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Research paper

Improvement of the performance of wearable textile antenna

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Abstract

In this article low cost wearable textile receiver antenna with copper ground is proposed. The anticipated antenna has the ability to re-ceive the frequency between 2.185 GHz to 6.625 GHz. The antenna parameters have been improved through the optimization technique. A com-parison is studied and described among some existing and anticipated antenna. The proposed wearable receiver antenna is appli-cable to re-ceive radio wave energy available in the range 2.185 GHz to 6.625 GHz.

Keywords: *Jeans Substrate; CST Software; Textile Antenna.*

1. Introduction

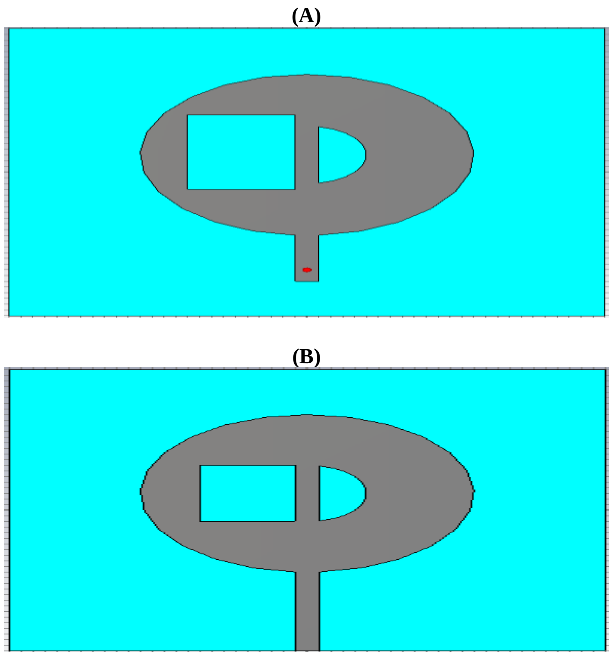
The material like textile is insisting due to their high flexibility, low cost, light weight, low profile. The textile materials like jean have a low dielectric constant which lowers the weight of material and also improves the bandwidth. The dielectric constant of the material is proportional to the antenna size; hence with the textile materials compact antennas are easy to be made. The properties of an antenna such as the reflection coefficient, Voltage Standing Wave Ration, antenna gain and antenna radiation pattern are stud-ied and analyzed for antenna designing [1-5].
The various kinds of antenna that are unable to bend and made up of a copper, known as printed antenna. In the case of textile anten-na the copper tape is utilized to make ground plane as well as the radiating element. Copper tape has been pasted on both sides of substrate to make radiating part and ground plane of textile anten-na. The handling of flexible materials for the development of mi-crostrip antenna has been quick because of the recent tininess of wireless devices [6-8]. The far field characteristics of antenna are also an important function, when as an application communication is established between body worn sensors and larger units such as Personal Computer, Laptop, Mobile phones and Personal Digital Assistant [9-15].
The anticipated receiver antenna can be received RF power at resonant frequency 3.76 GHz. The bandwidth and directivity of the anticipated receiver antenna is far better than some existing antennas. The presented flexible textile antenna is applicable to receive radio frequency energy available in the range 2.185 GHz to 6.625 GHz.

2. Wearable antenna design

The textile antenna was simulated in CST microwave studio 2010 environment. Table 1 contains the parameters and dimensions of the simulated textile antenna. The circular patch radius is calculat-ed by using Eq. (1).

Where
f_r = resonant frequency in GHz
ε_r = relative permittivity
r = radius of circular patch
The antenna designed and optimized with the CST microwave studio is depicted in Figure1. The designed antenna can be re-ceived RF power at resonant frequency 3.76 GHz.

$$r = \frac{87.94}{f_r\sqrt{\varepsilon_r}} \quad (1)$$



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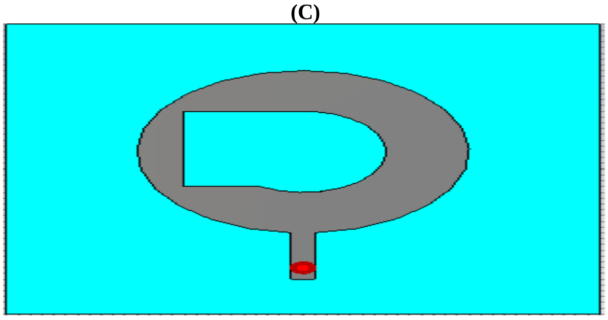

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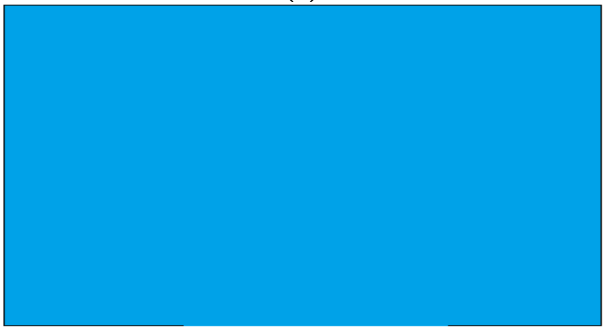

Fig. 1: Proposed Antenna Geometries (A) Antenna 1 (B) Antenna 2 (C) Antenna 3 (D) Ground Plane.

Table 1: Antenna Parameters of Receiver Antenna

Design	Semi-Circle Radius (mm)	Substrate dimension (mm)	Substrate thickness(mm)	Feed Width (mm)
Antenna-1	5	50x50	1	2.0
Antenna-2	5	50x50	1	2.0
Antenna-3	7	50x50	1	2.0

Table 2: Antenna Substrate Dimensions

Antenna Parameters	Values
Substrate Thickness(h)	1
Relative Permittivity(ε_r)	1.7
Semi-circle radius[mm]	14
Rectangle width[mm]	14
Rectangle length[mm]	10
Ground Plane Dimension	50×50

3. 3. Result and discussion

The reflection coefficient with frequency plot has been presented in figure 2 and the comparison of the reflection coefficient of different structures is presented in figure 3. Fig 4 presents smith chart Vs frequency plot of presenting receiver antenna which shows the 50 ohm impedance at the resonant frequency. The far field pattern & 3-D plot of the receiver antenna is given below in figure 5 and figure 6 which shows the directivity of 3.124 dBi. The value of reflection coefficient has shifted to its centre frequency by changing the slot. The bandwidth and directivity of the anticipated receiver antenna is far better than some existing antennas shown in table 2.

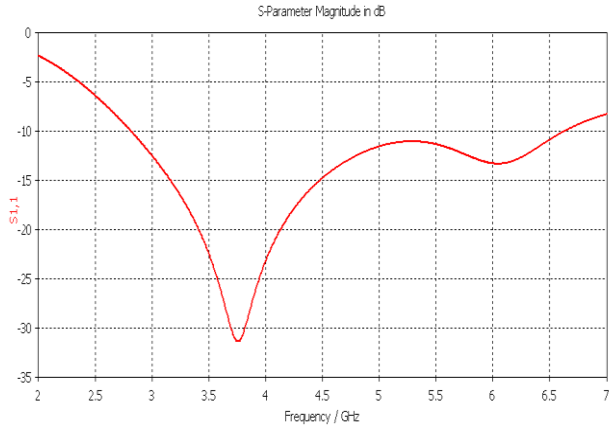

Fig. 2: Return Loss vs Frequency Plot of Proposed Antenna.

Table 3: Performance Comparison of Existing and Proposed Antenna

References	Substrate	Frequency Range	Size (mm)	Band Width	Peak Gain (dB)
Ling Xu [13]	Felt, ε_r =2.4	2.4-2.5GHz 5.725-5.875 GHz	70x40x3	2.40% 6.40%	2.7 dB
Marcus Grilo[14]	Denim ε_r =1.77	2.45 GHz	43.3x38x1.4	15%	0.78 dB
Rawat and Sharma [15]	FR-4 ε_r = 4.4	4.04-7.28 GHz	30x30x1.59	60.30%	3.0 dB
Proposed Antenna	Jeans ε_r =1.7	2.185-6.625 GHz	50x50x1.0	100.90%	3.124 dB

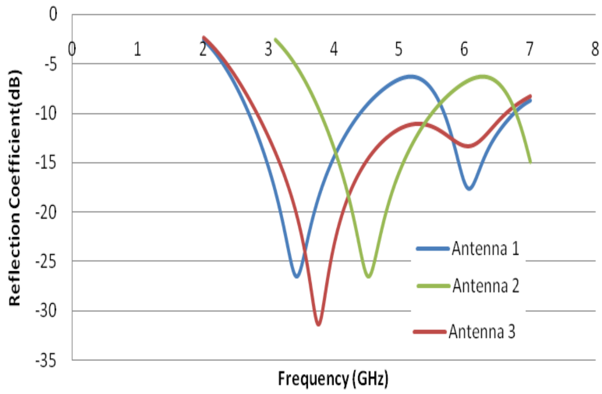

Fig. 3: Reflection Coefficient vs Frequency Plot through Optimization

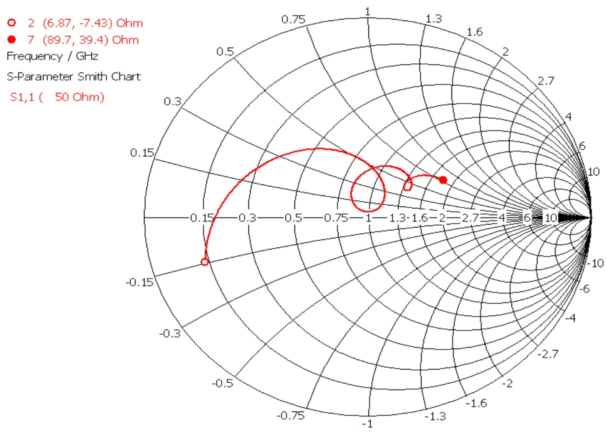

Fig. 4: Smith Chart vs Frequency Plot of Presented Receiver Antenna

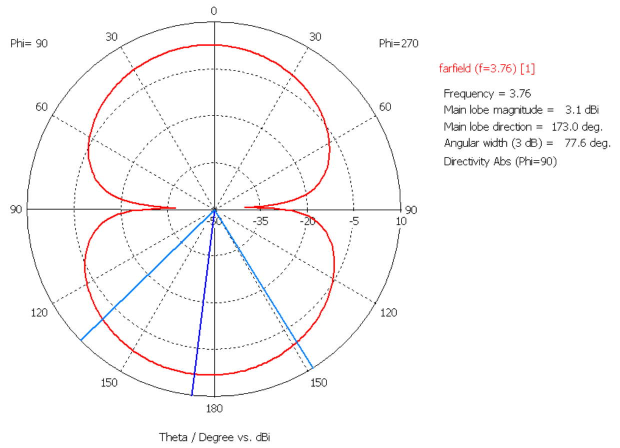

Fig. 5: Far Field Pattern vs Frequency Plot of Presented Antenna

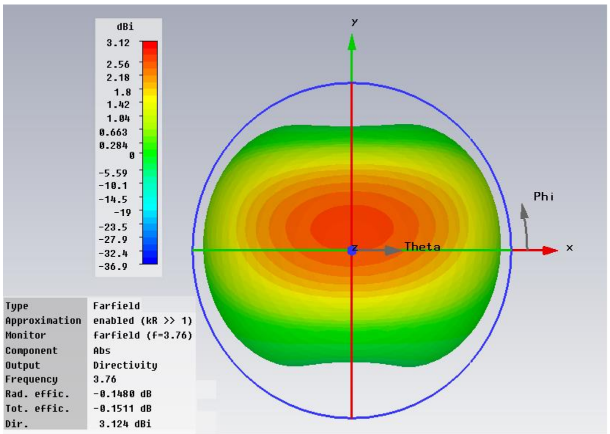

Fig. 6: Far Field 3-Dimensional Radiation Pattern Showing Directivity of Proposed Receiver Antenna.

4. Conclusion

An optimized low cost wearable textile receiver antenna is designed, simulated using jeans substrate. Simulation results have carried out by using CST simulation software. The antenna has covered the frequency range from 2.185GHz to 6.625 GHz having very large bandwidth of 100.90%. The designed receiver antenna can be received RF power at resonant frequency 3.76 GHz. The bandwidth and directivity of the anticipated receiver antenna is far better than some existing antennas.

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