Design and Analysis of triple Band Antenna for Wearable Application

D. Manoj *, M. Kasthuri Prasanth, M. Prasanth, P. Siva Gnanam
Department of Electronics and Communication Engineering, K. Ramakrishnan College of Technology, Trichy, Tamil Nadu, India

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Abstract
The achievement proposes the design of snipped shaped patch antenna for low spectrum of microwave frequencies. The patch has the jean cotton material substrate. The wearable antenna is recent proficiency in medical applications. The wearable antenna has less weight, small size and low cost. The proposed antenna resonates at 1.18 GHz, 2.45 GHz, 3.6 GHz, and 7.9 GHz to 9.94 GHz. Hence its applications fall on Industrial Scientific and Medical (ISM, 2.4 - 2.483 GHz) band, fixed mobile Wi-MAX (2 - 6 GHz) applications. Microstip patch antenna is used for the wearable antenna. Nowadays microstrip more advantage by using this antenna we have to examine the radiation characteristics, return loss and diagnosing patient's condition. These can be simulated by using Ansoft HFSS.

1. Introduction

WEARABLE antenna is an emerging technology that finds application in many fields that include military, telemedicine, sports, and tracking. Extensive research has been carried out for the usage of several fabrics and polymers as substrate materials for the above said applications, [1], **T**ELEMEDICINE is becoming increasingly utilized by health care providers due to the growing demand for remote monitoring of human vital signs. Telemedicine applications include but not limited to monitoring of seniors, recovery tracking of patients, monitoring the health parameters of a astronauts and athletes, and E-psychiatry, The health parameters that may be forwarded to remote stations via wireless transmission (off body mode) range from basal body temperature, heart rate, respiratory rate, blood pressure, to glucose levels and Electro Cardio Gram (ECG) waveforms [2]. Flexibility, nominal weight, resistant to shock and vibrations are the main advantages of these body wearable antennas. In spite of these advantages there are few drawbacks with these antennas. These antennas are having narrow bandwidth and sensitivity to environmental conditions such as humidity and temperature. Dielectric and conductor losses are more for thin patches resulting in degrading the antenna efficiency [2]. Wearable antenna is nothing but a microstrip patch antenna if textile is used as Substrate. The micro-strip patch antenna fabricated on different cotton garments which is wear by the patients was continuously monitored and diagnosed by the doctors in the hospitals remotely. The effect of the user's body on the antenna characteristics are maximum due to the antenna-body coupling and varies between different antennas separation distance and near-field coupling with tissue[3]. Micro strip antennas are to be constructed based on a dielectric material called 'Substrate'. The height of the substrate is another important factor. For a fixed resonant frequency, the design of a micro strip antenna is carried out based on dielectric constant of substrate material and its height. Materials which are used as substrates are FR4, Rogers, Duroid etc., it is possible to design and fabricate micro strip antenna with substrates such as cotton, jeans and leather. These antennas are known as wearable antennas or textile antennas. As these substrates are cloth material, user can wear this as clothes. It is easier to carry the wearable antenna [4]. There are many challenges in wireless monitoring of patients, including the coverage, reliability and quality of monitoring. One of the most difficult challenges in patient monitoring using wireless networks, especially for emergency messages, is the reliability of message delivery [6]. Many hospitals and nursing homes are deploying infrastructure-oriented wireless networks, such as wireless LANs, satellites, and cellular and GSM in telemedicine systems range from simple heart rate, blood pressure, body temperature to blood glucose levels and ECG wave forms. To overcome the coverage problems reliable low profile antenna is required for best performance [5].

Corresponding Author,
E-mail address: manojdeiva@gmail.com
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2. Antenna Design

To implement tripple band characteristics of micro strip antennas, various methods are being used. One of the methods is to provide two rectangular patches designed for specific frequency and then bridging the gap between them [1]. In this work, the same technique is used but wearable substrate is selected.

Various clothing materials such as cotton, jeans and leather can be used as substrates for a textile antenna. In this work, jeans cloth is used as substrate because of its strength and ruggedness. The dielectric constant of jeans cloth is found out as 1.6.

The normal design of rectangular patch as per the literature is used to design the rectangular patches. One resonant frequency is fixed at 2.4 GHz which is frequency of WLAN. The rectangular patches are designed for the above mentioned frequencies.

The proposed antenna has been developed from the basic rectangular patch antenna. Since miniaturization is the main need in many of the applications, certain structural modifications have been implemented in the snipped star patch. Hence a snipped star shape is preferred for patch.

The proposed wearable type microstrip rectangular patch antenna has been modeled using Ansoft HFSS.

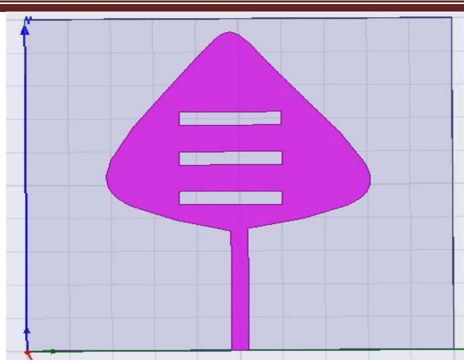

Fig: 1. Microstrip Snipped Patch Antenna

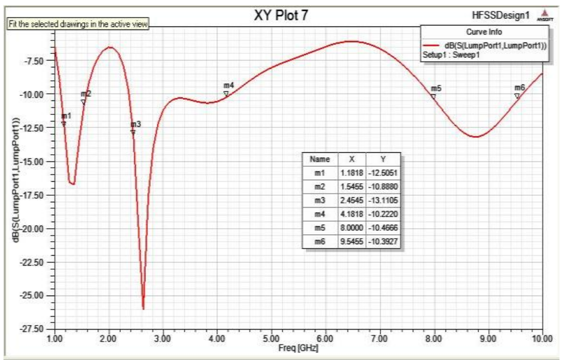

Fig: 2. Return Loss with Jeans Cotton as Substrate

HFSS is a commercial finite element method solver for EM structures. The software has a linear circuit simulator with integrated optimetrics for electrical network design. HFSS incorporates a powerful, automated solution process; hence we need to specify geometry, material properties and the desired output only. Using these, HFSS automatically generates an appropriate, efficient and accurate mesh analysis for the given geometry.[5]. The relative permittivity value of different cotton textiles used as dielectric material for wearable antenna is shown in table 1.

3. Dielectric Material

Table: 1. Materials & their dielectric values

Wash Cotton	1.45
Curtain Cotton	1.47
Polycotton	1.50
Jean Cotton	1.59

Table: 2. Performance Characteristics of Wearable Antennas under Investigation

Sl. No.	Parameter	Jeans cotton antenna (#1)		Polycot antenna (#2)		Polyester antenna (#3)	
		Simulated	Measured	Simulated	Measured	Simulated	Measured
01	Resonant frequency (GHz)	2.449	2.403	**2.46**	2.247	2.449	2.456
02	Impedance bandwidth (MHz) [-10dB points]	118.7 (4.84%)	170 (7.07%)	101 (4.1%)	106 (4.7%)	98 (4.0%)	100 (4.07%)
03	Gain in azimuth (dBi)	5.91	5.94	6.84	6.96	7.14	9.61
04	Gain in elevation (dBi)	5.91	5.77	6.84	6.91	7.14	9.61
05	3 dB beam-width in azimuth (deg)	79	59	79.0	60	72	65
06	3 dB beam-width in elevation (deg)	74	67	70.0	66	72	62

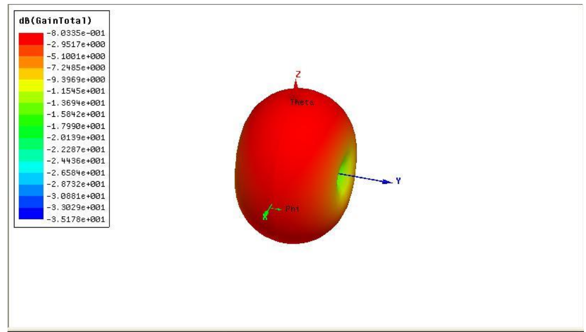

Fig: 3. Gain of Antenna

4. Conclusion

In this paper, a novel technique for the characterization of insulating fabric materials has been presented. The technique reported is one type of resonance method and utilizes the microstrip patch radiator concept. The salient feature of the microstrip antenna is its narrow bandwidth, and hence, even a small change in the value of the dielectric constant of the fabric substrate material produces a substantial shift in the resonant frequency of the antenna. The advantages of this method are as follows: 1) good accuracy; 2) simple sample preparation; and 3) fast measurement speed. Moreover, this is a nondestructive method. By performing this experiment, it is understood that the textile materials have generally low dielectric constant and are useful substrates for flexible antennas.

The following conclusions may be drawn from the extended part of this paper. The microstrip antenna is a suitable candidate for wearable applications, as it can be built using fabric substrate materials. In this paper, three antenna structures have been tested in order to get preliminary results on the performance of textile antennas. The antennas presented are very versatile, and it is easy to make them operate at various frequency bands. In addition, the well-known techniques of improving bandwidth and obtaining different polarizations, adopted for microstrip patch antennas, are readily suitable for wearable antennas too. It may be concluded that these textile microstrip patch antennas may eventually replace patch antennas on standard printed circuit board substrates for various applications. The textile antennas must be drapable, as the fabrics can take diverse shapes because of human body movements. It is under consideration to study these bending effects on the performance characteristics of wearable antennas. The authors' research activity is also under way to use electrotextiles [8] instead of copper conductive parts in order to further facilitate antennas' integration into clothing.

Reference

[1] S. D. Murali1, B. N. M. Muni1, Y. D. Varma1, S. V. S. K. Chaitanya1, Development of Wearable Antennas with Different Cotton Textiles, DST-FIST Sponsored ECE Department, KL University, Vaddeswaram, Guntur DT, AP, India, 4(7)(5), 2014, 08-14

[2] P. M. Kannan, V. Palanisamy, P. M. Kannan et al., Dual Band Rectangular Patch Wearable Antenna on Jeans Material, International Journal of Engineering and Technology, 3 (6), 2011-2012, 442-446

[3] S. C. Survase, V. V. Deshmukh, Electronics and Telecommunication Dept, Pune University, Design of Wearable Antenna for Telemedicine Application, International Journal of Engineering Science and Innovative Technology (IJESIT), 2(2), 2013
[4] Pichitpong Soontornpipit, Design of an Implantable Antenna Feasibility Study for Continuous Glucose Monitoring, 12(1), 2014
[5] S. Singh, S. Velan, M. Kanagasabai, Member, Aswathy K. Sarma, Chinnambeti Raviteja, M. Gulam Nabi Alsath, Polygon-Shaped Slotted Dual-Band Antenna for Wearable Applications Esther Florence, 13, 2014
[6] Haider R. Raad, Ayman I. Abbosh, Hussain M. Al-Rizzo, Daniel G. Rucker, Flexible and Compact AMC Based Antenna for Telemedicine Applications, 61(2), 2013
[7] Zhi Hao Jiang, Donovan E. Brocker, Peter E. Sieber, Douglas H. Werner, A Compact, Low-Profile Metasurface-Enabled Antenna for Wearable Medical Body-Area Network Devices, 62(8), 2014
[8] S. Sankaralingam, Bhaskar Gupta, Determination of Dielectric Constant of Fabric Materials and Their Use as Substrates for Design and Development of Antennas for Wearable Applications, 59(12), 2010
[9] S. Singh, M. Kanagasabai, Aswathy K. Sarma, C. Raviteja, R. Sivasamy, J. Kizhekke Pakkathillam, Dual-Band EBG Integrated Monopole Antenna Deploying Fractal Geometry for Wearable Applications Sangeetha Velan, Esther Florence, 14, 2015