DUAL BAND MICROSTRIP FABRIC ANTENNAS FOR MEDICAL APPLICATIONS

S. Daya Murali[1], V. Phani Sasank[1], O. Manoj Kumar[1], K. Sravan Kumar[1] and Shaik. Fayaz[1]

[1] DST-FIST Sponsored ECE Department, KL University, Vaddeswaram, Guntur DT, AP, India

Abstract

Recent evolution in medical applications is remote health monitoring through antennas. So in this paper we have designed a Microstrip Fabric Antenna used for this application. In this work we have observed how radiation characteristics for health monitoring purpose are varied when different fabrics are used as a substrate for fabric antenna. Here we have used Nylon and Polyester as dielectric materials. This antenna was energised by using coaxial feed. The proposed antenna was designed by using a software HFSS.

Keywords: Textile substrate, Wide-Band, Return Loss, Gain.

1. Introduction:

The development of wearable technology brought a new evolution in Medical, Military, Telemedicine, Radars and Space applications [2]. In this paper we have designed a flexible, low weight, planar structure, inexpensive, less maintenance Fabric antenna used for medical applications especially for remote health monitoring purpose. Fabric antenna integrates cloth in to the communication system in between doctor and patient. 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]. Fabric antenna is a three layered structure which consists of patch, dielectric material as substrate and ground plane [1].

Patch: There are different types of patch are available. But generally for most of the medical applications rectangular patch is used because of ease of fabrication and for easy analysis [1].

Fabrics as Dielectric Material: There are two types of textiles are there conductive and non-conductive textiles. Radiation characteristics and electromagnetic properties differ in between these textiles. Generally for medical applications non-conductive textiles are used. The bandwidth and efficiency greatly depends on the dielectric value and thickness of the textile substrate (dielectric material). Generally fabric materials present a very low relative permittivity that decreases the surface wave loses and improves the impedance bandwidth of the antenna [5].

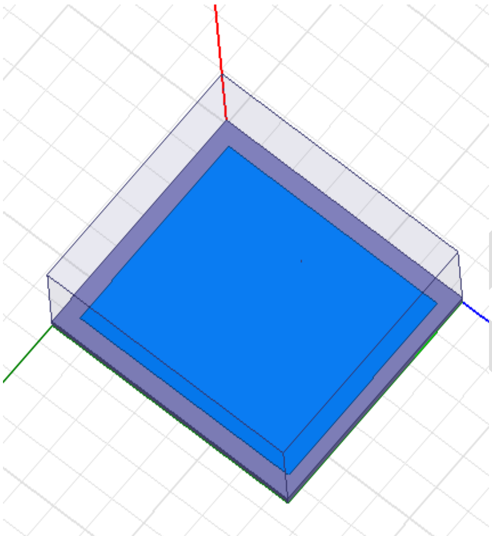
Here we have chosen Polyester with $\boldsymbol{\varepsilon_r}$= 3.2 and Nylon with $\boldsymbol{\varepsilon_r}$ = 4 as a dielectric materials for designing fabric antenna. Textiles are compressible, porous and anisotropic whose thickness and density changes with lowering pressures. The electromagnetic properties of the fabric antennas are varied with the change in temperature and surrounding conditions [5].

Ground Plane:
The ground plane not only for mechanical support of the antenna but also for shielding the body tissues from the radiation effect. The directivity and pattern has less effected by ground plane [2].

Coaxial Feed: Even though there are four different types of feedings are there for these microstrip patch antennas. Here in this work we have used coaxial feed for energising the fabric antenna in order to reduce spurious radiations and for ease of fabrication [2]. Care should be taken while connecting feed to antenna because if there is no proper impedance match then loading may takes place which has a serious effect on radiation characteristics [4].

2. Design Model:

The proposed Microstrip Fabric Antenna designed using HFSS is shown in the figure. 1.



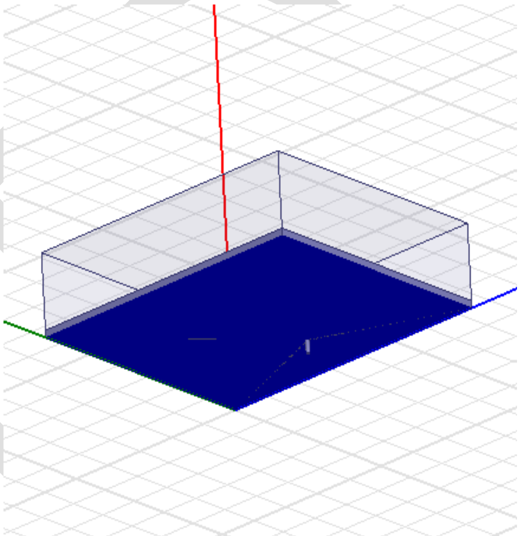


Fig. 1 Microstrip Fabric Antenna **Fig. 2** Microstrip Fabric Antenna with co-axial feed

HFSS is a commercial finite element method solver for EM structures. It provides a linear circuit simulator which includes optimetrics for network of electrical design. HFSS includes a powerful, automated solution scheme; hence we have to specify geometry, material properties and the desired output only. Using these inputs, HFSS automatically creates an appropriate, efficient and accurate mesh analysis for the given geometry [7].

3. Results and Discussions:

Return Loss:

Dual-band fabric antenna means it radiates power at two different frequencies. As shown in the figures 3 & 4 the proposed fabric antenna with polyester and nylon as dielectric material was resonating at two different frequencies

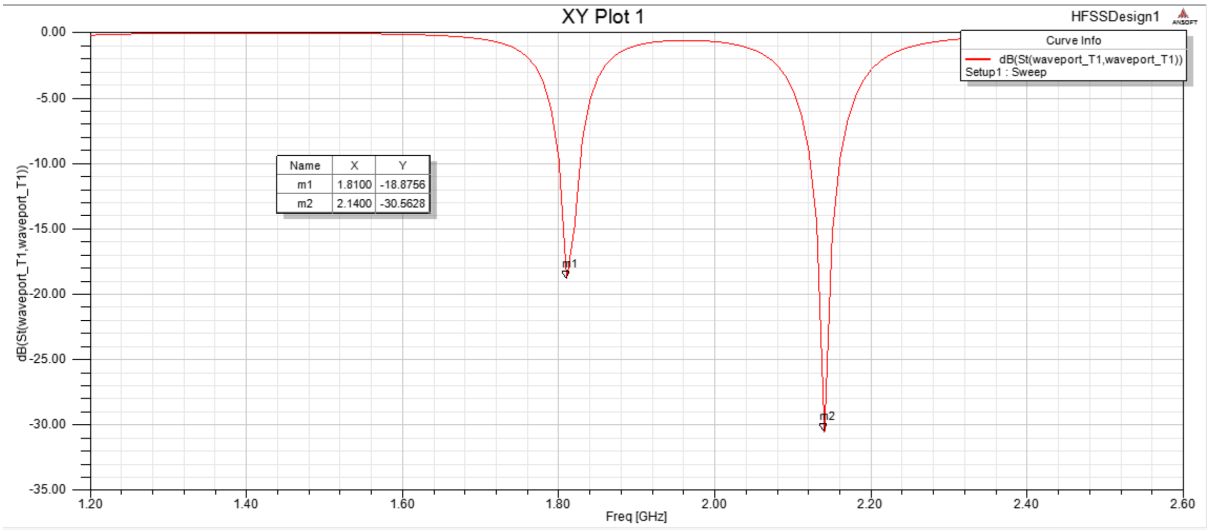


Fig. 3 Return loss with polyester substrate

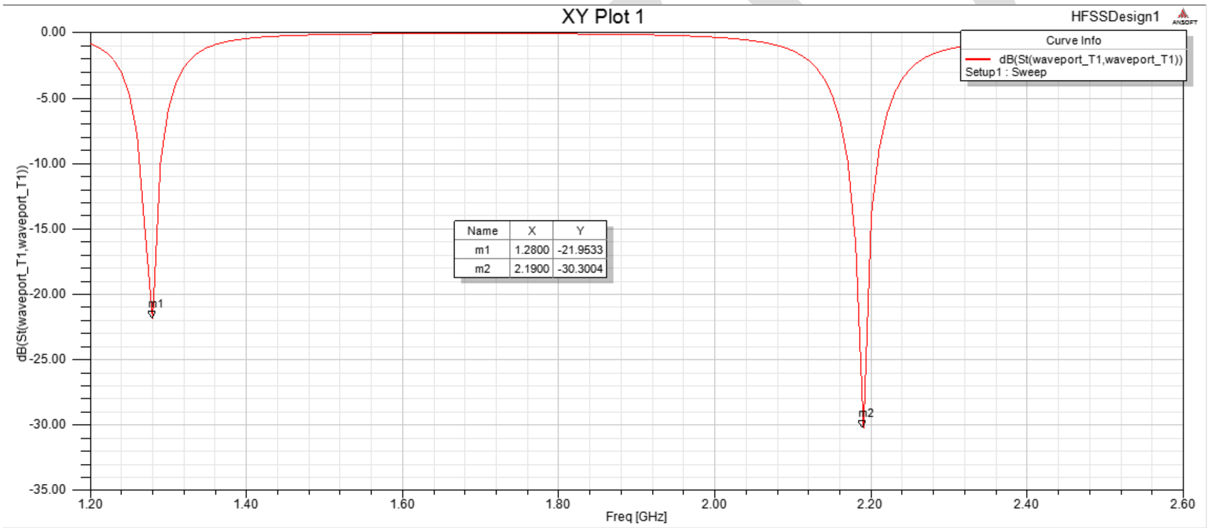


Fig.4 Return loss nylon substrate

Dielectric	ε_r	**Return loss**		**Bandwidth**
Polyester	3.2	f1=-18.87	f2=-30.56	11.69
Nylon	4	f1=-21.95	f2=-30.30	8.35

Table.1 comparison between dielectric and bandwidth

The operational disadvantage with microstrip antennas is having narrow frequency bandwidth. So it is proper to choose wide bandwidth antenna for any application [2]. From the above results nylon which is used as dielectric material for fabricating wearable antenna has wide bandwidth when compared to polyester material even though it is having dual band operation.

Radiation Characteristics:

Radiation Characteristics defines the relative field strength of the antenna from different directions. It includes both transmission as well as receiving properties.

2D- Radiation Pattern:

2d-radiation pattern is nothing but the graphical representation of antenna pattern in two dimensions of the radiation of the antenna as a function of angular direction.

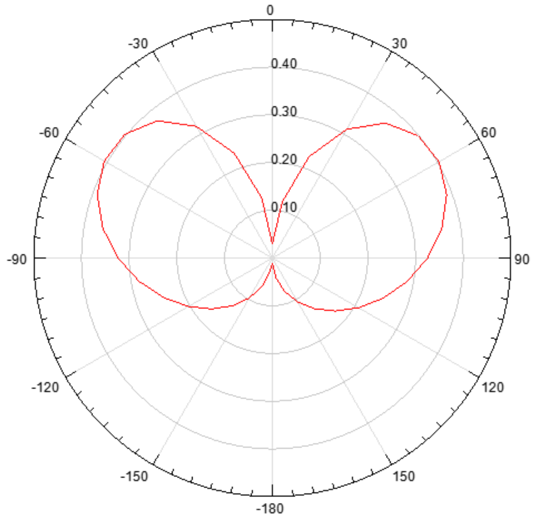


Fig.5 2d pattern with polyester

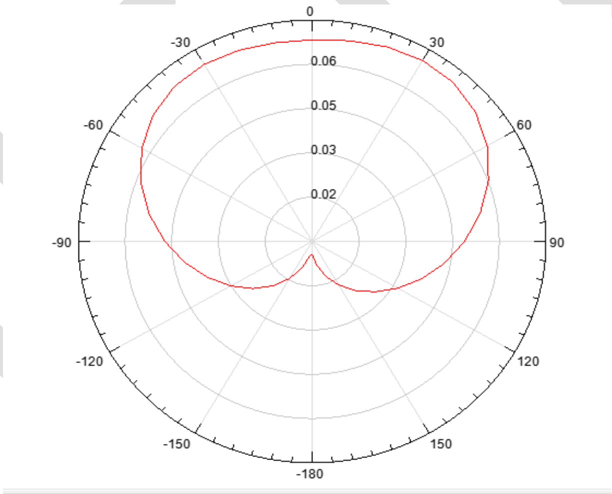


Fig. 6 2d pattern with nylon

Polarization is the propagation of the electric field vector. This is very important since humans are mobile is nature. So it is very essential to cover the entire body in 360 degrees to have perfect radiation characteristics for monitoring patient condition [6]. This is possible if the designed fabric antenna was producing circular polarisation.

3D- Radiation Pattern:

3d-radiation pattern is nothing but the graphical representation of antenna pattern in three dimensions of the radiation of the antenna as a function of angular direction. The radiation of the antenna is usually perpendicular to the direction of planar structure of the antenna.

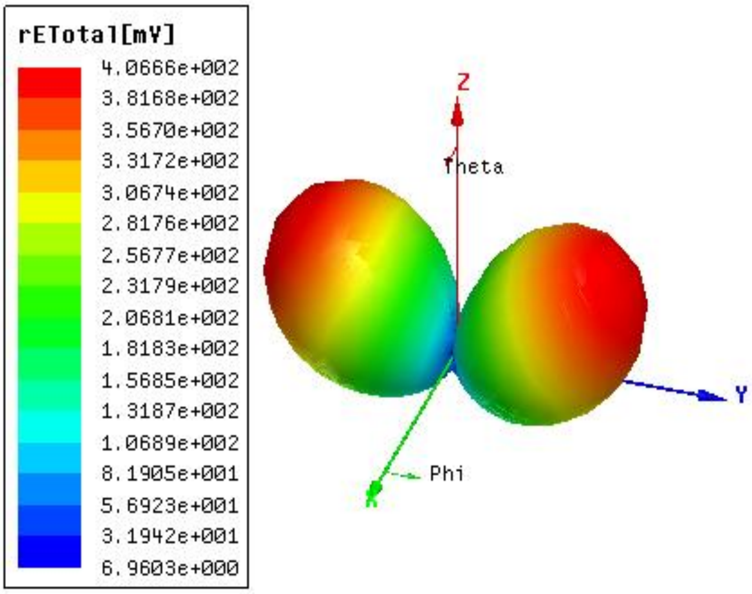


Fig.7 3d pattern with polyester

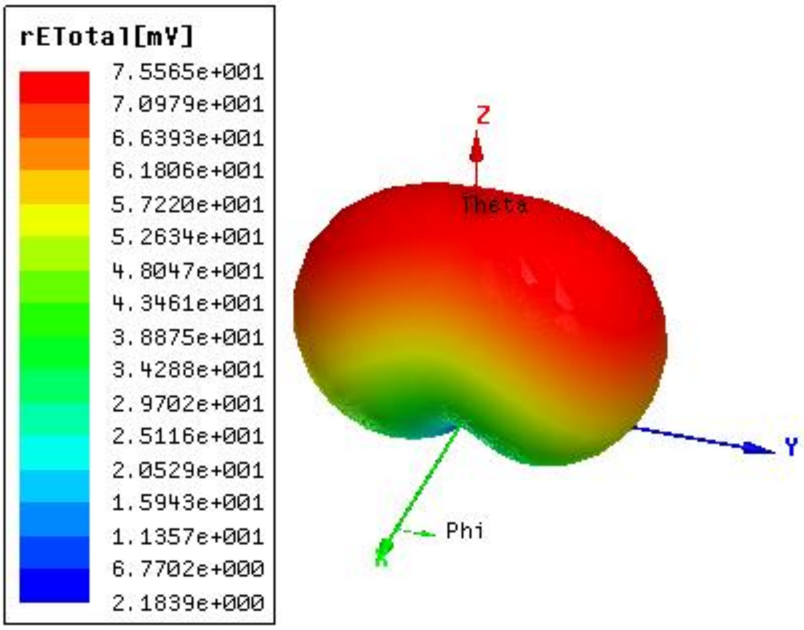


Fig. 8 3d pattern with nylon

Dielectric Material	ε_r	Gain
Polyester	3.2	4.0
Nylon	4	7.5

Table.2 comparison between ε_r and gain

Gain of the antenna is the ratio of the maximum radiation in a given direction to that of a reference antenna for equal input power and measured in decibels. It depends on the size, shape, frequency of operation and antenna configuration. It is also very important parameter because it measures the efficiency of the antenna. Generally for microstrip patch antennas the gain is very low. From the above results Nylon is having a gain of 7.5dB whereas Polyester is having a gain of 4.0dB.

E-Field Characteristics:

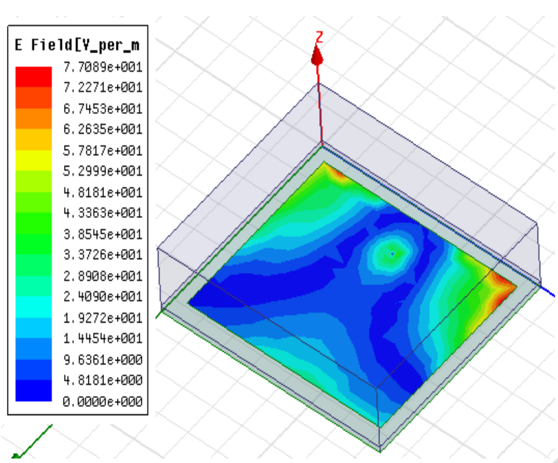


Fig.9 E- Field with Polyester

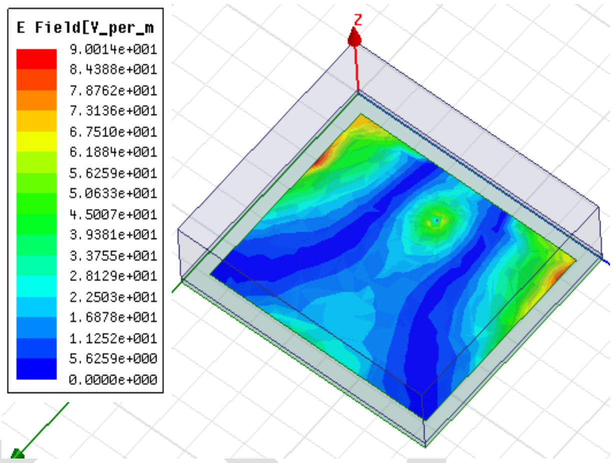


Fig.10 E-Field with Nylon

H-Field Characteristics:

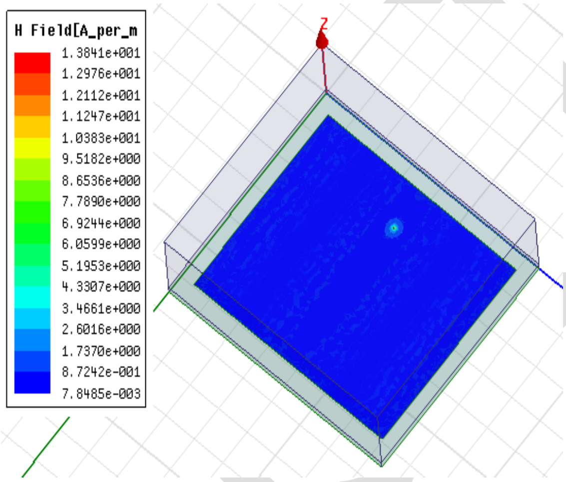


Fig.10 H- Field with Polyester

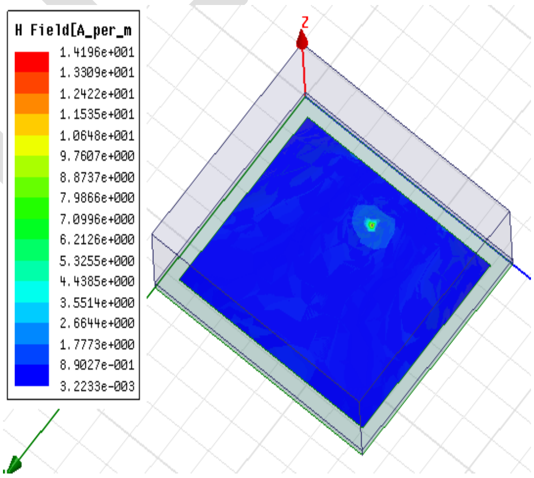


Fig.11 H-Field with Nylon

4. Conclusion:

From the above results achieved by Rectangular Microstrip Fabric Antenna there is a trade of between the use of Polyester and Nylon as dielectric material. For wide band applications polyester is more suitable whereas for high gain applications nylon as suitable. Especially for medical applications Polyester is most applicable because it achieves nearly circular polarization which has a greater advantage than linear polarization for monitoring patient condition appropriately.

 Issue 4, Vol.4 (June-July 2014)
ISSN 2249-6149

5. Future Work:

This work can be further extended to select a conductive textile as dielectric material which achieves multiband frequency of operation with high gain and wide bandwidth.

6. Acknowledgment:

Authors like to express their deep gratitude towards the department of ECE and the management of KL University for their support and encouragement during this work.

7. References:

[1] C.A.Balanis, “Antenna Theory, Analysis and Design,”Johnwiely&sons, New York, 1997.

[2] Randy Bancroft,”Microstrip and Printed Antenna Design”, Prentice Hall of India, New Delhi, 2006.

[3] S. Daya Murali,”Triple Band Microstrip Rectangular Patch Antenna Mounted on Silk Substrate for Wearable Applications”, IJSR, Vol. 3, Issue.6, pp.8-11.

[4]S .Daya Murali,”Development of Wearable Antennas with Different CottonTextiles”, IJERA, Vol. 4, Issue. 7, Version.5, pp.8-14.

[5] Rita Salvado, Caroline Loss, “Textile Materials for the Design of Wearable Antennas”,Sensors.2012,12,15841-15857;doi:10.3390/s121115841.

[6] Mai A. R. Osman, M.K.A. Rahim,”Design, Implementation and Performance of Ultra-Wideband Textile Antenna”, Progress in Electromagnetics Research B, Vol. 27, 307-325, 2011.

[7] www.HFSS.com

Author’s Profile:

S. Daya Murali was born in India, A.P, in 1994. He is pursuing his B. Tech in Electronics and Communication Engineering from K L University. He completed his B.A in Hindi. He is getting his specialization in VLSI. He is member of IETE. He published 2 papers in wearable antennas. His interest in research includes VLSI design and Microstrip patch antennas. [https://orcid.org/0000-0003-1631-5288].

V. Phani Sasank was born in India, A.P, in 1994. He is pursuing his B. Tech in Electronics and Communication Engineering from K L University. He is member of IETE. He published a paper in wearable antennas. His interest in research includes VLSI design and Microstrip patch antennas and optical communication.[https://orcid.org/0000- 0003-4078-8624].

Manoj Kumar. Olla was born in India, A.P, in 1993. He is pursuing his B. Tech in Electronics and Communication Engineering from K L University. He is member of IETE. He is getting his specialization in VLSI design. His interests in Microstrip patch antennas.

Sravan Kumar. Konijeti was born in India, A.P, in 1993. He is pursuing his B. Tech in Electronics and Communication Engineering from K L University. He is member of IETE. He is getting specialization in VLSI design. His interested areas include Microstrip patch antennas and Information theory and coding.

Shaik. Fayaz was born in India, A.P, in 1994. He is pursuing his B. Tech in Electronics and Communication Engineering from K L University. He is member of IETE. He is getting specialization in VLSI design. His Interested areas include Microstrip patch antennas and optical communication.