Advance Physics Letter

Textile Antenna for Bluetooth Devices Applications

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Abstract: In this article an innovative design of textile antenna using jeans substrate is presented and studied, which can cover the frequency range from 2.11GHz–5.01GHz. The antenna was successfully developed by using CST microwave studio. The proposed textile antenna has wide impedance bandwidth of about 81.46% which is best suitable for blue tooth / WLAN application. In this article the parametric study such as radiation pattern, return loss and smith chart has been presented.

Keywords: Microstrip antenna, wide band, CST

I. INTRODUCTION

In an advance wireless system, an antenna is used to optimize the most of the radiation energy in some direction and contain it in others. Under ideal condition energy generated by source should be totally transferred to the radiation resistance, which is used to represent radiation by the antenna. However in practical system, there are conduction dielectric losses due to lossy nature of the transmission line and the antenna as well as due to reflection losses at the interface between line and antenna [1-8]. Antenna also serves as a directional device in addition to a probing device. It takes various forms to fulfill its need like a piece of conducting wire, an aperture, a patch, an array, a lens, and so forth. Antenna is a major component for wireless communication system. A correct design of antenna can complete all requirements and improve overall system performance [9-16]. The antenna serves to a communication system the same purpose that eye and eye glasses serve to a human.

Smart fabrics have attracted growing interest in the last ten years, especially for wearable system applications. The first textile based flexible antenna was made in year 2007 on 100 % cotton. As this can be accomplished conveniently and unobtrusively, the integration of such an antenna system into a rescue worker’s garment is no hindering for the operations to be performed. So the necessary requirements of wearable antenna designing are planar structure, flexible conductive materials in the patch and ground plane, and flexible dielectric materials. The behavior of the antenna depends on the characteristics of the material. The bandwidth and the efficiency of the planar antenna depend on the permittivity and the thickness of the dielectric substrate and the conductivity of the ground plane and of the patch is an important factor influences the efficiency of the antenna [17-24]. The Electrical properties of conductive textiles are determined by the transmission line method and their surface resistivity is often given by specialized producers. Sometimes electro textiles are used to design Specific conductive textiles that are commercially available. Ordinary textile fabrics or cloths are used as dielectric substrates in wearable antenna.

II. GEOMETRY OF PROPOSED ANTENNA

The substrate of the proposed antenna is made of textile material where as copper tape is used for radiating patch and the ground plane. The proposed antenna is simulated using CST Microwave Studio software and the radiating patch is fed by a 50 Ω microstrip line. The top view and back view of the partial ground plane of the proposed antenna is shown in figure 1. The design specifications of the proposed antenna are given in table 1.

Table 1 Design specifications of the proposed antenna.

Parameters	**Values**
Thickness, h [mm]	1.0
Relative permittivity [ε_r]	1.7
Loss Tangent	0.025
Lg [mm]	76
Wg [mm]	14
L_S [mm]	76
W_S [mm]	76
W_1 [mm]	35
L_1 [mm]	44
W_2 [mm]	25
W_3 [mm]	35
Height of copper [mm]	0.038
Height of antenna [mm]	1.076

The effective dielectric constant of antenna structure can be calculated as [16, 20]:

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + \frac{10h}{W}\right]^{-\frac{1}{2}} \qquad (1)$$

Where, W denotes the width of micro strip patch, h represents height of the dielectric substrate, and ε_r denotes dielectric constant and ε_{eff} effective dielectric constant. The width of the micro strip patch is computed as: [20]

$$W = \frac{C}{2f}\sqrt{\frac{2}{(\varepsilon_r + 1)}} \qquad (2)$$

Due to fringing, the length of the patch increases electrically. Thus, the increase in length is given by: [20]

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.300)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.813\right)} \qquad (3)$$

Where, ΔL represents an increase in length. The length is increased on both side of the micro strip patch. Thus, the effective length is given as: [20]

$$L_{eff} = L + 2\Delta L \qquad (4)$$

$$L = \frac{1}{2f_r\sqrt{\varepsilon_{reff}}\sqrt{\mu_0\varepsilon_0}} - 2\Delta L \qquad (5)$$

Thus, the resonance frequency for the microstrip antenna with length L and dielectric constant ε_r is given as [16, 20]:

$$f_r = \frac{1}{2L\sqrt{\varepsilon_r}\sqrt{\mu_0\varepsilon_0}} \qquad (6)$$

If the fringing has finite impact, the effective length and effective dielectric constant is considered. In this case, the resonance frequency is calculated as [16, 24]

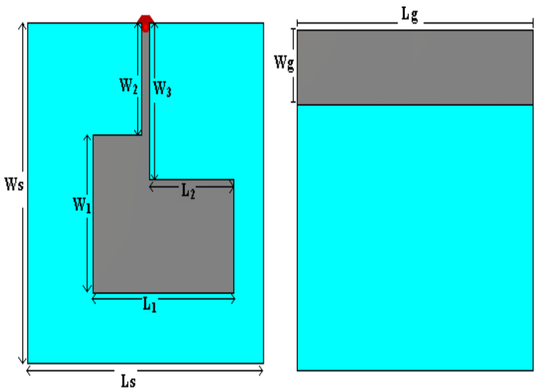

Figure 1 Geometry of proposed antenna (a) Top view (b) Back view

III. RESULTS AND DISCUSSIONS

Figure 2 shows the S_{11} parameters at desired frequency after simulation on CST. Jeans is taken as substrate having the dielectric constant of 1.7. The proposed antenna has an improved bandwidth of 81.46% covering the range 2.11 GHz to 5.01 GHz which is suitable for bluetooth Application. When a transmission cable is terminated by impedance that does not match the characteristic impedance of the transmission line, not all of the power is absorbed by the termination but part of the power is reflected back down the transmission line. The incident signal mixes with the reflected signal to cause a voltage standing wave pattern on the transmission line Figure 3 shows 2D radiation pattern of proposed textile antenna. Figure 4 shows the smith chart vs frequency of proposed textile antenna.

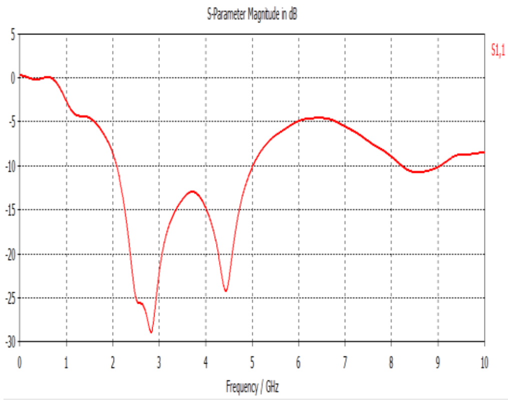

Figure 2 S_{11}-parameter Vs Frequency of proposed antenna

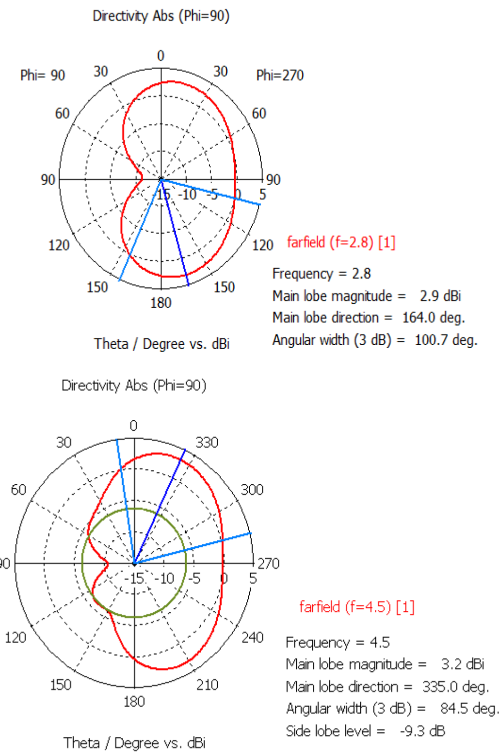

Figure 3 2D Radiation pattern of proposed textile antenna

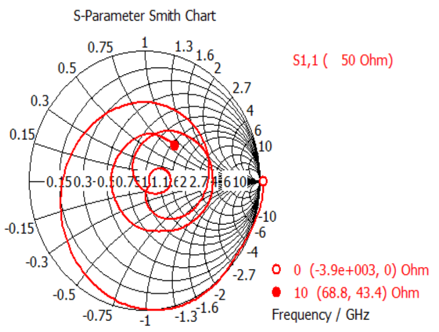

Figure 4 Smith Chart Vs Frequency of proposed textile antenna

Table 2 Performance of proposed antenna

Parameters	**Proposed Antenna Characteristics**
Frequency Range	2.11GHz - 5.01 GHz
Bandwidth	81.46 %
Substrate	Jeans (ε_{r} = 1.7)
Application	WLAN & Bluetooth

IV. CONCLUSION:

In this paper the conductive textile antenna using jeans substrate is presented and studied, which can cover the frequency range from 2.11 GHz – 5.01GHz. The antenna was successfully developed using CST Microwave Studio. The proposed textile antenna has wide impedance bandwidth of about 81.46 % covering the frequency range from 2.11 GHz to 5.01 GHz which is best suitable for blue tooth / WLAN application.

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