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Development of Textile Antennas using Different Substrates for Wireless Body Area Network(WBAN)

Dr.D.Prabhakar[1], T. Sai Ramcharan[2], T. Vamsi Sai[3], Y. Pravallika[4], K. Anil Kumar[5]
Associate Professor[1], Final Year Students[2, 3, 4, 5],Department of Electronics and Communication Engineering, Gudlavalleru Engineering College, Seshadri Rao Knowledge village, Gudlavalleru, Andhra Pradesh, India.
Email: prabhakar.dudla@gmail.com[1], ramcharantangirala@gmail.com[2], vamsisai900@gmail.com[3], ypravallika77@gmail.com[4], anilkommineni29@gmail.com[5]

Abstract-Communication systems consolidate with cloths and wearable items by which medical devices are creating an impact on intensifying healthcare provisions. These wearable items when fully flourished will be capable of warning and demanding attentiveness, if needed also minimizing the hospital resources and money. Further, they can play a crucial role in blocking ailments, health irregularities and unanticipated heart or brain disorder in healthy people. This paper discloses the performance analysis of wearable textile micro strip patch antenna designed with two different substrates like Jeans and Lycra for Wireless Body Area Network(WBAN). In this proposed work, wearable textile antenna was designed at 2.45 GHz frequency by using HFSS (High Frequency selective simulation software). The developed antenna has been simulated for various performance parameters like Reflection coefficient, Gain, Directivity, VSWR, Efficiency and Bandwidth

Keywords—Micro strip Patch Antenna, Textile Antenna, Jeans, Lycra, and ISM**.**

1. INTRODUCTION

As per the current situation, researchers are moving their focus towards designing and analysis of wearable textile antenna. In wireless communication, wearable textile antenna is one of the key element in order to establish Wireless Body Area Network (WBAN). Wearable textile antennas are being used in many applications in our daily life like Health monitoring, Physical training, Navigation, Medicine, Military and RFID etc. The reason behind using the wearable antenna is its low cost, easily available flexible textile.

Authors have strived in designing wearable textile antennas for bio medical applications like signal monitoring application [1], Tele- Medicine applications [2], skin cancer detection [3], For bio- information applications [4]. In [1] authors showed a simple approach to design a wearable antenna for smart clothing in the ISM frequency band using HFSS software. The reason behind using smart cloths is they monitor vital parameters like bio signals of patients and soldiers. In [2] a low cost and easy to Combine wearable antenna has been designed on fabrics such as Cotton, Jeans and Silk.In [3] the author presented a design approach for high gain wearable antenna to be applied for detection of cancer. In [4] authors proposed a study report on wearable textile antenna design that can be usedfor medical applications. The two antennas were resonated at 2.45 GHz and were simulated using HFSS software and fabricated on Jeans and Lycra substrates.Some authors have attempted wearable concepts in wireless communication fields [5-7]. Like, in [5], rectangular wearable patch antenna was designed at 2.45 GHz frequency for WLAN applications.

The antenna was fabricated on Jeans substrate and the measured result was compared with simulated results. In [6], author developed a wearable patch antenna mainly focused on analysis and design because in order to investigate the performance of rectangular micro strip patch antenna fabricated on various textile substrates.

2. DESIGN CONSIDERATION

A microstrip antenna in its simplest configuration consist of a radiating patch on one side of a dielectric substrate (€r<10), whichhas a ground plane on the other side. The patch conductors normally of copper and gold, can assume virtually any shape, but conventional shapes are generally used to simplify, analysis and performance prediction.

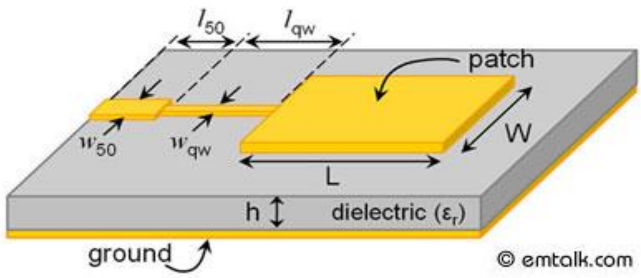

Fig.1: Basic micro strip patch antenna

The dimension considerations of Patch Antenna are found using the formula given below

Calculation of Width (W):

Antenna Patch Width is found by using

$$W=\frac{c}{2fo\sqrt{\epsilon r+1/2}}$$

Where c= $3*10^8$

Calculation of Actual Length (L):

The effective Length of Patch Antenna relies on the resonant frequency (f_0).

$L_{eff} = \frac{c}{2f0\sqrt{\epsilon r}}$ Where $\epsilon_r = \frac{\epsilon r+1}{2} + \frac{\epsilon r-1}{2}{}^{2}\sqrt{1+12\frac{h}{w}}$

Actual Length and effective length of Patch antenna can be combined as

$L = L_{eff} - 2\Delta L$

Where ΔL depends on effective dielectric constant ϵ_{reff} and the ratio $(\frac{W}{h})$

Substituting L_{eff} and ΔL we get L value

Calculation of Ground plane dimensions(Lg, Wg);

Since the transmission line model is applicable to infinite ground planes, We should choose finite ground plane for practical considerations,].

$$L_g = W_p + 2*L_f;$$
$$Wg = Lp + 2*L_f;$$

Where $L_f = \lambda/4$.

TABLE I: ANTENNA DIMENSIONS

Parameters	Jeans	Lycra
Solution Frequency(f_o) (GHz)	**2.45**	**2.45**
Dielectric Constant (€r)	**1.7**	**1.5**
Height of Substrate (h) (mm)	**1.6**	**1.6**
Width of Patch (W_p) (mm)	**52.693**	**54.76**
Length of patch (L_p) (mm)	**45.851**	**48.68**
Width of Ground (W_g)	**98.53**	**103.44**
Length of Ground (L_g)	**105.37**	**109.52**

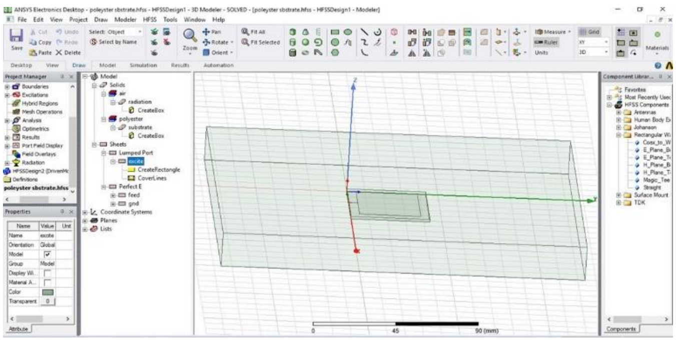

Fig. 2: Creating Radiation Box

Fig. 3: Jeans Fabric

Fig. 4: Lycra Fabric

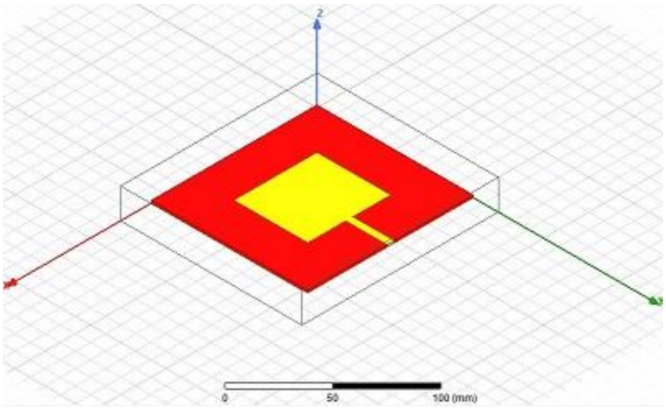

Fig. 5: Micro strip antenna with Jeans as a substrate

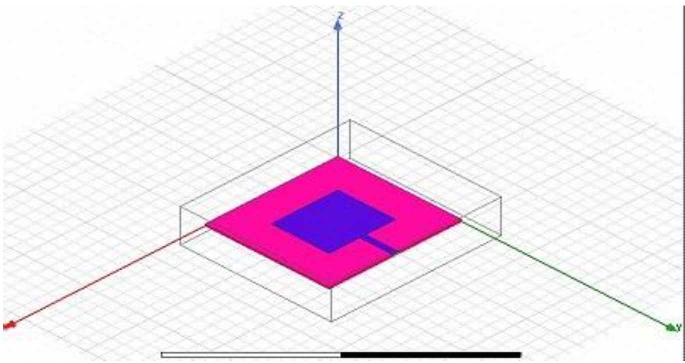

Fig. 6: Micro strip antenna with Lycra as a substrate

3. RESULTS AND DISCUSSION

Results of Jeans Substrate:

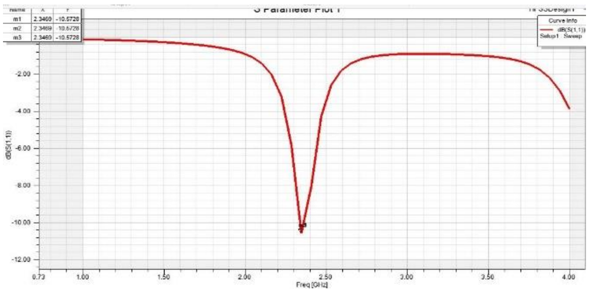

Fig. 6: Reflection Coefficient plot

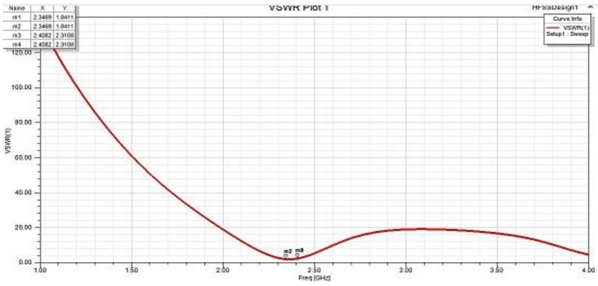

Fig. 7: VSWR Plot

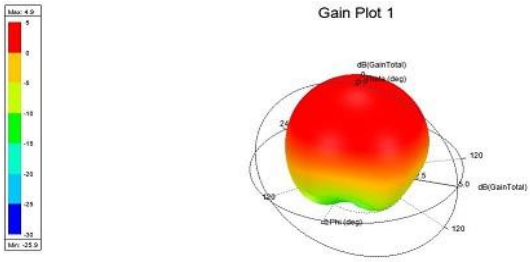

Fig. 8: Gain Plot

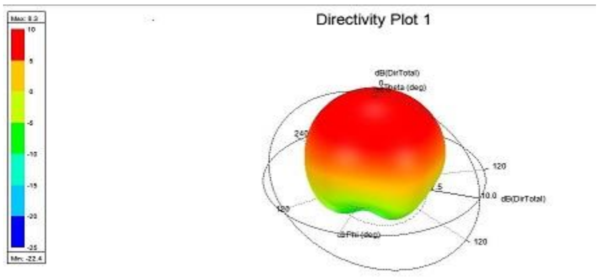

Fig. 9: Directivity Plot

Results of Lycra Substrate:

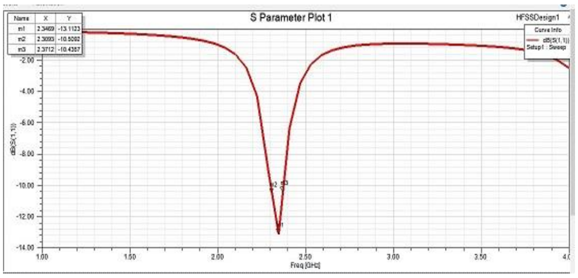

Fig. 10: Reflection Coefficient plot

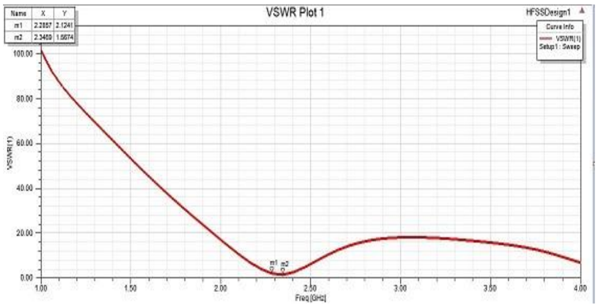

Fig. 11: VSWR Plot

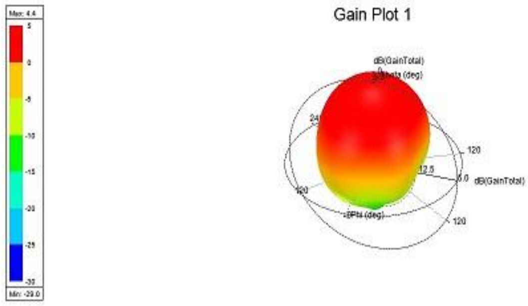

Fig. 12: Gain Plot

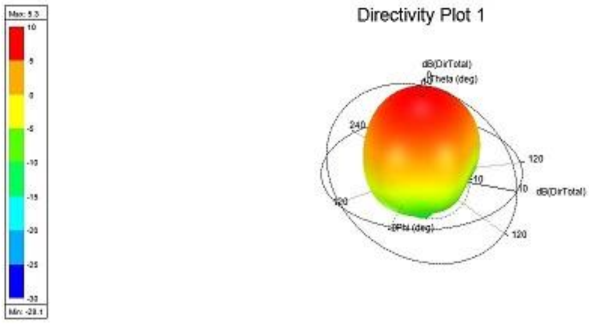

Fig. 13: Directivity Plot

Reflection Coefficient is obtained at 2.38 GHz in case of Jeans Substrate and 2.30 GHz for Lycra Substrate. The Voltage Standing Wave Ratio (VSWR) is obtained at 2.38 GHz and 2.34 GHz for Jeans and Lycra Substrates.

As the antenna is designed for bio-medical applications it should radiate with much reduced power. Fig. 8 and Fig, 12 shows the gain of the antenna. Jeans Substrate had a gain of 4.9 dB which is maximum when compared to that of Lycra substrate which had a gain of 4.4 db.

We can also observe the Directivity plots from the Fig.9 and Fig, 13. It clearly shows that Jeans Substrate is having high Directivity about 8.3 dB and 5.3 dB for Lycra Substrate.

The below table provide the various performance parameters of the two substrates Jeans and Lycra.

TABLE II
COMPARISION AND ANALYSIS

Parameter	**Jeans**	**Lycra**
Resonant Frequency (GHz)	**2.38**	**2.38**
Reflection Coefficient (dB)	**-10.016**	**-10.5092**
Gain (dB)	**4.9**	**4.4**
Directivity (dB)	**8.3**	**5.3**
VSWR	**1.84**	**1.5674**
Bandwidth (Hz)	**0.02**	**0.026**
Efficiency	**59.03**	**83.018**

4. CONCLUSION

Designed and simulated micro strip patch antenna using different substrates like jeans and Lycra by using HFSS software. Observed different antenna parameters like Gain, Directivity, VSWR, Reflection Coefficient, Bandwidth and Efficiency. We conclude that in the designing of wearable micro strip patch antenna it is suggested to use Lycra material as a substrate because it is having higher efficiency when compared to that of the efficiency of Jeans fabric.

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