National Research Journal of Information Technology & Information Science
Volume No: 13, (January) Year: 2026 (Special Issue)
PP: 1-6
ISSN: 2350-1278
Peer Reviewed & Refereed Journal (IF: 7.9)
Journal Website www.nrjitis.in

LOW COST SMALL SIZE PATCH ANTENNA FOR WEARABLE APPLICATIONS

Sushil Kakkar

ECE Deapartment, Bhai Gurdas Institute of Engineeringand Technology, Sangrur, Punjab, India

Shweta Rani

ECE Deapartment, Giani Zail Singh Campus College of Engineering and Technology, MRSPTU, Bathinda, Punjab, India

ABSTRACT

Present day wearable technology possesses a significant contribution in health monitoring systems. A small size cost effective patch antenna for wearable applications has been elaborated in this paper. The presented antenna is square in shape and designed with FR4 substrate. The dimensions of the antenna have been optimized using numerous simulations. In view to obtain the effect of slot on the performance of antenna, a rigorous analysis has also been performed.

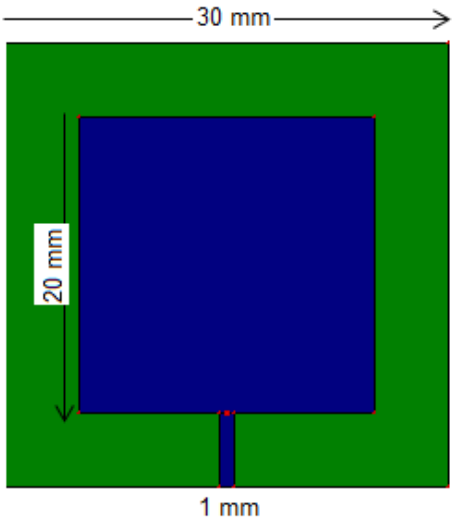
Keywords: Antenna, micorstrip, wearable, radiation pattern.

I. INTRODUCTION

The COVID-19 pandemic has turned the attention of the antenna design engineers towards the advancement in technology of patient monitoring systems. To augment the process of monitoring health, tracking vital parameters and detection of disease, wearable patch antennas can be employed [1]. These parameters are heart rate, temperature of body, pulse rate and respiratory rate etc. [11-13]. These wearable patch antennas have been gained popularity because these can fixed within the cloth directly [2]. This results in the very low profile, less weight and cost effective devices. The frequency bands of interest for wearable applications are Industrial Scientific and Medical (ISM) bands at 900 MHz, 2.4 GHz, 5.15 GHz, 5.2 GHz, 5.8 GHz and the MICS (Medical Implant Communication Services) band at 400-405 MHz [3]. In the similar context, an attempt has been made here to develop a wearable patch antenna to monitor and detect the patients by tracking their vital parameters.

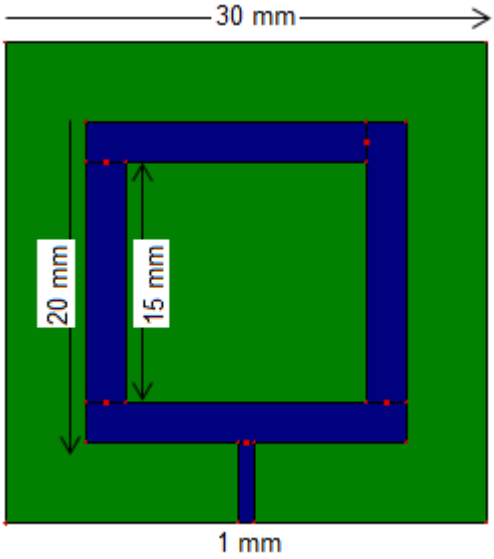
II. ANTENNA DESIGN CONFIGURATION

The developed microstrip patch antenna is constructed using FR4 substrate having electrical permittivity of 4.4. The geometry of the antenna comprises of a square having side of 20 mm. The square ground plane of the proposed antenna has finite dimension with side length of 30 mm. A thin microstrip line of 1mm is used to feed the antenna. The length, width and position of the feed strip are optimized to obtain the maximum impedance matching. Further to enhance the radiation and resonating properties of the antenna, a square shape slot has been taken out from the centre of the patch. Fig. 1 gives the geometry of the presented patch antenna. The slot implementation provides the miniaturization of about 56.25% in terms of patch reduction. This miniaturization leads to the significant reduction to the cost of the patch antenna and provide remarkable cost effectiveness, especially when fabricated in bulk.



(a)

ISSN: 2350-1278
Peer Reviewed & Refereed Journal (IF: 7.9)
Journal Website www.nrjitis.in



(b)

Fig. 1 Geometry of the proposed antenna sensor (a) square patch (b) with slot on the patch

III. RESULTS AND DISSCUSSION

The performance of microstrip patch antenna constitutes a wide range of parameters. IE3D full wave environment was used to simulate the numerical model to assess the performance of the developed patch antenna.

A. Resonating Parameters

The resonating parameter of the presented patch antenna is shown in Fig. 2. The results revealed that proposed antenna possesses -23.03 reflection coefficient at 3.37 GHz and -20.67 dBi reflection coefficient at 5.02 GHz. The feed strip has been designed and placed in a way to achieve high impedance matching so that maximum power can be transferred to antenna. .

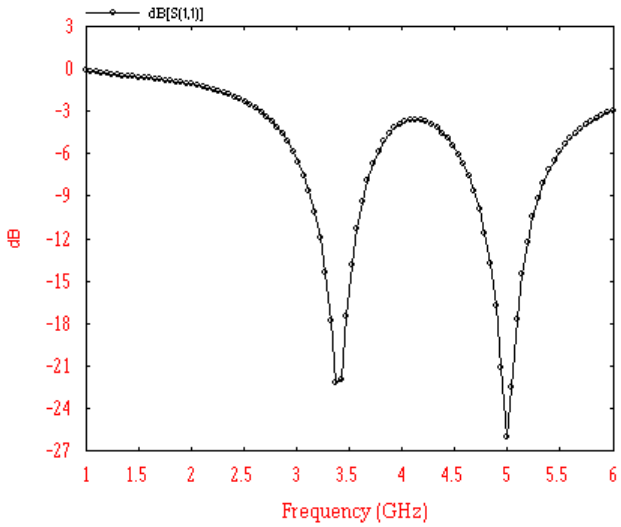


Fig. 2 S_{11} Parameter of the Presented Antenna

B. Analysis with varying slot side length

In view to make a critical analysis of the proposed antenna, side of the square slot has been varied extensively. There is change in the current flow because of variation in the slot of the antenna. Hence the resonant and radiation properties experiences changes. S11 parameter of the presented antenna with varying slot side length is given in Fig. 3. This analysis illustrate that the proposed antenna perform better when the dimension of the slot is 10 mm in comparison to the other presented dimensions of the slot. The detailed performance parameters of proposed antenna is depicted in Table 1.

ISSN: 2350-1278
Peer Reviewed & Refereed Journal (IF: 7.9)
Journal Website www.nrjitis.in

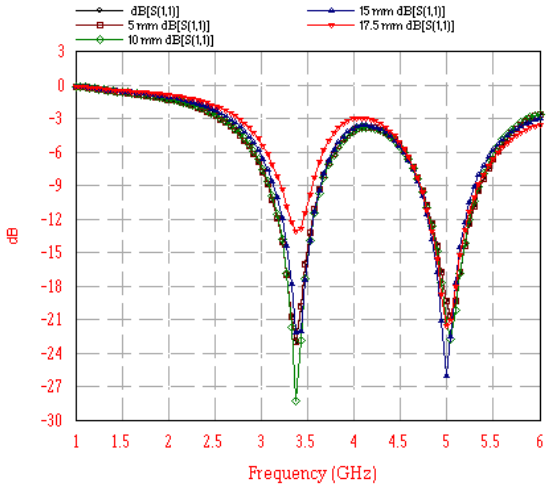


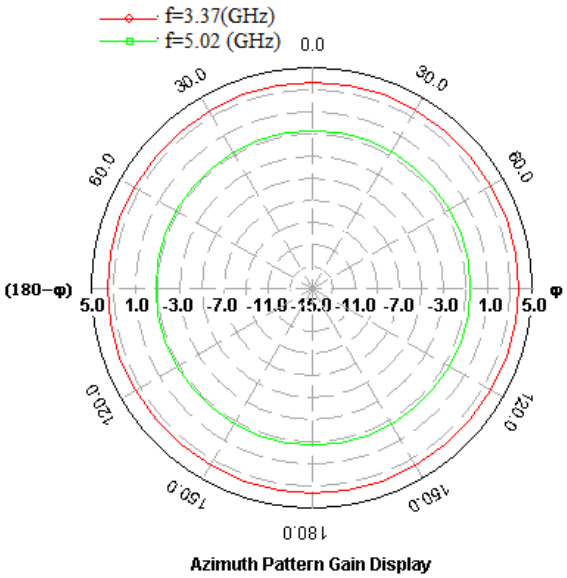
Fig. 3 S_{11} Parameter of the Presented Antenna with Varying Slot Side Length

TABLE I. PERFORMANCE PARAMETERS OF PROPOSED ANTENNA WITH VARYING SLOT LENGTH

Slot	Radio Frequency (GHz)	Return Loss	VSWR	Input Impedance (Ω)	Bandwidth (GHZ)	Gain
2.5 mm	3.37	-23.13	1.15	56.95+j2.69	3.12-3.57	3.77
	5.04	-20.73	1.203	59.46+3.46	4.78-5.29	4.63
5 mm	3.37	-23.03	1.15	57+j2.82	3.12-3.57	3.77
	5.04	-20.67	1.204	59.49+3.56	4.78-5.29	4.63
10 mm	3.37	-28.35	1.152	57+j2.85	3.17-3.57	3.82
	5.04	-22.82	1.20	59.49+3.56	4.78-5.29	4.93
15 mm	3.37	-22.23	1.168	44.3-j4.55	3.17-3.57	3.88
	5.02	-26.04	1.105	55.19+j0.787	4.73-5.24	4.58
17.5 mm	3.37	-13.17	1.56	32.48-J4.68	3.27-3.47	3.72
	4.99	-21.66	1.18	58.96-j0.80	4.78-5.29	5.34

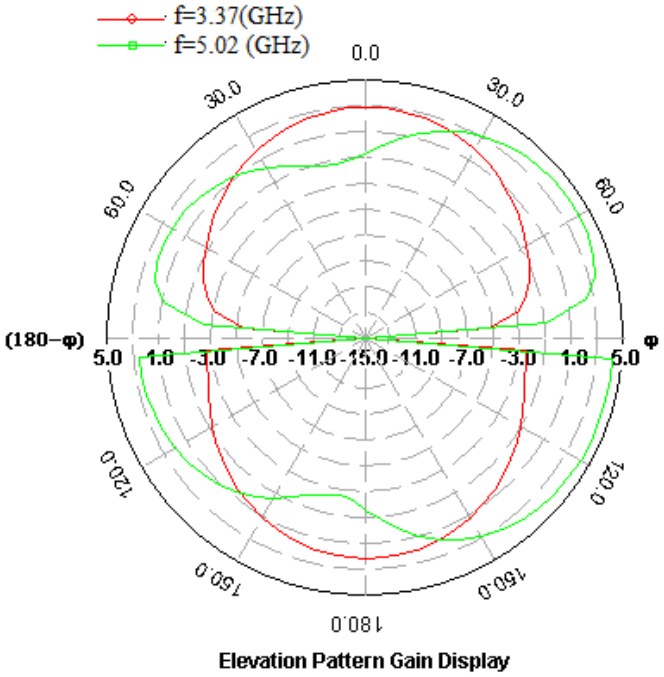
C. Radiation Patterns

Fig. 4 depicted the radiation patterns of the proposed microstrip wearable antenna. The given results revealed that the patch antenna behaves more like a dipole and provide bidirectional radiation pattern in the elevation plane and possesses omnidirectional radiation pattern in the azimuthal plane.



(a)

ISSN: 2350-1278
Peer Reviewed & Refereed Journal (IF: 7.9)
Journal Website www.nrjitis.in



(b)

Fig. 4 Radiation patterns of the presented antenna at 3.37 GHz and 5.02 GHz (a) E-Plane (b) H-Plane

D. Gain of the Proposed Antenna

The simulated result of gain parameter of the proposed patch antenna is given in Fig. 5. It has been observed that the proposed antenna possesses 3.88 dBi gain at 3.37 GHz and 4.58 dBi at 5.02 GHz.

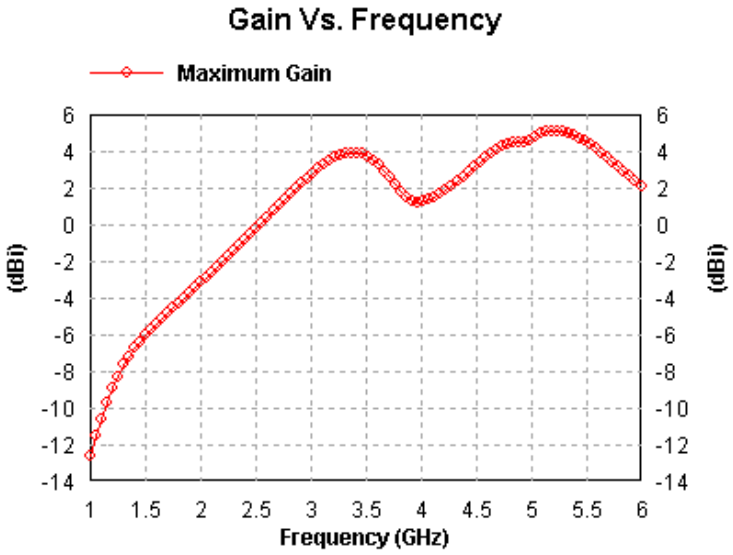
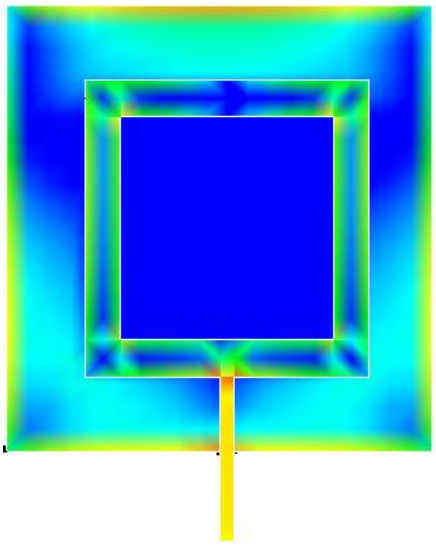


Fig. 5 Gain of the proposed sensor antenna

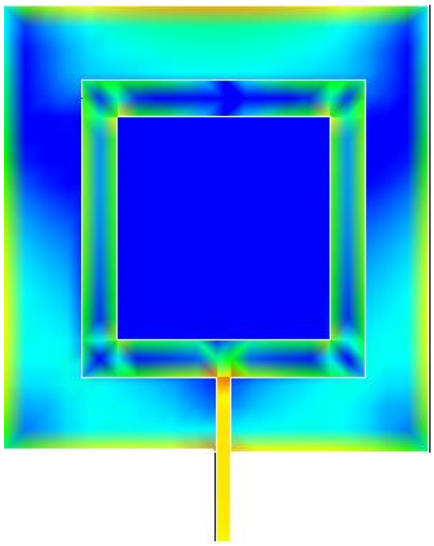
E. Current Distribution

As per the results received of current distribution of the proposed antenna, it may be noticed that the current density is more at the edges of the patch, slot and ground plane in comparison to the rest of the parts of the antenna. The current distribution of the proposed antenna at resonating frequencies is given in Fig. 6.

ISSN: 2350-1278
Peer Reviewed & Refereed Journal (IF: 7.9)
Journal Website www.nrjitis.in



(a)



(b)

Fig. 6 Current distribution of the proposed sensor antenna (a) 3.37 GHz (b) 5.02 GHz

IV. CONCLUSION

The development of wearable patch antenna has been presented that is required to obtain the crucial data sets of vital parameters for health monitoring systems. The antenna is small in size and further implementation of slot not only makes it cost effective but also provides more miniaturization in a significant manner.

ACKNOWLEDGMENT

Authors are indebted to the ECE Department Giani Zail Singh Campus College of Engineering and Technology, MRSPTU, Bathinda, Punjab and Bhai Gurdas Institute of Engineering and Technology, Sangrur, Punjab for providing guidance and support.

REFERENCES

1. M. A. R. Osman, M. K. A. Rahim, N. A. Samsuri, H. A. M. Salim and M. F. Ali, "Embroidered fully textile wearable antenna for medical monitoring applications" Progress In Electromagnetics Research, vol. 117, pp. 321-337, 2011.
2. C. A. Balanis, Antenna Theory (John Wiley & Sons, Inc. 1997).

ISSN: 2350-1278
Peer Reviewed & Refereed Journal (IF: 7.9)
Journal Website www.nrjitis.in

3. Amar Partap Singh Pharwaha, Shweta Rani, "On the Design of Wearable Fractal Antenna", International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol: 9, No: 7, pp. 1181-1186, 2015.
4. Y. Cheng and H. Liu, "A Novel Concentric Annular-Ring Slot Dual-Band Circularly Polarized Microstrip Antenna" *Hindawi International Journal of Antennas and Propagation*, vol. 2018, pp. 1-8, Dec. 2018
5. N. K. Kumar, V. K., Amala P. Sri, "Design of Concentric Circular Ring Patch with DGS for Dual-Band at Satellite Communication and Radar Applications", *Wireless Personal Communications*, vol. 98, pp. 2993–3001, Feb. 2018.
6. G. Singh, B. K. Kanaujia, V. K. Pandey, D. Gangawar and S. Kumar, "Design of compact dual-band patch antenna loaded with D-shaped complementary split ring resonator" *Journal of Electromagnetic Waves and Applications*, vol. 33, no. 16, pp. 2096-2111 sep. 2019.
7. K.N. Ketavath, "Enhancement of Gain with Coplanar Concentric Ring Patch Antenna", *Wireless Personal Communications*, vol. 108, pp. 1447–1457, Oct 2019.M. Ramirez and J. Parron, "Concentric Annular Ring Slot Antenna for Global Navigation Satellite Systems," *IEEE Antennas and Wireless Propagation Letters*, vol. 11, pp. 705-707, Jun 2012