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Triple Band Micro-strip Rectangular Patch Antenna Mounted on Silk Substrate for Wearable Applications

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Abstract: ***In present trends miniaturization of antennas place a vital role in medical applications, so we have designed a microstrip patch antenna used for wearable applications. In this paper we have simulated the results of return loss, 2-D and 3-D radiation pattern of microstrip rectangular patch antenna for wearable applications. These are performed by using ANSOFT HFSS. Here we used silk as the dielectric substrate having relative permittivity of 4.5.The antenna is fed with co-axial feed.***

Keywords: Co-axial feed, Return loss, Rectangular patch antenna, Silk substrate, Wideband**.**

1. Introduction

As miniaturization of antennas is required in wearable applications and to operate in wide range of frequencies micro-strip antennas have major role. Rectangular patch are the most common micro-strip patch antennas because of ease of analysis and fabrication, and their attractive radiation characteristics especially low cross polarization radiation [1]. Major operational disadvantages of micro-strip antennas are their low efficiency and very narrow frequency bandwidth. So by increasing the height of the substrate that can be used to extend the efficiency but however as the height increases surface waves are introduced. As the radiation characteristics depend on the substrate it plays a vital role in choosing a dielectric material with good electrical properties [2-3]. Even though there are various feeding techniques here coaxial feeding is used to have low spurious radiations and easy to fabricate [1].

Generally for micro-strip antennas the substrate dielectric constants are usually in the range of $2.2 \leq \varepsilon_r \leq 12$. In this paper we have designed a rectangular patch antenna mounted on silk substrate which is having a relative permittivity of 4.5. Silk is a protein polymer where different amino acids control the physical properties. Conductivity of the silk depends upon the humidity, exposure to polar solvents. It is resistant to mineral acids. The conductivity increases exponentially with relative humidity and/or solvent and incremental increase after iodine doping [6].

A wearable antenna is meant to be a part of clothing used for communication purposes, which includes tracking, navigation, fire fighters, paramedics and athletes for the purpose of monitoring. The micro-strip patch antenna fabricated on silk garments which is wear by the patients was continuously monitored and diagnosed by the doctors in the hospitals. The effect of the user's body on the antenna characteristics are largely due to the antenna-body coupling and will vary between different antennas separation distance and near-field coupling with tissue.

HFSS is a commercial finite element method solver for electromagnetic structures. The software includes a linear circuit simulator with integrated optimetrics for input and matching network design. HFSS solver incorporates a powerful, automated solution process, so we need only to specify geometry, material properties and the desired output. From there, HFSS automatically generates an appropriate, efficient and accurate mesh for solving the problem using the selected solution technology [5].

2. Design Specifications

The designed parameters of rectangular micro-strip patch antenna are selected in such a way that length of the patch is 65.80mm, width of the patch is 55.41mm, length of the dielectric is 74.40mm, width of the dielectric is 65.01mm, height of the dielectric is 1.60mm and the relative permittivity of the dielectric i.e., silk is 4.5, inner and outer radius of coaxial feed is 0.13&0.47, position is (16.446,37.7,0) as shown in the figures 1&2. The proposed micro-strip rectangular patch antenna has been modeled using ANSOFT HFSS.

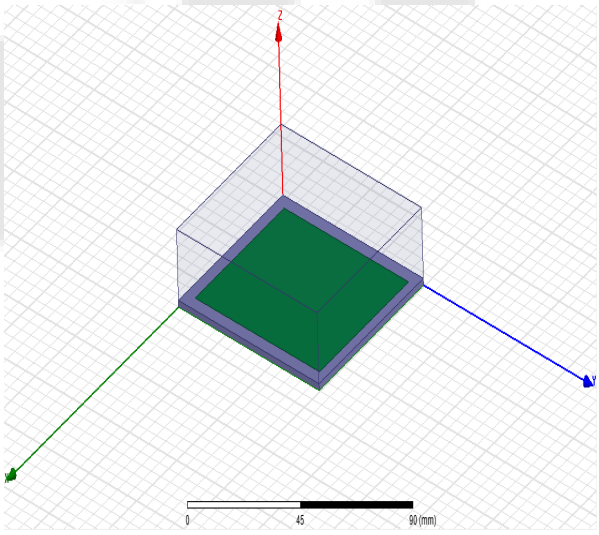


Figure 1: Microstrip Rectangular Patch Antenna

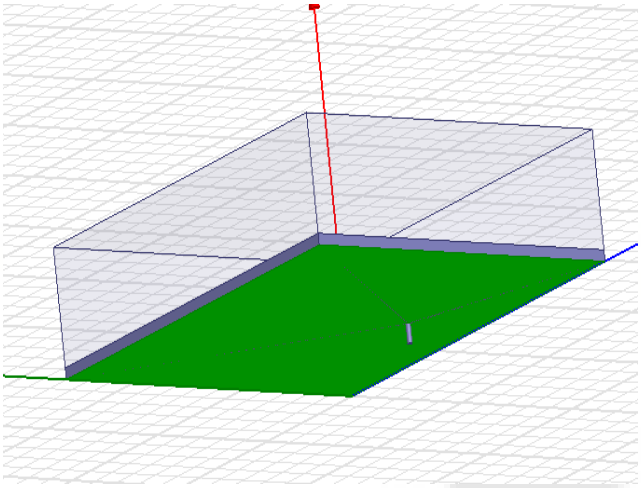


Figure 2: Patch Antenna with coaxial feed

Name	Theta	Ang	Mag
m1	60.0000	60.0000	0.4674
m2	-50.0000	-50.0000	0.4945

Figure 3: 2D Directivity Pattern

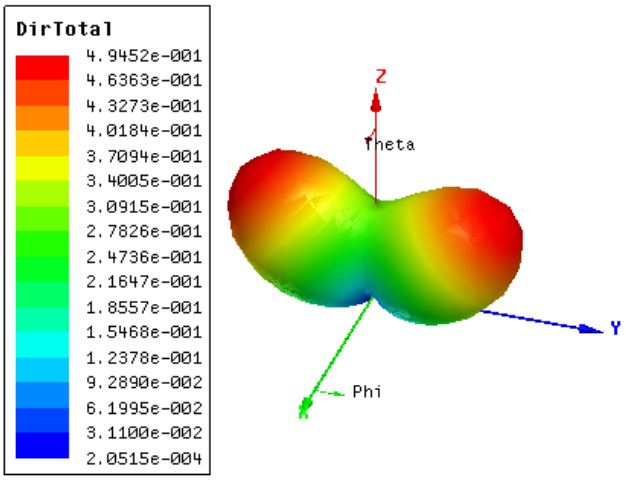
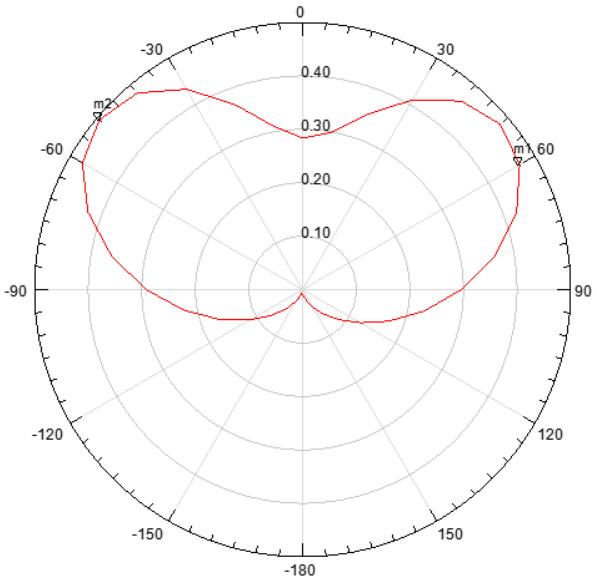


Figure 4: 3D Directivity Pattern

3. Results and Discussions

Generally for micro-strip patch antennas the minimum gain should be 5db.Here for our design we have achieved 8db which is best suitable for wide band applications as shown in the figure 3.



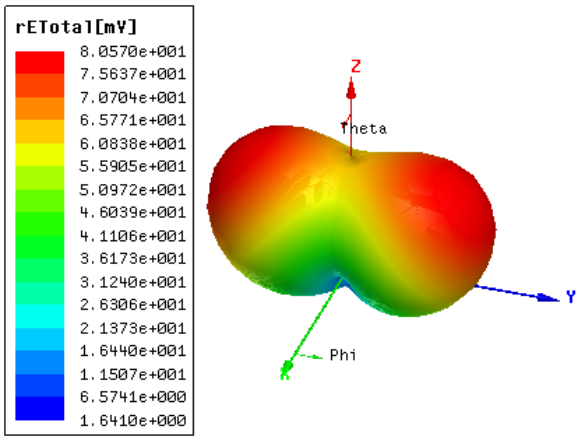


Figure 5: 3D Radiation Pattern

Return Loss:

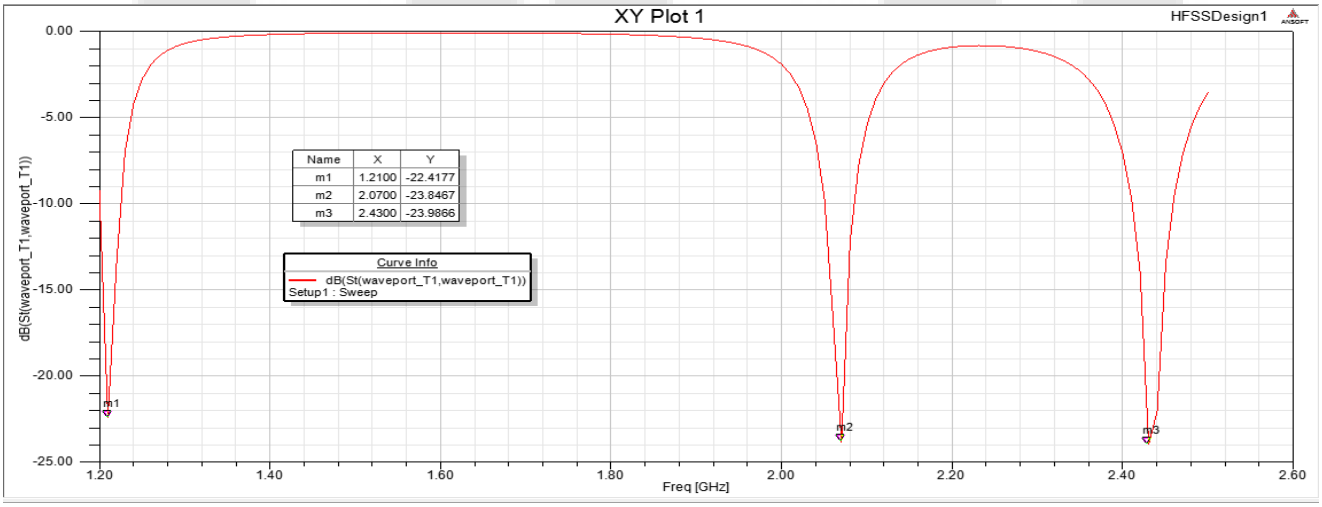


Figure 6: Return Loss

The simulated results of return loss are shown in the figure 6. For efficient working of antenna the return loss should be minimum greater than -10db. The curve has deep and wide dips at frequencies 1.2, 2.0 and 2.4 GHz. The return loss obtained at these frequencies is -22.41, -23.84 and -23.98 respectively.

Field Characteristics:

The E field and H field patterns are shown in the figures 7&8 respectively.

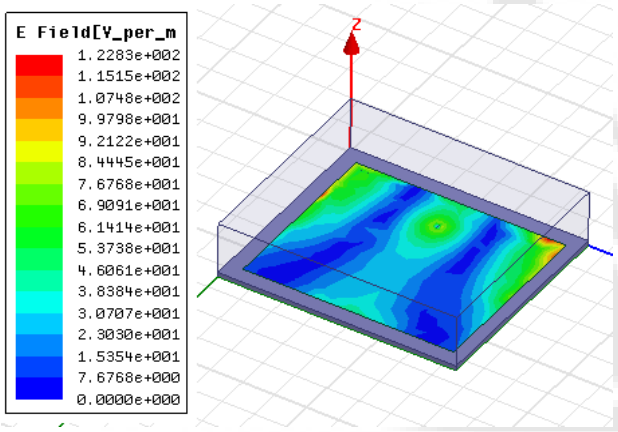


Figure 7: E-Field Pattern

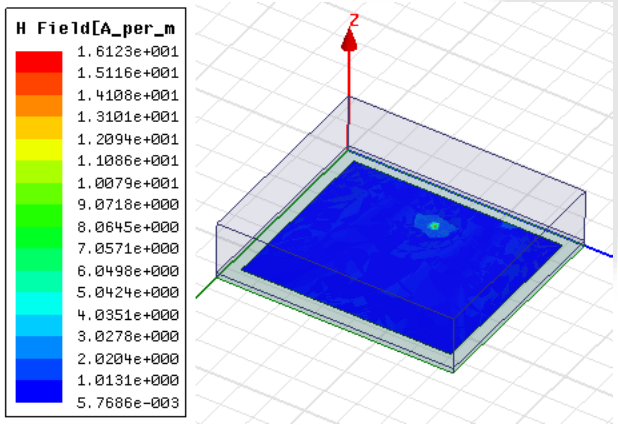


Figure 8: H-Field Pattern

4. Conclusion

Micro-strip rectangular patch antenna has been designed and investigated with silk as substrate resonates at three different frequencies (1.2, 2.0, 2.4) GHz with efficient gain of 8.05 db. The results are giving moral support to design Micro-strip patch antennas used for wide band of operation in wearable applications. Further good the circular polarization can be obtained by changing the feed position and shape of the patch.

5. Future Scope

This idea can be extended with the help of wireless sensor networks for different cloth materials which have different dielectric constant particularly in medical applications for continuous monitoring of patient`s condition.

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