Study & Design of Uwb Antenna For Wearable Applications

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Abstract : *In the recent era, Wearable Technology is one of the promising and challenging technologies.*

Wearable Antennas are those antennas which we can wear & that are designed to function while being worn. It used for communication purposes, which includes tracking and navigation, mobile computing and public safety. It also has various applications in the field of medical, mobile communication, navigation and military.

Textile is used as a patch in such antennas. Textile patch antenna uses fabric material for substrate, patch and ground and it becomes part of wearable clothing.

Ultra-wideband (UWB) is a range of frequency (3 GHz to 12 GHz) used for communication purposes, for the transmission of data from transmitting antenna to receiving antenna. It is an emerging technology that promises high-speed data transmission at low cost for wireless communications.UWB is the best technology to be used for the purpose of wearable applications.

Keywords – Circular Patch; UWB; Textile material; Wearable; VSWR; Return Loss; SAR.

I. INTRODUCTION :

To meet the requirement of wearable applications, antenna should be small in size i.e. .low profile, conformability, easy association with other circuit components and very important easy to bend & easy to withstand with moisture, wet conditions.

Microstrip antenna (MSA) is mostly used for wearable applications. Microstrip or patch antennas are becoming useful because they can be printed directly onto a circuit board. Patch antennas are low cost, have a low profile and are easily fabricated.

Simple microstrip antenna is fed by a microstrip transmission line. The patch antenna, microstrip transmission line and ground plane are made of high conductivity metal (typically copper). The patch is of length L, width W, and sitting on top of a substrate (some dielectric circuit board) of thickness h with permittivity ε_r . The thickness of the ground plane or of the microstrip is not critically important. Typically the height h is much smaller than the wavelength of operation, but not much smaller than 0.05 of a wavelength.[2]

II. ANTENNA WITH FABRIC

We can integrate Microstrip Ultra-Wideband (UWB) antenna into cloths. Here, at the base we have ground plane, on top of it dielectric substrate and at the top there is metallic patch. Both ground plane and patch are conducting. Such antennas are very small in size, light weight and comfortable to the wearer. [3]

One of the important factors to be considered for designing wearable antenna is Specific Absorption Rate (SAR). As, antenna is very near too human body, SAR affects greatly on the body. Due to SAR, body temperature increases and it greatly affects on the general behavior and memory of the person. The standard value of SAR is 1.6 W/kg per 1gm of actual tissue, as limited by Federal Communication Commission (FCC).

Radiation pattern indicates the energy distribution around the antenna. For UWB antenna it is Omni-directional and effort has to be made to make it unidirectional.

Voltage Standing Wave Ratio, (VSWR) describes whether antenna impedance is matched with the transmission line to which it is connected. Smaller value of VSWR indicates better matching between antenna and the transmission line i.e. more power is delivered to the antenna. To have no reflection of power, VSWR value should be equal to 1.0. For UWB antenna it should be less than 2.

Return loss / Reflection coefficient also known as s_{11} describes how much power is reflected back from antenna to the transmission line. Its value should always be less than -10dB.

III. ANTENNA DESIGN

Following materials has been used for the study & design.

Table I : Materials & their dielectric values

Sr. No.	Substrate	Dielectric Constant (ε_r)	Tangent Loss
1	Rogers 5880	2.2	0.009
2	Flannel	1.7	0.025
3	Polyester	1.44	0.003
4	Jeans	1.59	0.05

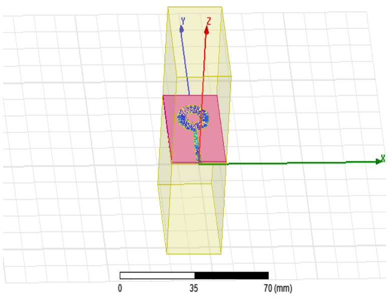

Figure 1: Implemented structure with circular patch & circular slot using Rogers 5880 as substrate [12]

This design consists of circular patch of radius 7.76mm which is resonant at 7.76GHz frequency.

Resonant frequency of Circular patch antenna is given as:

$$f_r = \frac{1.8412 * v_o}{2 * \pi * a_e * \sqrt{\varepsilon_r}}$$

V_o - velocity of the light, a_e - effective radius of the patch.

IV. RESULTS & DISCUSSION

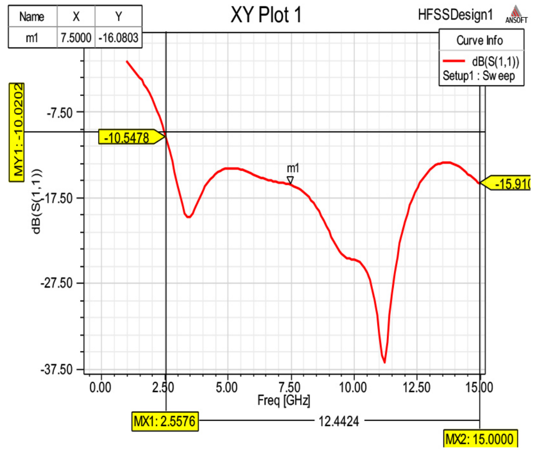

Figure 2 : S11(dB) Vs. Frequency(GHz) with Rogers 5880

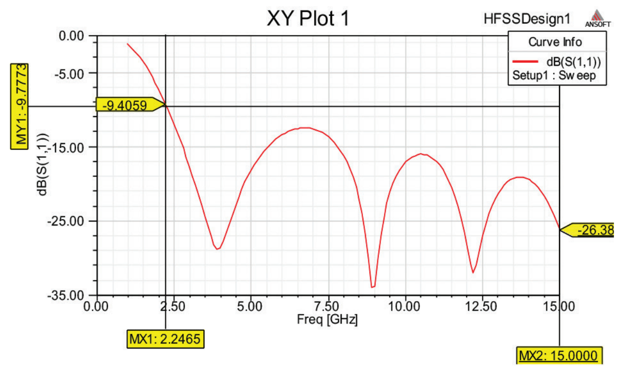

Figure 3 : Return Loss S11(dB) Vs. Frequency(GHz)- indicating bandwidth improvement & S_{11} with polyster substrate. [3]

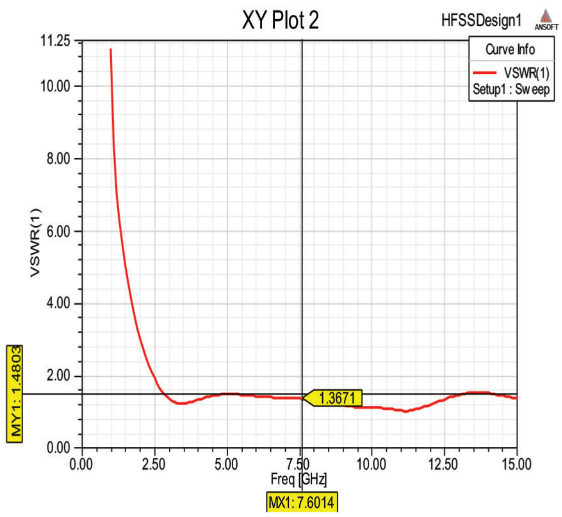

Figure 4: VSWR Plot Vs. Frequency(GHz).

In this application study for UWB range applications, flannel, polyester, jeans material is used as substrate material [12].These results are compared with Rogers 5880. Other materials include denim silk, wash cotton, curtain cotton etc.

Effect of substrate & thickness of the dielectric material has been observed. The study indicates Flannel has very less return loss, VSWR & more bandwidth as compared to Rogers 5880. This is because flannel is 100% cotton & suitable for wearable applications. [12] If Circular Patch and circular slots are used, polyester has improved bandwidth than flannel.

Bandwidth and efficiency of a patch antenna is mainly decided by the substrate dielectric constant and its thickness. The thickness should be $0.003\lambda \leq h \leq 0.005\lambda$, where λ is a wavelength. Lesser the dielectric constant better is the bandwidth.

V. RESULTS OBTAINED

Sr. No.	Type of the Antenna	Substrate	Return Loss	VSWR	Bandwidth (GHz)
1	MSA with Circular Patch and 2 slots	Rogers 5880	-16.21	1.3559	12.46
		Polyester	-12dB	1.68	12.6
		Flannel	-16.56	1.33	12.53
2	MSA with Circular Patch and circular slots	Rogers 5880	-16.06	1.36	12.44
		Polyester	-15	1.48	13.78

VI. CONCLUSION

In this paper a design of MSA with Circular Patch and circular slots are implemented & simulated using Ansys HFSS simulation software. Effects of three different substrate materials have been studied. For all designs VSWR is less than 2 & S_{11} (dB) is less than -10dB.

Circular Patch and circular slots with polyester as a substrate material shows considerable improvement in bandwidth & is about 13.78 GHz. Hence we can conclude that to improve the bandwidth & to have results in the UWB range, Polyester is one of the best material to be used as a substrate for wearable applications.

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