Wearable Textile Antenna For Gps Application

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Abstract: We propose a GPS wearable textile Antenna. The antenna has a rectangular shape with the size of the 88x88x1.6 mm3. The resonating frequency band of the proposed antennas are 1.575 GHz. The entire structure is fabricated on a cotton substrate which make use of the micro strip feed line for feeding and the structure is analyzed with the help of HFSS electromagnetic simulator. The structure is validated with analysis of return loss, radiation pattern, Smith Chart and Gain. The optimum dimensions of the structure are selected with the help of parametric analysis is conducted on three parameters such as circular patch radius, feed width and the ground size. The proposed structure has good matching of impedance at 1.575 GHz resonating bands.

Index Terms: GPS, RFID, Cotton substrate, Copper patch, Circular Patch, Textile antenna, Wearable antenna

1. INTRODUCTION

Global Positioning System, Zigbee and Radio Frequency Identification Detection are some of the technologies used to monitor the movement of people and also helps us to ensure the safety. Out of which the GPS is widely used because of its wide coverage. The antenna used for this purpose usually have a textile material as its substrate. Such antennas are called as wearable textile antenna which has light weight and low cost [1]. For all the military and civil application, the GPS technology plays a vital role.it can able to detect the location of a person at the same time it can find the direction, speed and distance. The entire GPS system is based on the navigational signal at 1.575 GHz from MEO satellites [2]. The common requirements for many wearable applications are weightless, robustness, very low fabrication and maintenance cost. The microstrip patch is implemented with copper film and the adhesive is used to fix the patch on textile material. Since the thickness is negligible and the dielectric properties are nearly equal to textile material, the double adhesive tape are widely employed in the design of wearable antenna. For wearable antenna, the microstrip patch antenna is the right candidate [3], [4], [5], [6], [7] because of tis compatibility and low profile. The major disadvantage of this antenna is narrow bandwidth and low gain, which can be improved with the help of various techniques like parasitic resonators [8] and modified ground structures [9]. A circular monopole antenna with microstrip feed is designed on a fully grounded 100% cotton textile. In order to reduce the back radiation, the full ground is used. εr=1.7 and δr=0.025 are the electrical properties of the substrate material [10]. Different values of the thickness are chosen and simulated in order to find the optimum thickness value of 1.6mm is used for the substrate material. This substrate material is used because of its flexibility and low cost, which are the key properties required by the wearable antenna.

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2 DESIGN OF TEXTILE ANTENNA

The proposed design has two evolution stages. First a circular monopole with microstrip feed operating atm1.575 GHz is designed on a cotton substrate based on the following equations, but the antenna is not having good impedance matching and therefore the microstrip feed is converted into inset feed in order to achieve the impedance matching at 1.575 GHz.

$$F = \frac{8.791 * 10^9}{f_r\sqrt{\varepsilon_r}} \quad (1)$$

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi\varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h} + 1.7726\right)\right]\right\}^{1/2}} \quad (2)$$

$$a_e = a * \left\{1 + \frac{2h}{\pi\varepsilon_r a}\left[\ln\left(\frac{\pi a}{2h} + 1.7726\right)\right]\right\}^{1/2} \quad (3)$$

$$F_r = \frac{1.8412 * c}{2\pi a_e\sqrt{\varepsilon_r}} \quad (4)$$

Figure 1 shows the structure of the proposed antenna along with its parameters. Table 1 gives the optimum parameters used to design the proposed structure. The proposed antenna with inset feeding is capable of resonating at 1.575 GHz.

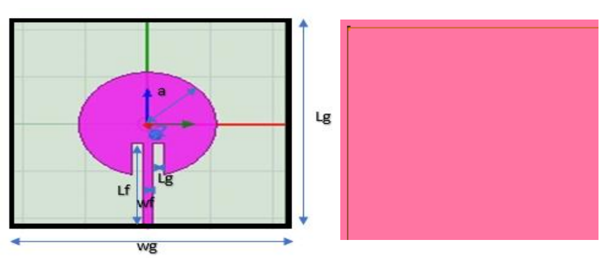

***Fig. 1**. Front and back view of textile antenna*

Table 1
Parameter of the textile antenna

Lg	Wg	a	Lf	Wf	H	T	g
88	88	22	18.2	3	1.6	0.1	0.5

Figure 2 shows the evolution of the proposed structure. Figure 3 depicts the return loss plot of both the basic structure and the proposed design, from that we can clearly understand because of the inset feeding only the impedance is matched. The entire structure is simulated using HFSS.

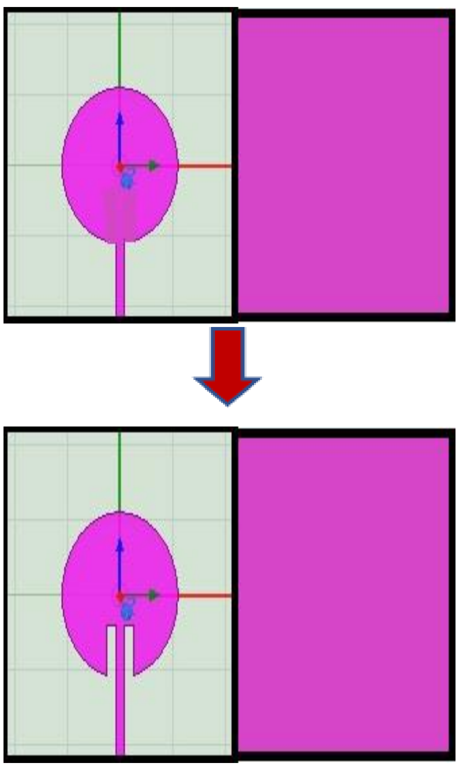

***Fig. 2**. Evolution of textile antenna*

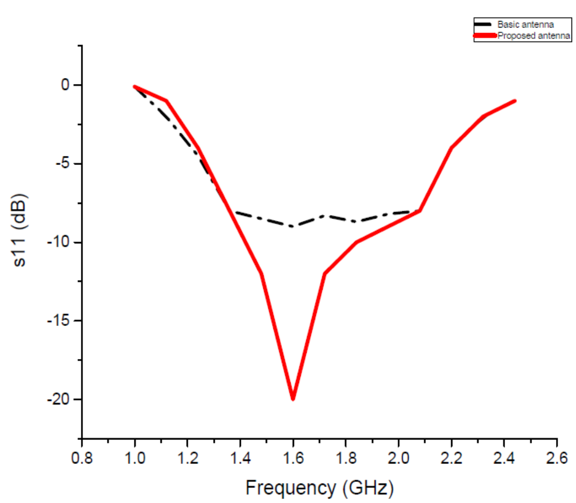

***Fig. 3.** s11 plot – initial vs proposed*

3. PARAMETRIC ANALYSIS

In order to find out the optimum value for the critical parameters, which adversely affect the characteristics of the proposed design, the parametric sweep is used. Feed width(wf), radius of the circular patch (a) and the Ground length (lg) is considered for the parametric sweep.

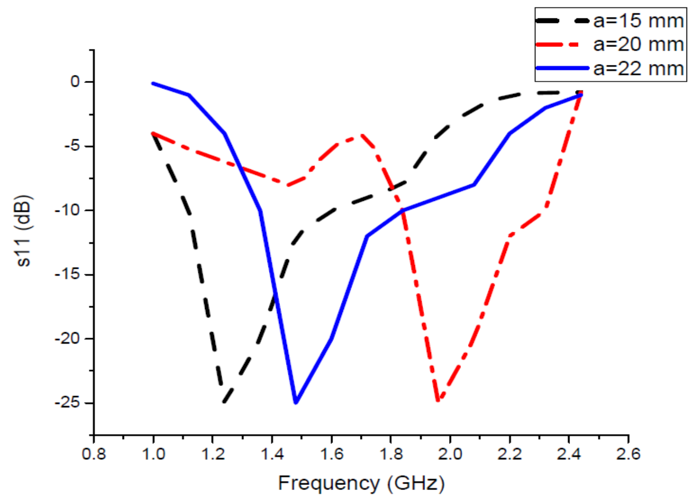

***Fig. 4.** s11 plot for various radius of circular patch*

Figure 4 depicts the return loss performance of the proposed design for various values of the circular patch radius. From the figure it is inferred that the value a=22mm is giving a good impedance matching with decent bandwidth at the desired resonating frequency. The return loss performance of various ground length is showed in figure 5 and from that it is inferred that the full ground structure can have good impedance matching in desired band. With the help of full ground structure, the back radiation from the proposed structure is very low, which is the essential requirement for the wearable antennas.

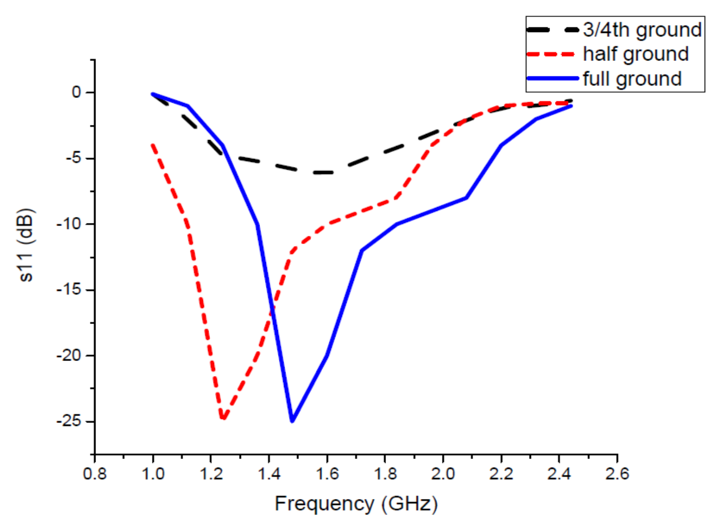

***Fig. 5.** s11 plot for various ground size*

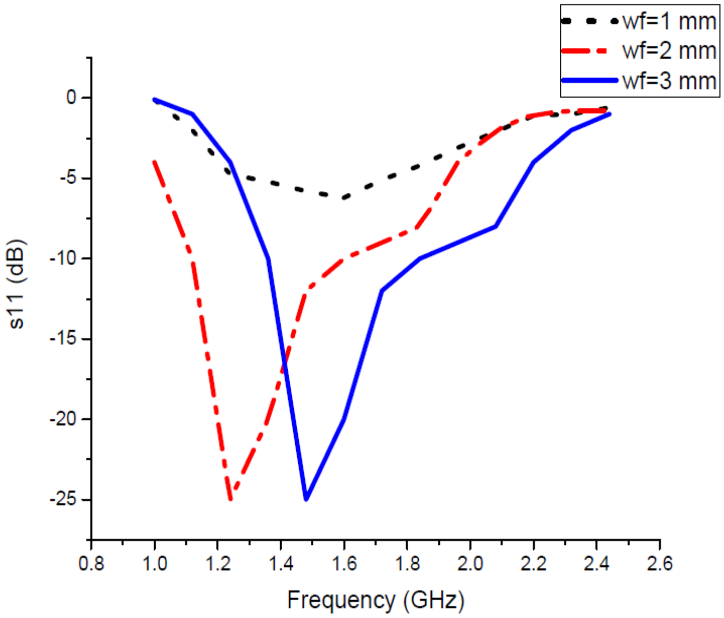

***Fig. 6**. s11 for various feed width*

In figure 6, the return los plot for the various feed width size is shown, from which it is inferred that the feed width of 3mm gives good bandwidth and impedance matching. Therefore, it is chosen as the optimum value.

4. Result and Discussion

Figure 7 and figure 8 shows the 3D gain plot and smith chart of the proposed antenna. From the figure we can infer that the maximum gain of 5dBi is achieved and with good impedance matching

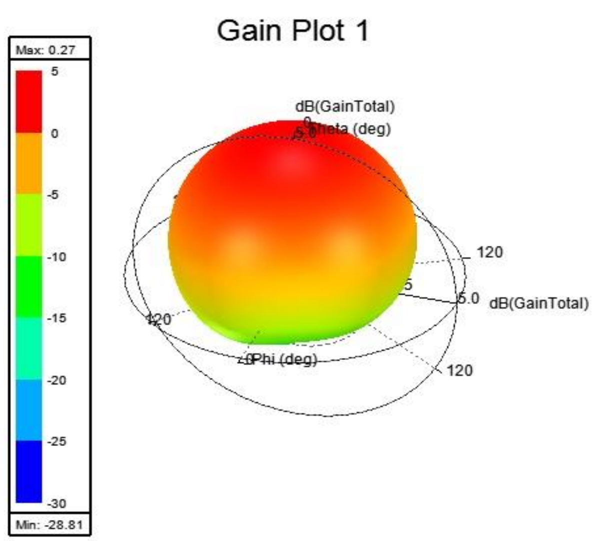

***Fig. 7**. 3D Gain plot*

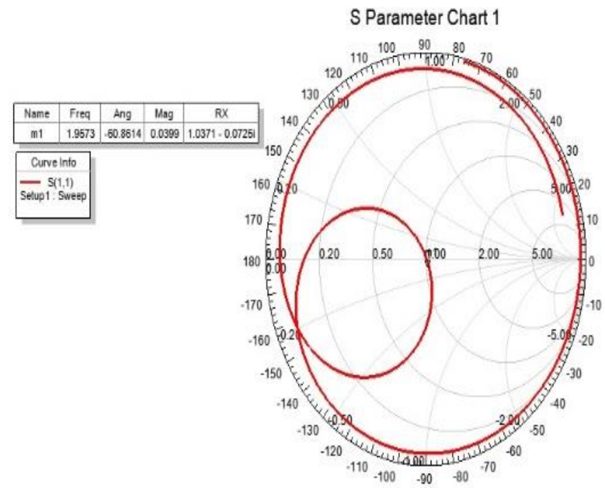

***Fig. 8**. Smith Chart*

Figure 9 shows the E plane and H plane radiation pattern in XZ, YZ and XY plane respectively. From the figure we can infer an omnidirectional E plane pattern and bi directional H plane pattern, which is key property for any tracking application like GPS. Figure 10 depicts the frequency vs gain plot, from which we can infer that the maximum of 5 dBi is achieved in the desired resonating band.

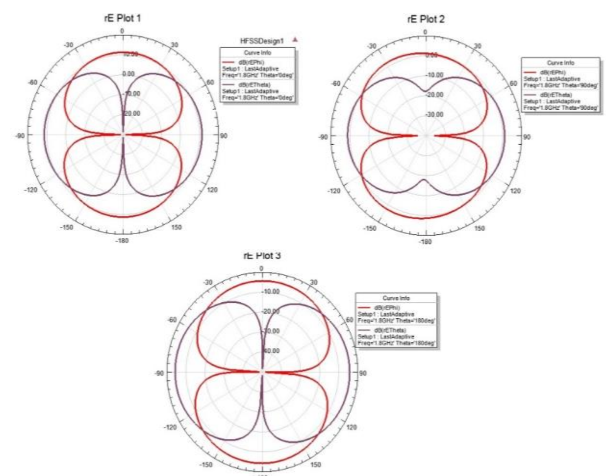

***Fig. 9**. E plane and H plane pattern at 1.575 GHz in XZ, YZ and XY plane*

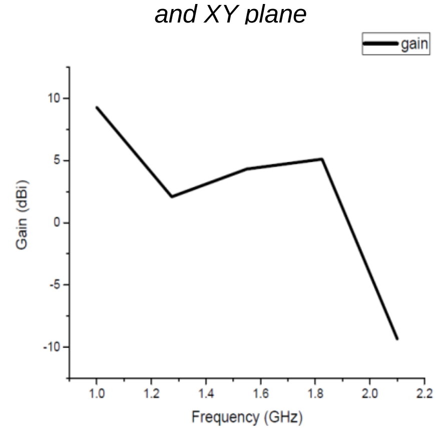

***Fig. 10.** Frequency vs Gain plot*

5. CONCLUSION

A wearable inset feed circular patch antenna for GPS application is proposed. Initially a simple circular patch with microstrip feed is designed on a cotton textile material, but it has very less impedance matching. Then, the inset feed is proposed in order to achieve impedance matching and wider bandwidth in the desired GPS resonating band of 1.575 GHz. The entire structure is simulated using HFSS electromagnetic software and it is characterized with the help of simulates return loss, gain, smith chart and radiation plots. The proposed antenna will be good choice for the wearable GPS tracking application.

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