International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 04, April-2015

Comparative Analysis of Fabric Antenna with Conventional Antenna at 2.4GHz

Trivedi Darshit R.
M. Tech Student
C. U. Shah University, Wadhwan, Gujarat

Dr. Vedvyas J. Dwivedi
Pro. Vice Chancellor
C. U. Shah University, Wadhwan, Gujarat

***Abstract*- This paper gives the design flow of fabric antenna. Conventional microstrip antennas at 2.4GHz frequency are designed with the substrate FR-4 and RT/duroid 5880. Fabric substrate 3mm fleece material is used for the simulation and analysis process of fabric antenna. For the fabric antenna, conductive material nylon based silver coated cloth(zell) is used as the ground and the patch of antenna. Normal copper is used for FR-4 and RT/duroid 5880 substrate antenna. Simulation is done based on the properties of material.**

Keywords— Fabric antenna, Conductive fabric (zell), micro strip antenna.

I. INTRODUCTION

This effort helps to prepare for possible future applications of multiple wearable antennas such as GPS antennas and other wearable applications oriented antennas. Use of wearable antennas removes the antenna from the receiver casing, which reduces the size and weight of the receiver unit, and also allows larger antennas to be used. On-body antenna is very important element to be used for various future IEEE802.15 wireless standard applications. [4] In this paper, the design of a nearly square micro strip antenna using fleece as a substrate and available conducting fabric by zell as a conductive patch and ground. With the use of available parameters by manufacturer, properties of both materials are calculated and fabric antenna is simulated in CST microwave studio software. Other two antennas are also simulated to compare the results with fabric antenna.

A. *Fabric Characterization:*

First step for any fabric antenna is to define fabric properties. In fabric antenna it is necessary to achieve data for dielectric material and conductive textile material.

1. Conductive Fabric**:**

Conductive metalized nylon fabric (Zell) is used as the patch and ground of micro strip antenna. 3 metalized layer plated nylon fabric Tin/ Nickel over silver.

Table 1: Conductive cloth properties (Datasheet)

Surface resistivity	0.02Ohm/sq
Abrasion resistance	5,00,000 Cycles
Temperature Range	-30˚C to 90˚C
Total thickness	0.1mm

Now,

$$Rs = \frac{1}{\sigma t}$$

Rs= Surface Resistivity of the conductive fabric
t= Thickness of the cloth
Obtained conductivity: $5 \times 10^5 S/m$

Workflow**:**

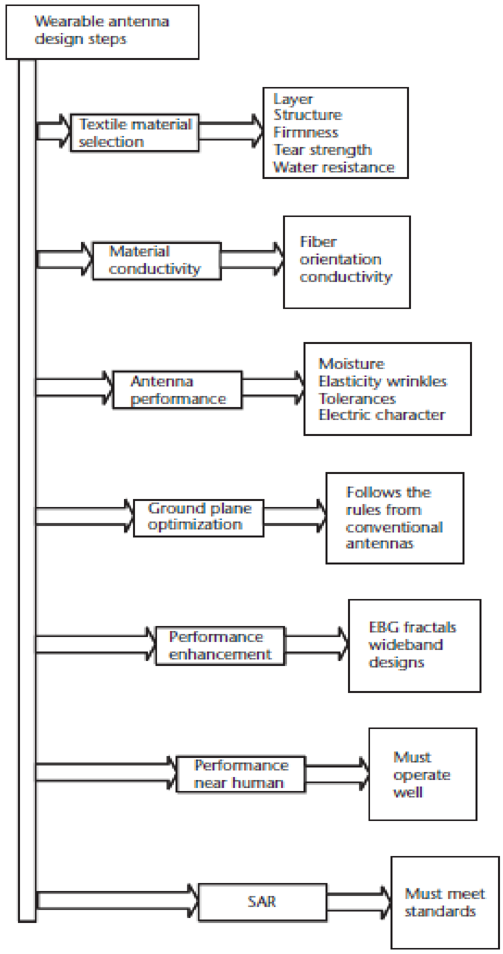

Fig-1 Design Flow[8]

2. Dielectric Fabric:

For the dielectric part of the antenna, a 3 mm thick fleece fabric is used. A good characterization of this material, namely an accurate knowledge of the permittivity and loss tangent, is very important since the behavior of a micro strip antenna is strongly dependent on these parameters. Here data is taken from standard IEEE papers. Fabric characterization methods will be discussed later on.

Table 2: Dielectric Property [5]

Material	$\in_r$	$\tan\delta$	f_r (GHz)
Fleece	1.2	0.004	2.4

II. Design and Model of Microstrip Antenna

As shown in Figure 2, is generally a single-layer design and consists of a metallic patch situated on one side of a thin, non conducting, substrate panel with a metallic ground plane situated on the other side of the panel. The metallic patch is normally made of thin copper foil or is copper-foil plated with a corrosion resistive metal, such as gold, tin, or nickel. Each patch can be designed with a variety of shapes, with the most popular shapes being rectangular or circular. In fabric antenna, traditional design of microstrip antenna is used but the substrate and conductive patch is replaced by textile material.

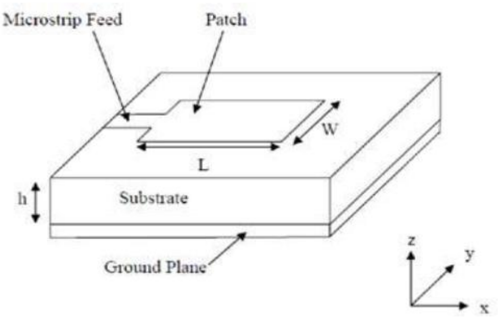

Fig-2 Microstrip antenna [6]

$\in_{reff}$ = Effective dielectric constant

$\in_r$ = Dielectric constant of substrate

h= Height of substrate
W=Width of the patch
L=Length of the patch
Wg=Width of the ground
Lg=Length of the ground

Table 3: Antenna dimensions (Dimensions in mm)

Substrate	Lp	Wp	Lg	Wg	h
FR-4	28.5	37	47.2	56.45	1.59
RT/duroid 5880	39.5	49	50	64	1.6
Fleece	49	51	76	70	3

III. SIMULATION

Simulation process is performed in CST microwave studio software and Optimization through iterations. Results for Gain, VSWR, S-parameter and efficiency are given in this paper.

A. *Gain (3D):* Here in Figure(a),(b) and (c), Gain of three different microstrip antenna having substrate FR-4, RT-duroid 5880 and Fleece fabric is given.

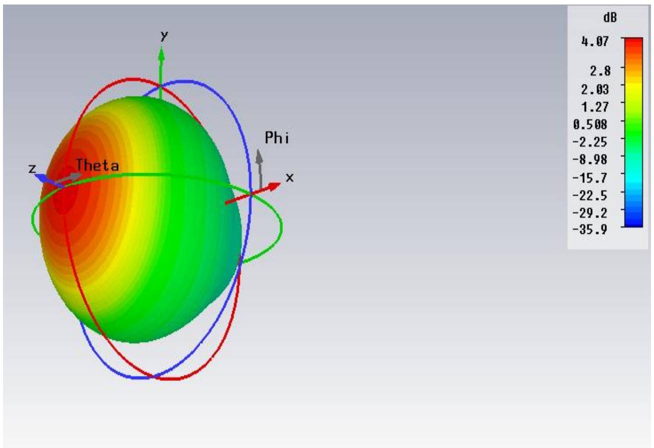

Figure (a): Gain (FR-4)

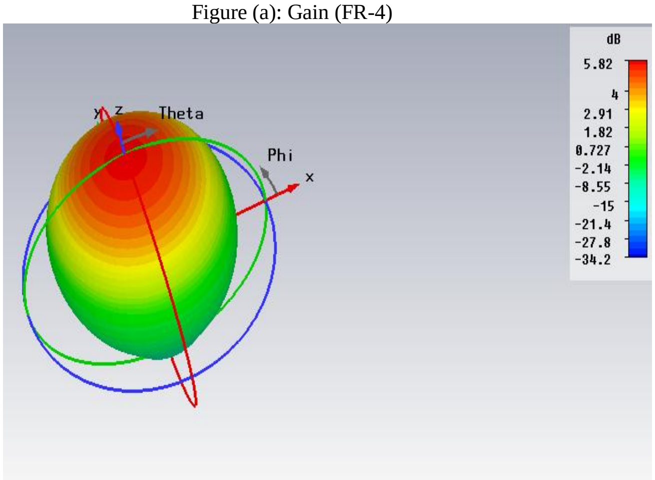

Figure (b): Gain (RT/ duroid 5880)

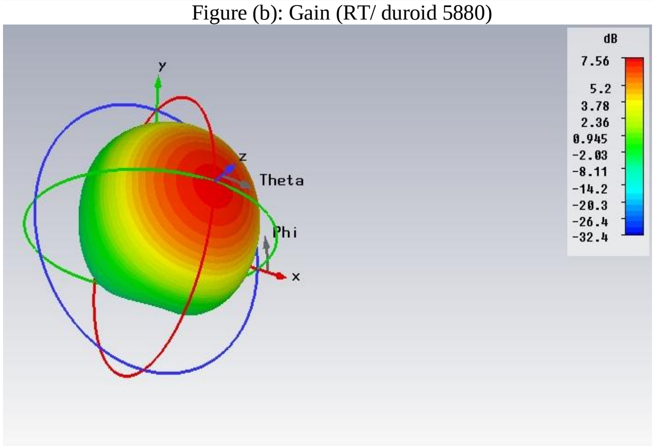

Figure (c): Gain (Fleece)

B. Gain polar plot: For the three different substrate polar plot and comparison of gain is given with this figure(d).

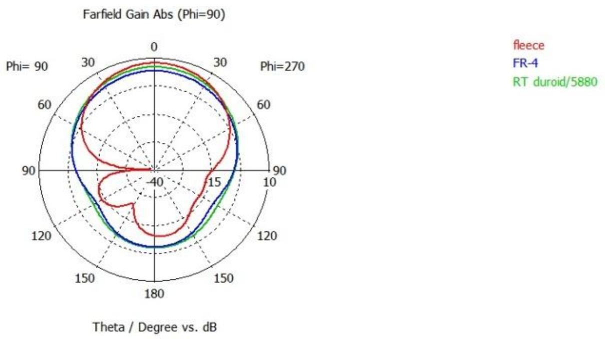

Figure (d): Polar plot for FR-4, RT-duroid 5880 and Fleece

C. S-parameter: S-parameter comparison for three of the substrate is given in figure(e).

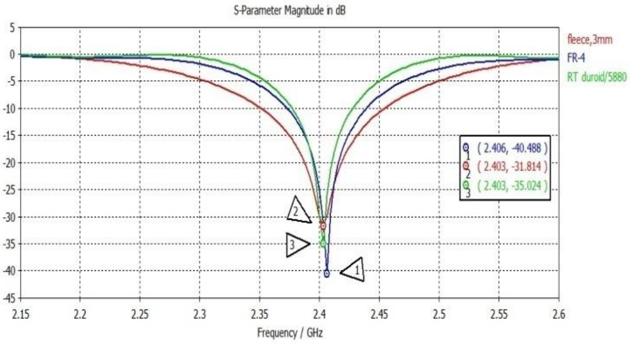

Figure (e): S1,1 for FR-4, RT-duroid 5880 and Fleece

D. VSWR:

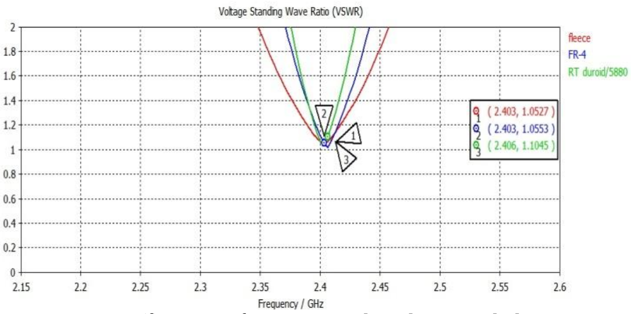

Figure (f): VSWR for FR-4, RT-duroid 5880 and Fleece

E. Efficiency:

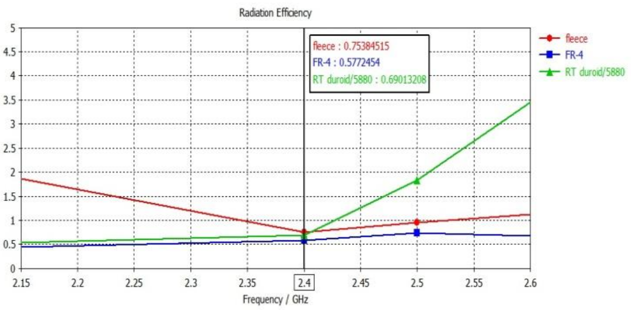

Figure (g): Polar plot for FR-4, RT-duroid 5880 and Fleece

IV. COMPARISON

Comparison of Gain, S11 and VSWR is given in Table 4. With different substrates which are available in the market, we can achieve best results according to our design and application for wearable circuits or wearable embedded systems. Here fleece is used as the substrate but we can also use Felt, denim and other wearable textile material as a substrate.

Table 4: Results comparison

Material	Gain	S11	VSWR
FR-4	4.07dB	-40.48dB	1.05
RT duroid	5.82dB	-35.02dB	1.10
Fleece	7.56dB	-31.81dB	1.05

V. CONCLUSION

Fabric antennas are efficient. In comparison with conventional antennas, there are lots of advantages provided by fabric antennas. However the design process and real implementation of fabric antennas is tough and complex. But from the simulation we can have idea about the innovative concept of fabric antennas and comparison of results with conventional antennas.

ACKNOWLEDGMENT

First I would like to thank Dr. Vedvyas J. Dwivedi and the entire department of Electronics and Communication Engineering at C.U.Shah University, Wadhwan which prepared me for this research.

I would like to personally thank Dr. Vedvyas J. Dwivedi, for giving me the opportunity to work on this very demanding and very rewarding research work and for his devotion to this research.

REFERENCES

[1] T.F. Kennedy, P.W. Fink, A.W. Chu, G.F. Studor , 'Potential Space Applications For Body-Centric Wireless and E-Textile Antennas', NASA Johnson Space Center, Houston, TX, USA.(Paper style)

[2] Prof. Kiran Rathod , PranjalGupta , Bhavik Janjmera , Suchit Patel , Jignesh Bhagat ," Circular microstrip textile antenna, " International Journal of Students Research in Technology & Management Vol 1(2), April 2013, pg 118-124.(Journal article type)

[3] S. Sankaralingam and B. Gupta, " Development of textile antennas for body wearable applications and investigation on their performance under bent conditions.," Progress In Electromagnetics Research B, Vol. 22, 53–71, 2010. (Journal article type)

[4] H. A. Rahim , F. Malek , I. Adam , S. Ahmad , N. B. Hashim , and P. S. Hall , "Design and Simulation of a Wearable Textile Monopole Antenna for Body Centric Wireless Communications."(article type single column paper)

[5] Aris Tsolis, William G. Whittow, Antonis A. Alexandridis and J. (Yiannis) C. Vardaxoglou , "Embroidery and Related Manufacturing Techniques for Wearable Antennas: Challenges and Opportunities.2013-2014"(Open access electronics).

[6] B.Sai Sandeep, S.Sreenath Kashyap, "Design and simulation of microstrip patch array antenna for wireless communication at 2.4 GHz".(Paper)

[7] Balanis, C. A., "Antenna Theory Analysis and Design"(Book)

[8] Peter S. Hall, Yang Hao, "Antennas and Propagation for body centric wireless communications" (Book)

[9] Data available at www.cst.com.(Internet)