Wearable Antennas Using Different Substrates

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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 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 Wash cotton and Resin for Wireless Body Area Network (WBAN). In this proposed paper, wearable textile antenna was designed at 2.45 GHz frequency by using HFSS. The developed antenna has been simulated and tested for various performance parameters like Reflection coefficient, Gain, Directivity, VSWR, Efficiency, and Bandwidth.

Index Line: Micro strip Patch Antenna, Textile Antenna, Wash cotton, Resin, WBAN, ISM.

I. 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] author showed a simple approach to design a wearable antenna for smart clothing in the ISM frequency band using HFSS software.

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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 used for medical applications. The two antennas were resonated at 2.45GHz and were simulated using HFSS software and fabricated on Wash cotton and Resin 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 Wash cotton 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.

II. DESIGN CONSIDERATION

A micro strip antenna in its simplest configuration consist of a radiating patch on one side of a dielectric substrate (€r<10), which has 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.

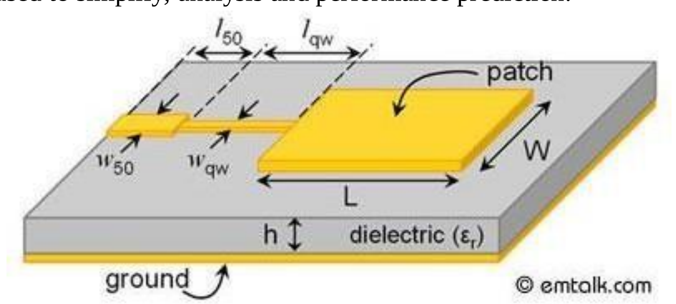

Fig.1: Basic micro strip patch antenna

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

Calculation of Width (W):
Antenna Patch Width is found by using

Parameters	Wash cotton	Resin
Solution Frequency(fo) (GHz)	2.45	2.45
Dielectric Constant (€r)	1.51	3.5
Height of Substrate (h) (mm)	1.6	1.6
Width of Patch (Wp)(mm)	54.65	40.81
Length of patch (Lp) (mm)	48.52	32.27
Width of Ground (Wg)	103.17	73.085
Length of Ground (Lg)	109.3	81.625

$$W = \frac{c}{2f_0\sqrt{\epsilon r + 1/2}}$$

Where C=3*10^8 m/s

1. Calculation of Actual Length:

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

$$L_{eff} = \frac{c}{2f_0\sqrt{\epsilon r}} \quad \text{Where } \epsilon r = \frac{\epsilon r+1}{2} + \frac{\epsilon r-1}{2}^{2}\sqrt{1+12\left(\frac{h}{w}\right)}$$

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 ($€_{reef}$) and the ratio (w/h)

Substituting Leff and ΔL we get L value.

2. Calculation of Ground plane dimensions (Lg, Wg):

The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have finite ground plane.

L_g= W_p+ 2*L_f; W_g= L_p+2*L_f;

TABLE I OPTIMISED ANTENNA DIMENSIONS

Fig. 2: Wash cotton Fabric

Fig. 3: Resin Fabric

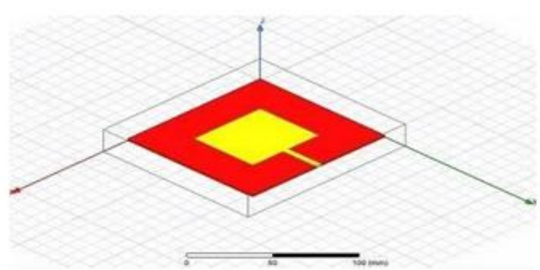

Fig. 4: Micro strip antenna with Wash cotton as a substrate

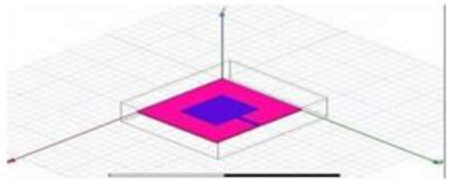

Fig. 5: Micro strip antenna with Resin as a substrate

III. RESULTS AND DISCUSSION

RESULTS OF WASH COTTON SUBSTRATE

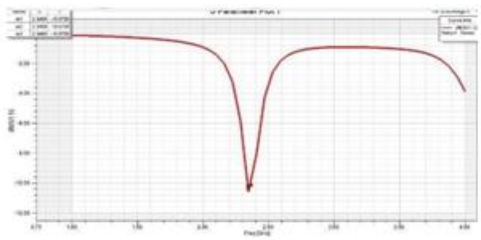

Fig. 6: Reflection Coefficient plot

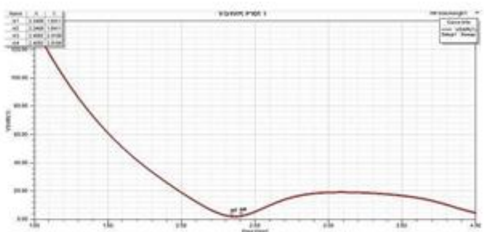

Fig. 7: VSWR Plot

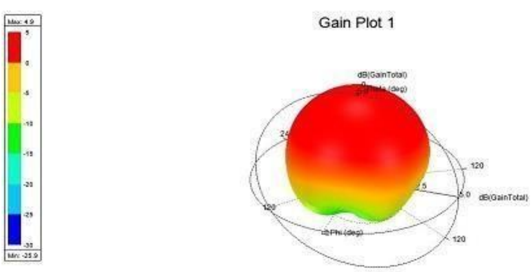

Fig. 8: Gain Plot

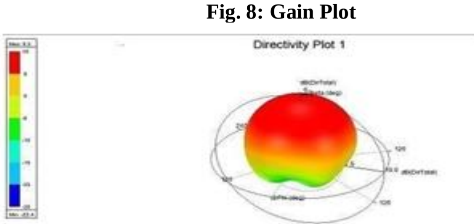

Fig. 9: Directivity Plot

Results of Resin Substrate:

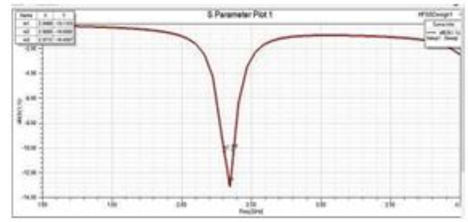

Fig. 10: Reflection Coefficient plot

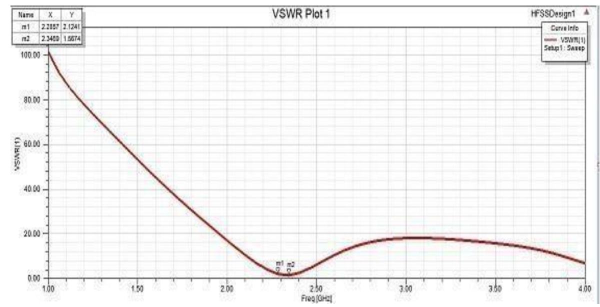

Fig. 11: VSWR Plot

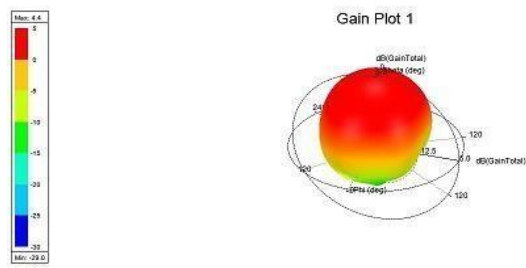

Fig. 12: Gain Plot

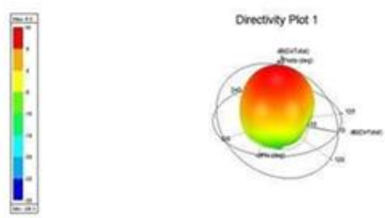

Fig. 13: Directivity Plot

Reflection Coefficient is obtained at 2.36 GHz in case of Wash cotton Substrate and 2.28 GHz for Resin Substrate. The Voltage Standing Wave Ratio (VSWR) is obtained at 2.3GHz and 2.4GHz for Wash cotton and Resin 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 antenna. Wash cotton substrate gain of 5.2 is greater when compared with the resin substrate with a gain of 0.4. We can also observe the Directivity plots from the Fig.9 and Fig, 13. It clearly shows that Wash cotton Substrate is having high Directivity about 7.9 dB and 6.9 dB for Resin Substrate.

The below table provide the various performance parameters of the two substrates Wash cotton and Resin.

3. TABLE II

COMPARISION AND ANALYSIS

Parameter	*Wash cotton*	*Resin*
Resonant Frequency (GHz)	2.36	2.28
Reflection Coefficient (dB)	-10.016	-10.5092
Gain (dB)	5.2	0.4
Directivity (dB)	7.9	6.9
VSWR	1.7486	1.864
Bandwidth (Hz)	0.02	0.026
Efficiency	65.82	57.97

IV. CONCLUSION

Designed and simulated micro strip patch antenna using different substrates like Wash cotton and Resin 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 suggested that Wash cotton material as a substrate because it is having higher efficiency when compared to that of the efficiency of Resin fabric.

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