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Research Paper

Design and analysis of key shaped wearable textile antenna

Nausheen Bano [1 *], Vinod Kumar Singh [1], Akash Kumar Bhoi [2], Sanjeev Sharma [3]

[1] SR Group of Institution, Jhansi, U.P. India
[2] Sikkim Manipal Institute of Technology, Sikkim, India
[3] Sandip Institute of Technology & Research Center, Nashik, India
**Corresponding author E-mail: singhvinod34@gmail.com*

Abstract

The proposed antenna is designed to achieve high gain and wide band with partial ground. In this paper, textile wearable antennas working in the craved range of frequency are fabricated and demonstrated. Simulated and measured reflection coefficient, directivity and radiation characteristics have been studied. CST is used for design & simulation of existing antenna with design frequency 3GHz.

Keywords: *Microstrip Antenna; CST; Reflection Coefficient; Directivity*

1. Introduction

In recent years, antenna has achieved a prominent status and wearable antenna is an incipient technology. Zelt, Flectron and pure copper are conductive textile materials that are used as the radiating element whereas jeans, cotton, felt and expandable polystyrene foam (EPS) are non-conductive textile material used as substrates [1-2]. A major factor in area of demanding of such antenna is the advancement in computer architecture and numerical computation. Wearable textile antenna offers wide applications in satellite communication, telecommunication, navigation system etc. The choice of substrate gives antenna good characteristics such as impedance bandwidth, gain, radiation pattern. These materials are light in weight, low cost profile, less relative permittivity [3-7]. The anticipated antenna design is used jeans as a substrate whose relative permittivity is approximately 1.7. Due to low dielectric constant the losses and attenuation are very less than other substrate antenna. Also the low dielectric constant of substrate enhances the bandwidth of antenna of textile antenna [8-10].
In the anticipated antenna jeans is used as a substrate material sandwiched between two layers of copper tape of width 0.038 mm. First layer is ground plane and second layer is patch which is made of copper tape and thickness (h) of substrate is 1.0 mm, dielectric constant is 1.7 and design frequency is 3 GHz. Simulation is done by using CST software studio and gives the results in terms of reflection coefficient, gain, bandwidth [11-13].

2. Antenna design procedure

The patch of anticipated antenna has been made on jeans fabric with dielectric constant equal to 1.7 and height of the substrate is equal to 1.0 mm. The overall size is 49x43.6x1.0 mm which is a very compact size and hence suitable for satellite applications. The design specifications of the proposed antenna are described below. The patch is Key shaped made up of thin copper tape. Fig.1 describes the geometry of final anticipated Antenna and Fig.2 describes the geometries of Antenna1, Antenna2 and Antenna3. The design is simulated with CST software and the results are transcribed.

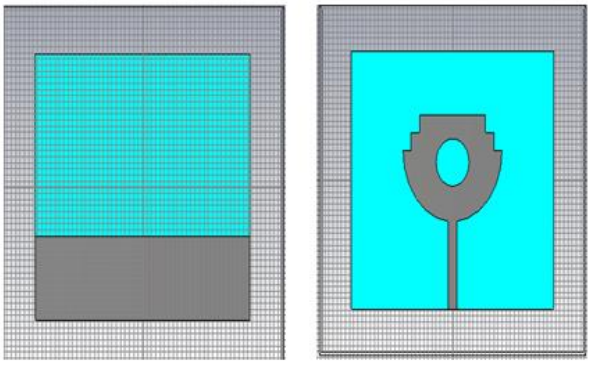


Fig. 1: Proposed Antenna Geometry (A) Back Side (B) Front Side.

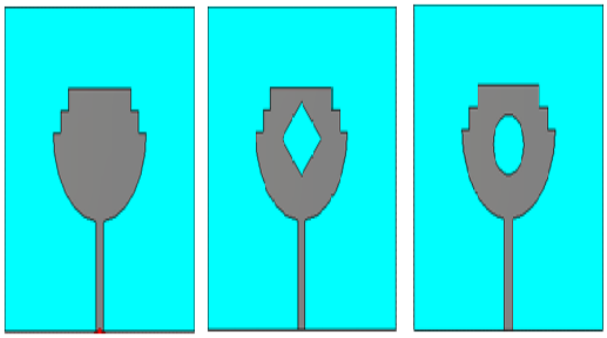


Fig.2: Comparison of Antenna Geometry (A) Antenna1 (B) Antenna2 (C) Antenna3.

Table 1: Dimension of Proposed Textile Antenna

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S. No.	Design Parameters	Values
1	Design Frequency of antenna (GHz)	3
2	Dielectric constant	1.7
3	Substrate thickness (mm)	1
4	Dimension of partial ground(mm)	49x13.8
5	Dimension of substrate(mm)	49x43.6
6	Width of microstrip line (mm)	2

3. Results & discussions

The comparison of various textile antenna designs and their reflection coefficient vs. frequency graph are shown in the Fig.3. The comparative study leads that the result of antenna 1 is more prominent than the other two antennas. Simulation of anticipated antenna is done by CST Microwave Studio software. The presented antenna provides the bandwidth of 81.99% (4.26GHz – 10.18GHz) with resonance frequency 5.4GHz and 8.0 GHz. Simulated results of 3-dimensional characteristics of proposed antenna are shown in Fig.4 and Fig.5 which shows good directivity 3.391dBi at 5.4 GHz and 4.674 dBi at 8.0 GHz. The polar plot of the anticipated antenna at resonant frequencies 5.4 GHz and 8GHz are shown in the Fig.6 and Fig.7 correspondingly.

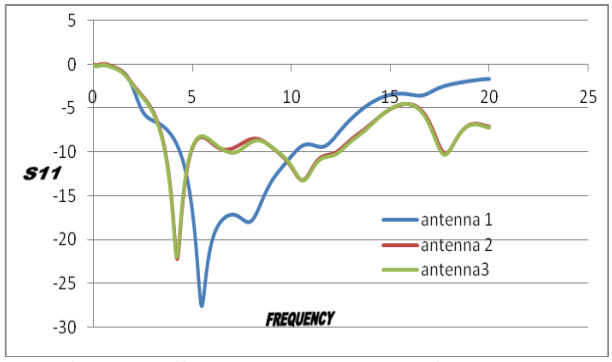


Fig.3: Reflection Coefficient Vs Frequency Graph of Antenna1, Antenna2 and Antenna3.

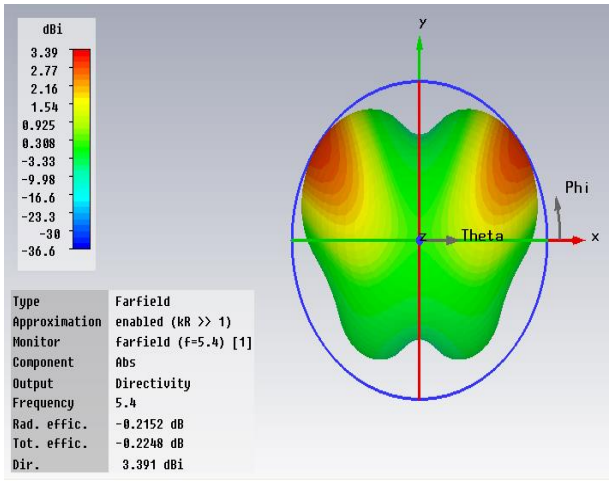


Fig.4: 3-Dimensional Radiation Pattern at 5.4 Ghz.

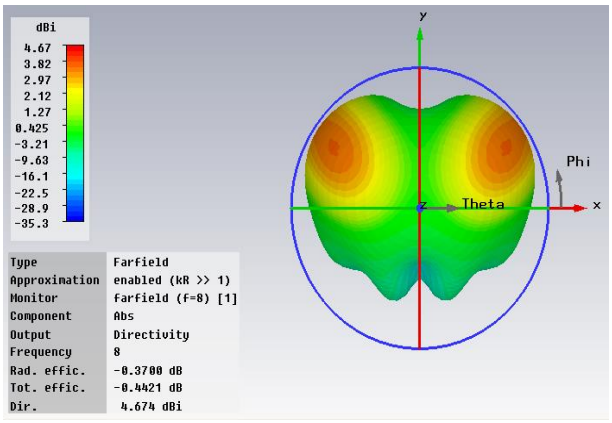


Fig. 5: 3-Dimensional Radiation Pattern at 8 Ghz.

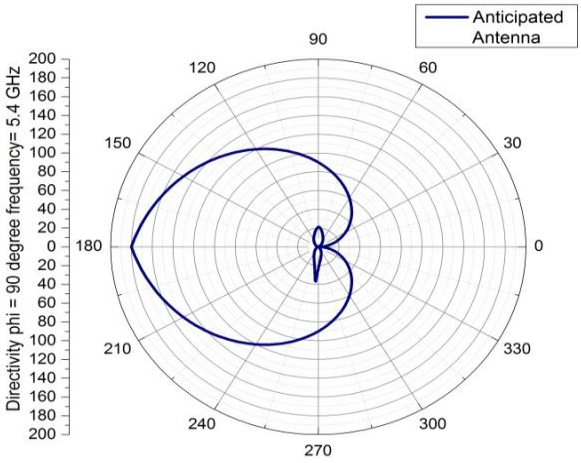


Fig. 6: Polar Plot of Anticipated Antenna at 5.4 GHz.

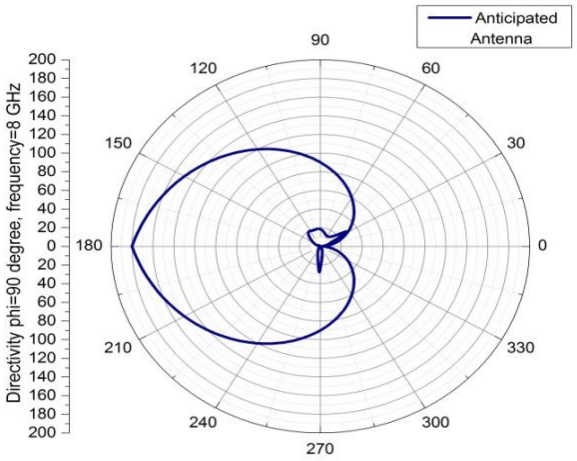


Fig.7: Polar Plot of Anticipated Antenna at 8 GHz.

4. Fabricated proposed antenna and experimental results

Fig.8 shows the front and the back view of the fabricated antenna. The proposed antenna hardware is fabricated by using jeans as substrate and copper as the conductive patch of the antenna. The fabricated antenna is tested in microwave lab at IIT Kanpur and the results are recorded. The recorded results are plotted which shows compromising measured results with the simulated results. The resemblance of measured and simulated reflection coefficient of presented antenna is shown in Fig.9.

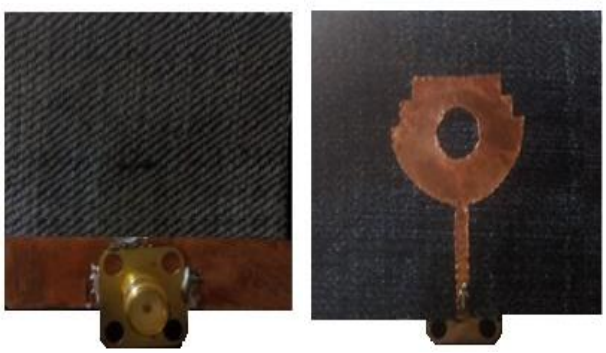


Fig. 8: Hardware of Proposed Antenna (A) Front View (B) Back View.

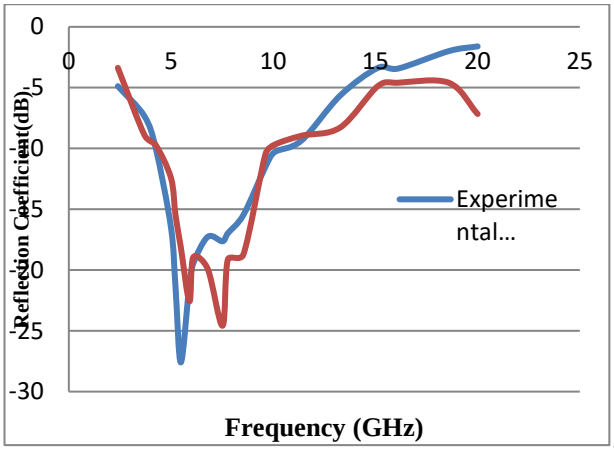


Fig.9: Comparison of Return Loss Vs Frequency Plot of the Simulated and Measured Results of Proposed Antenna.

5. Conclusion

The proposed antenna design gives wide bandwidth of around 78.03%. Therefore this antenna is best suitable for wideband applications. Also the gain of antenna at frequencies 5.4 GHz and 8 GHz are 3.39 dBi and 4.67 dBi respectively. The planned jeans based textile antenna is able to be used for modern communication systems. There are wide applications in wireless communication. The presented antenna covers simulated bandwidth 81.99 % & experimental bandwidth 78.03% with high directivity of 4.67 dBi.

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