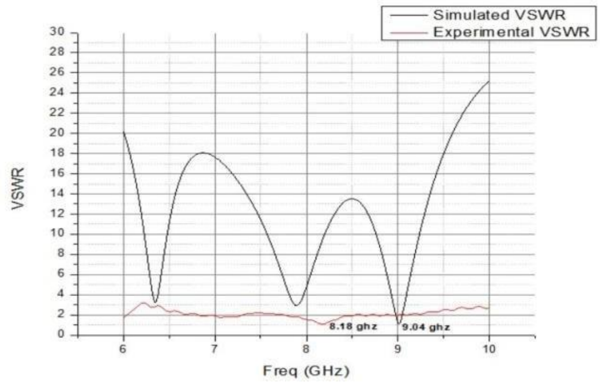


Fig. 6. VSWR value

E. Radiation Pattern

The directional (angular) dependence of the strength of the radio waves from the antenna or other source is referred to as a radiation pattern (or antenna pattern or far-field pattern). Fig. 7 depicts the Rectangular Micro Strip Wearable Textile Antenna's radiation pattern.

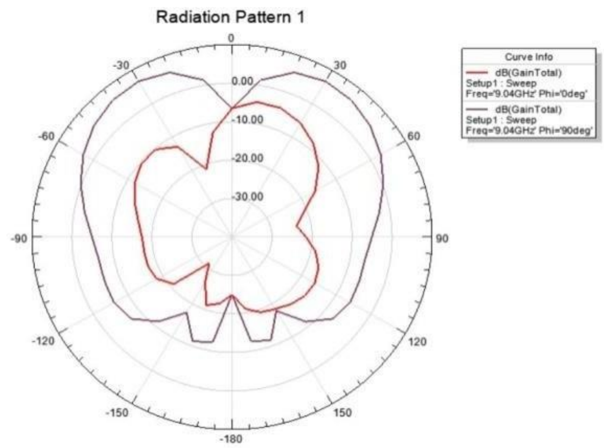


Fig. 7. Radiation pattern

Fig. 8. Top view of the fabricated antenna. Fig 9 Bottom view of the fabricated antenna.

Fig. 8 shows that top view of the fabricated antenna with a 5 mm distance between the centre slot and the immediate side slot, and a 2 mm distance exists between the immediate side slot and the outermost slot, the size of antenna is 10 mm X 2 mm, while the outermost slot is 15 mm X 2 mm. Fig. 9 shows bottom view of the fabricated antenna.

The manufactured antenna's experimental setup is depicted below, and the antenna is tested at the intended frequency, with the results displayed as shown in Fig. 10.

Fig. 10. Experimental setup of the fabricated antenna.

In the Fig. 11, the findings from the network analyser setup and the HFSS simulation results are compared.

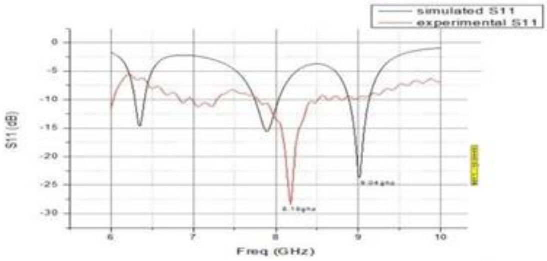


Fig. 11. Contrasting the difference between experimental S11, VSWR and simulated S11,VSWR.

F. HFSS Results for Case 2

The results obtained for case 2 in which distance is 2mm are

G. 3D Gain

The power transmitted per unit solid angle is known as gain. Fig. 12 depicts the 3D gain of the Rectangular Micro strip wearable textile antenna in HFSS. For any application, the gain of any antenna should be greater than 3dB. This antenna has an output gain of 8.02 dB

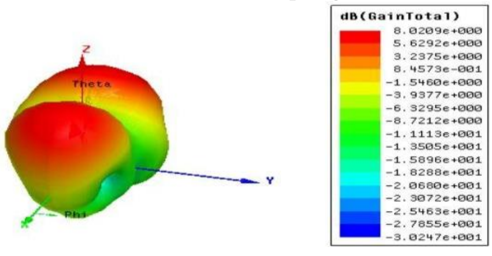


Fig. 12. 3D-gain plot

H. Smith Chart

The smith chart for Rectangular Micro strip wearable textile antenna is shown in Fig. 13

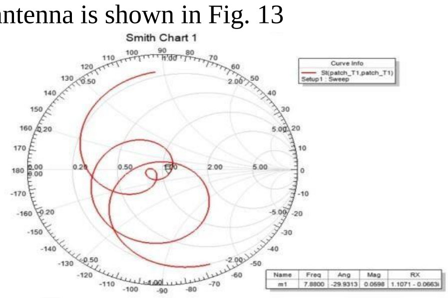


Fig. 13. Smith chart

I. Return Loss

Return loss is a parameter that describes how much power is lost in the load and does not return as a reflection. From 6 to 9 GHz, the simulated results for the Rectangular Micro strip wearable textile antenna were taken. Fig. 14 shows the best return loss results at 6.72 -2352dB, 7.88 GHz is -24.47 dB, and 8.32 25.78dB

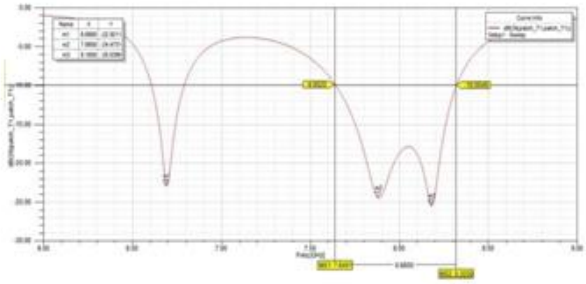


Fig. 14. Return loss curve

J. VSWR and Radiation Pattern

An antenna's VSWR ranges from 1 to infinity. It should be anywhere between 1 and 2 for practical purposes. Because the best simulated return loss result was obtained at 7.88 GHz, we used a VSWR of 1.03 at that frequency, as shown in Fig. 15. Fig. 16 depicts the Rectangular Micro Strip Wearable Textile Antenna's radiation pattern.

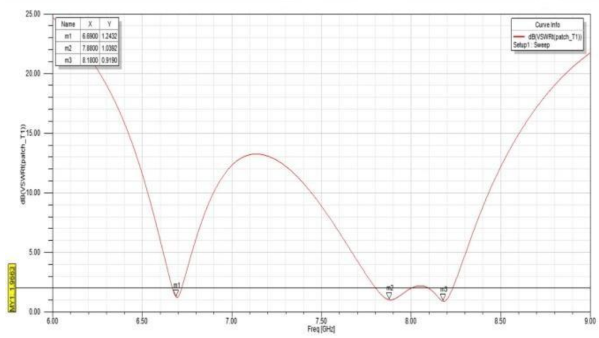


Fig. 15: VSWR value

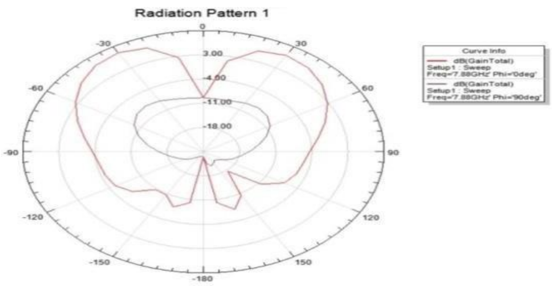


Fig. 16. Radiation pattern

VI. Result Analysis

A. Return Loss

Both antennas are said to resonate at a frequency where the return loss is ideally less than -10 dB. The return loss value for the simulated antennas is higher than the optimal value.

B. VSWR

At resonant frequency, the VSWR value is between 1 and 2, as shown by the simulated VSWR curves of both antennas, which are within acceptable limits

C. Gain

An antenna's gain should be greater than 3dB, although the simulated antenna's gain is higher than the optimal amount. The manufactured antenna's experimental setup is depicted below, and the antenna is tested at the intended frequency, with the results as in Fig. 17, Fig. 18.

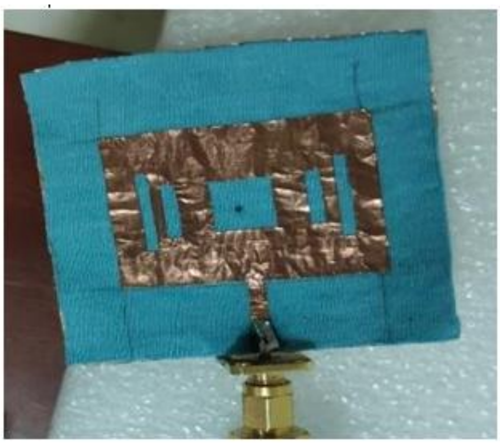
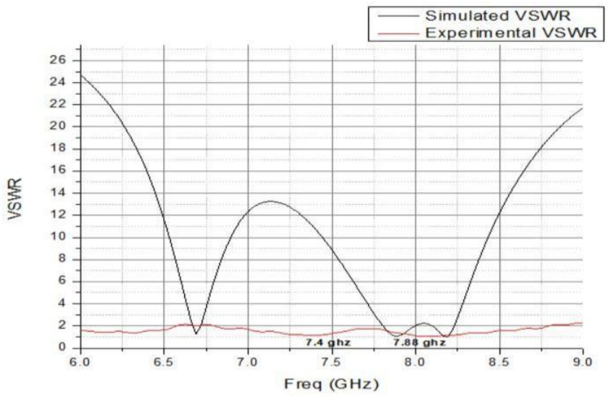
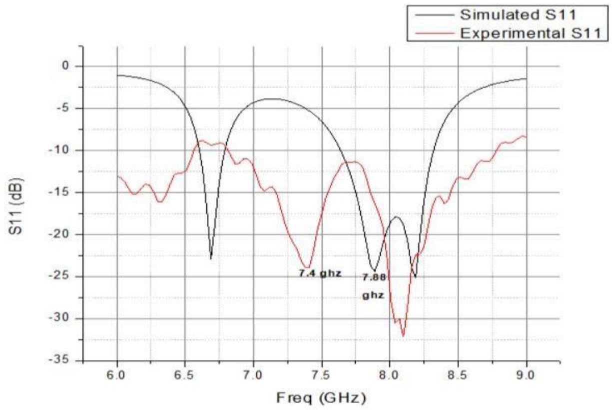


Fig. 17. Topview Bottom view of the fabricated antenna

Fig. 18. Experimental setup of the fabricated antenna



(a) Experimental S11, VSWR



(b) Simulated S11, VSWR

Fig. 19. Contrasting the difference between

Fig. 19a depicts the VSWR of the antenna measured by the network analyzer, it is obtained as <2 at 6.72GHz and 7.88GHz. Fig. 19b indicates the return loss of the antenna measured in network analyser it is evident that the antenna resonates at6.72GHz and 7.88GHz with good return loss

VII. COMPARISION

From Table II, THE study case 1 and 2 are compared. For Case 1, return loss=-23.74 dB, VSWR= 1.13 and Gain=6.71 dB. For Case 2, return loss=-24.47dB, VSWR= 1.03and Gain =8.02dB. Case2 has high gain.

TABLE II: COMPARISON OF TWO CASES FOR THE WEARABLE TEXTILE ANTENNA WITH SLOTS

Wearable textile Antenna with slots	Solution frequencyGHz	Return loss dB	VSWR	Gain dB
CASE 1	9.04	-23.74	1.13	6.71
CASE 2	7.88	-24.47	1.03	8.02

VIII. CONCLUSION

A rectangle shaped wearable textile antenna construction is retained as a patch with a succession of slots is designed and simulated using Ansoft HFSS, this is fabricated on FR-4 substrate and test by vector network analyzer. The performance of the antenna is analyzed by measuring the radiation pattern, return loss, VSWR, gain, and return loss etc... When compared to the previous two antennas, this one has a higher gain. It is utilized for X-band applications since it operates at a frequency of 9.04 GHz. The frequency of operation of the aforementioned antenna is altered to 7.88 GHz by adjusting the position of a series of slots. The radiation pattern, return loss, VSWR, gain, and return loss are all noted. When compared to the other three antennas, this one has a higher gain and it operates at a frequency of 7.88 GHz.

CONFLICT OF INTEREST

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript. Author names: A. Rajesh[1], R. Vani[2], B. RamaRao[3]

AUTHOR CONTRIBUTIONS

Author 1 - Simulate design and fabricated

Author 2 -Scrutinized and checked the plagiarism of manuscript.

Author 3 - Tested and verified results and prepared the manuscript.

REFERENCES

[1] C. Hertleer, H. Rogier, S. Member, L. Vallozzi, and L. V. Langenhove, "A textile antenna for off-bodycommunication integrated into protective clothing for firefighters," *IEEE Transactions on Antennas and Propagation*, vol. 57, no. 4, pp. 919– 925, 2009.

[2] B. Grupta, S. Sankaralingam, and S. Dhar, "Development of wearable and implantable antennas in the last decade: A review," in *Proc. IEEE Conference Publications*, 2010, pp. 251–267.

[3] J. C. G. Matthews and G. Pettitt, "Development of flexible, wearable antennas," in *Proc. IEEE Conference*, 2009, pp. 273–277.

[4] R. Salvado, C. Loss, R. Gonçalves, and P. Pinho, "Textile material for the design of wearable antennas: A survey," *Sensors Magazine*, vol. 12, pp. 15842–15857, 2012.

[5] A. Bonfiglio, D. D. Rossi, Danilo (Eds.), *Wearable Monitoring Systems*, 1st edition,Cambridge: Springer, 2011.

[6] J. Tavares, *et al.*, "Spectrum opportunities for electromagnetic energy harvesting from 350 MHz to 3 GHz," in *Proc. IEEE Conference Proceedings ISMICT13*, 2013, pp. 126-130.

[7] S. Brebels, J. Ryckaert, C. Boris, S. Donnay, W. De Raedt, E. Beyne, and R. P. Mertens, "SOP integration and codesign of antennas," *IEEE Transactions on Advanced Packaging*, vol. 27, no. 2, pp. 341–351, 2004.

[8] I. Locher, M. Klemm, T. Kirstein, and G. Troster, "Design and characterization of purely textile patch antennas," *IEEE Transactions on Advanced Packaging*, vol. 29, no. 4, pp. 777–788, 2006.

[9] C. Hertleer, A. Tronquo, H. Rogier, and L. Van Langenhove, "The use of textile materialsto design wearable microstrip patch antennas," *Textile Research Journal*, vol. 78, no. 8, pp. 651–658, Aug. 2008.

[10] P. Salonen and H. Hurme, "A novel fabric WLAN antenna for wearable applications," in *Proc. IEEE Conference*, 2003, vol. 2, pp. 100–103.

[11] P. Nepa and H. Rogier, "Wearable antennas for off-body radio links at VHFand UHF bands: Challenges, the state of the art, and future trends below 1GHz," *IEEE Antennas Propag. Mag.*, vol. 57, no. 5, pp. 30-52, 2015.

[12] R. Balint, N. J. Cassidy, and S. H. Cartmell, "Conductive polymers: Towards a smart biomaterial for tissue engineering," *Acta Biomaterialia*, vol. 10, pp. 2341-2353, Jun. 2014.

[13] R. Salvado, C. Loss, R. Gonçalves, and P. Pinho, "Textile materials forthe design of wearable antennas: A survey," *Sensors*, vol. 12, no. 11, pp. 15841-15857, 2012.

[14] L. Corchia, G. Monti, and L. Tarricone, "Wearable antennas: Nontextileversus fully textile solutions," *IEEE Antennas Propag. Mag.*, to be published.

[15] M. Park, *et al.*, "Highly stretchable electric circuits from a composite material of silver nanoparticles and elastomeric _bres," *Nature Nanotechnol.*, vol. 7, pp. 803-809, Nov. 2012.

[16] M. A. R. Osman, M. K. A. Rahim, N. A. Samsuri, M. K. Elbasheer, and M. E. Ali, "Textile UWB antenna bending and wet performances," *Int. J.Antennas Propag.*, vol. 2012, Mar. 2012.

[17] Y. Kim, *et al.*, "Stretchable nanoparticle conductors with self-organized conductive pathways," *Nature*, vol. 500, pp. 59-63, Aug. 2013.

[18] R. B. V. B. Simorangkir, Y. Yang, K. P. Esselle, and B. A. Zeb, "A method to realize robust flexible electronically. tunable antennas using polymer embedded conductive fabric," *IEEE Trans. Antennas Propag.*, vol. 66, no. 1, pp. 50-58, Jan. 2018.

[19] H. A. E. Elobaid, S. K. A. Rahim, M. Himdi, X. Castel, and M. A. Kasgari, "A transparent and flexible polymer-fabric tissue UWB antenna for future wireless networks," *IEEE Antennas Wireless Propag. Lett.*, vol. 16, pp. 1333-1336, Dec. 2016.

[20] A. Tronquo, H. Rogier, C. Hertleer, and L. V. Langenhove, "Applying textile materials for the design of antennas for wireless body area networks," in *Proc. IEEE Conference*, 2006.

[21] P. Salonen, M. Keskilammi, J. Rantanen, and L. Sydanheimo, "A novel bluetooth antenna on flexible substrate for smart clothing," in *Proc. IEEE Conference*, vol. 2, pp. 789–794, 2001.

[22] P. Salonen, Y. Rahmat-samii, M. Schafhth, and M. Kivikoski, "Effect of textile materials on wearable antenna performance: A case study of GPS antenna," in *Proc. IEEE Conference*, vol. 1, no. June, pp. 459–462, 2004.

[23] S. Zhu and R. Langley, "Dual-Band wearable antennas over EBG substrate," *Electronics Letters*, vol. 43, no. 3, 2007.

[24] C. A. Balaneis, *Antenna Theory Analysis and Design*, John Willey & Sons. Inc., Publication

Copyright © 2022 by the authors. This is an open access article distributed under the Creative Commons Attribution License (CC BY-NC-ND 4.0), which permits use, distribution and reproduction in any medium, provided that the article is properly cited, the use is non-commercial and no modifications or adaptations are made.

Mr. Attada Rajeh completed his B.Tech in the stream of ECE in 2010,from JNTUK,KAKINADA ., Master of Technology in the stream of Systems and Signal Processing in the same University JNTUK Kakinada in 2013. And now he is pursuing Ph.D.at SRMIST Ramapuram, CHENNAI. Now, he is working as Asst Professor in Aditya Institute of Technology And Management, Tekkali, India. He is the member of ISTE, His area of interests are Antenna and wave propagation, Microwave and Radar systems. He has published 1 reputed International journal and 4 National and International conferences.

Dr. R. Vani received her B.E. degree in Electronics and Communication Engineering from Bharathiar University, Coimbatore in 1998 and M.E. degree in Communication Systems from Anna University, Chennai in 2004. She completed her Ph.D. in Anna University, Chennai in 2016. She has teaching experience of 20 years. She is working as Professor in ECE department, SRM Institute of Science and Technology, Ramapuram, Chennai. She has published 32 research papers in National and International Journals. She is member of IAENG, ISTE and IEI. Her research interest includes Image processing, Machine learning, medical data analytics, and Video Coding.

Dr. B. Rama Rao completed his B.E., Master of Technology in the stream of Radar and microwave engineering and Ph.D.in the year of 1998, 2004and 2015 respectively from Andhra University, Visakhapatnam. Now, he is working as Professor and HOD of ECE in Aditya Institute of Technology and Management, Tekkali, India. He is the senior member of IEEE, Life member of IETE and ISTE His area of interests are Antenna and wave propagation, Microwave and Radar systems. He has published 28 reputed international journal and 12 National and International conferences.