A Novel Trident shaped Ultra wide Band Textile Antenna

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Abstract- In this paper, a contemporary trident shaped antenna on a textile fabric is projected for boosting the gain and impedance bandwidth. The proposed antenna is designed to have the frequency range from 0 GHz to 10 GHz. The proposed trident fashioned radiating element is exemplified in one-of-a-kind substrate materials like jeans, leather, and foam. The overall performance of the proposed antenna is examined and compared with the prevailing antenna. The proposed antenna improves return loss by means of -10dB and covers the ultra-wideband frequency range.

Keywords – Textile antenna, Jeans, Foam, leather, impedance, bandwidth, and Gain

I. INTRODUCTION

Nowadays, wearable devices have a great impact in the field of communication due to the rapid growth of wireless communication technology. The textile antenna is a crucial part of a wearable device. Many researchers in the field of wearable devices focus their research on the design of the textile antenna. UWB technology is associated with textiles, a UWB antenna is designed, simulated in HFSS, fabricated and tested with the assistance of a vector network analyzer. This wearable antenna integrates into the communication systems in smart clothes that provide real-time information about the patients' health. In recent years, wearable antennas received great attention which can be integrated into the clothing.

Many authors have reported the performance and applications of the textile antenna for real-time applications. Various types of UWB microstrip antenna have been investigated and implemented with different feed lines, such as microstrip line [1]-[3], coplanar waveguide (CPW) [4] and different shapes, such as the crescent patch.

On the added pointer, the crucial attentions for wearable microchip technology are to be lightweight, flexible, small size, inexpensive, able to withstand damage from obstacles (robust), and comfortable to wear [5]. Since the Federal Communications Commission (FCC) in 2002 approved the commercial use of frequency bands from 3.1 to 10.6 GHz for Ultrawideband(UWB) systems, UWB antennas received more and more attention with the advancement of communication technology [6]. The striking features of UWB antennas, such as low profile, cost, and radiation properties, and the compact size enhanced the possibilities of reducing the size of the wearable devices and therefore ease the fabrication process [7].

A body wearable textile antenna is designed using an insulating textile substrate bonded with conducting a thin copper plate as a ground and patch of an antenna. In this paper, four types of substrate material are used to design the patch antenna operating at a UWB frequency band. In this work, we have proposed a Trident shape planar microstrip antenna which is the combination of semicircular and triangular patches. The combination of these two makes the radiator radiate the incident energy across the ultra-wide frequency range. The simulated and measured return loss of the proposed antenna is presented. The return loss curve indicates that this proposed structure achieves a high impedance and gain is also increased compared with a conventional structure, The characteristics of the proposed antenna through the parametric substrate study are investigated and presented.

II. PROPOSED ANTENNA STRUCTURE

2.1 Trident shape Textile antenna

To improve impedance bandwidth and gain of the antenna, the existing semi-circular patch antenna is modified as a trident shape antenna and it is embodied in textile material like jeans. The radius of the radiating element is calculated by equation (1).

$$r = \frac{F}{\left\{1 + \frac{2h}{\pi\varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h} + 1.7726\right)\right]\right\}^{1/2}} \; ; \; F = \frac{8.791 * 10^9}{f_r\sqrt{\epsilon_r}}$$

The proposed antenna is modified from the semi-circular conventional antenna the radius of the circle is 13.5 mm, the trident shape is 7 mm width and the height is 7 mm with spacing is 2.5 mm, the entire dimension of the proposed antenna is 27 mm width and height is 30 mm. To energize the antenna a microstrip feed is used, for inset feeding line, length and width of feed line 7.5 mm and 1.2 mm respectively is calculated for impedance matching of feed line and patch. The feeding line plays an important role in the impedance matching of an antenna with characteristics impedance of 50 ohms of the feeding line.

The resonant frequency is considered to be 7GHz. The proposed UWB antenna is designed considering three materials such as jeans, leather, and foam. Figure 1(a) and (b) show the conventional and proposed antenna structure respectively.

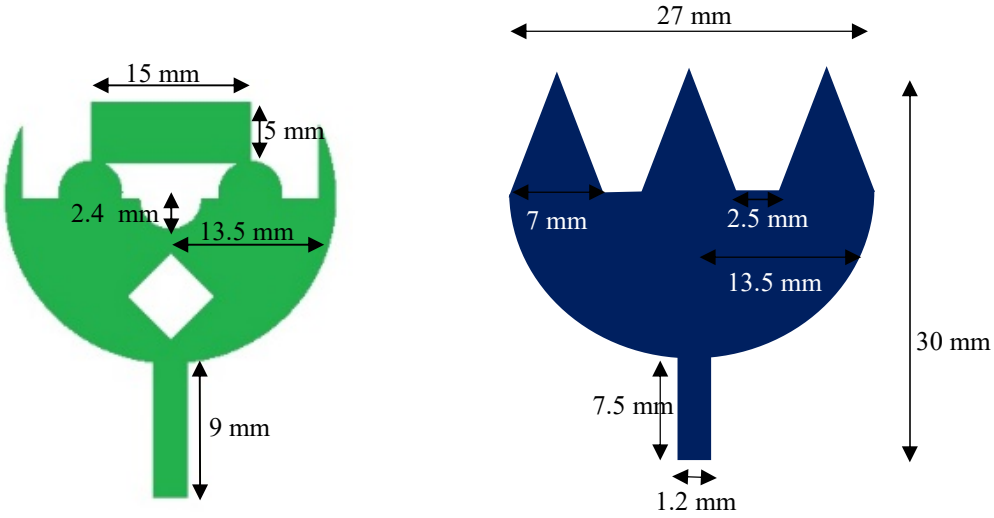
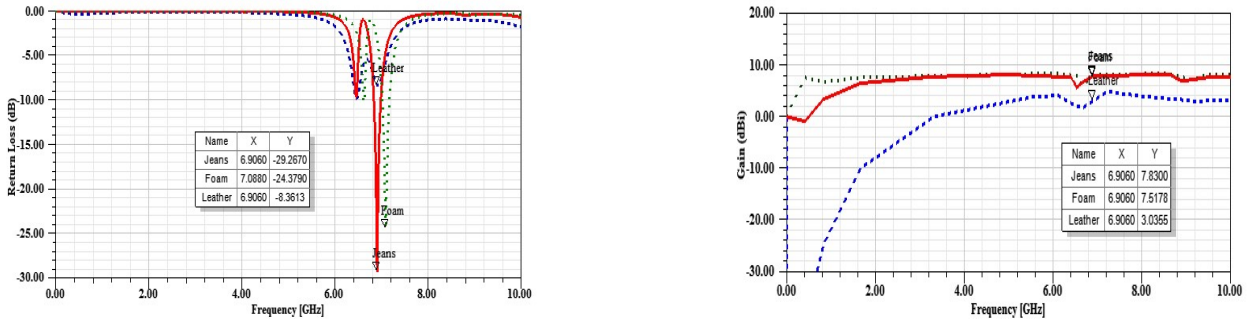


Figure 1: (a) Conventional Semi Circular Antenna (b) Proposed Trident Shaped Antenna

III. Result and Discussion

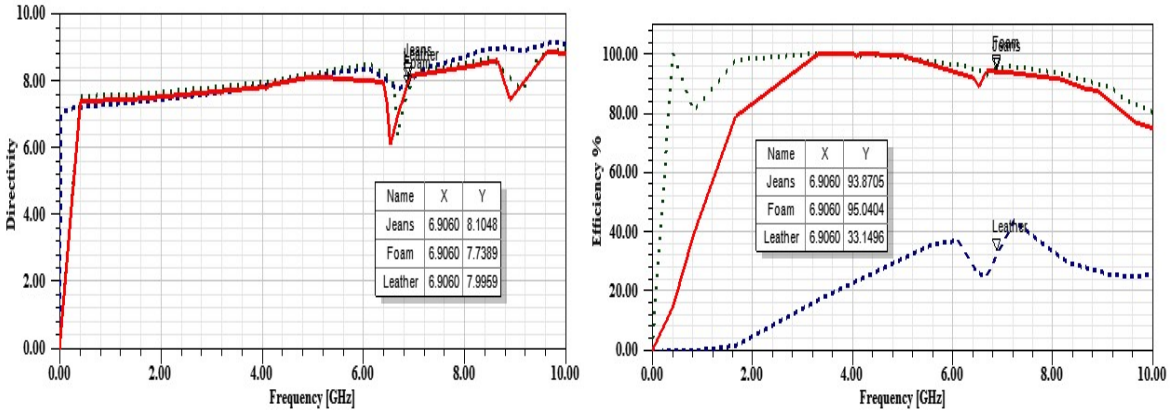
The performance of the proposed antenna is analyzed with the help of electromagnetic simulation tool Ansoft HFSS. The conventional and proposed antenna structures are simulated over the frequency range of 10GHz. Microstrip line feeding is used to achieve a better performance of the proposed antenna. Jeans, foam, and leather are used as a substrate with a dielectric constant of 1.67, 1.6 and 1.79. Conducting a thin copper plate as a ground and patch of an antenna to radiate.



(a) (b)

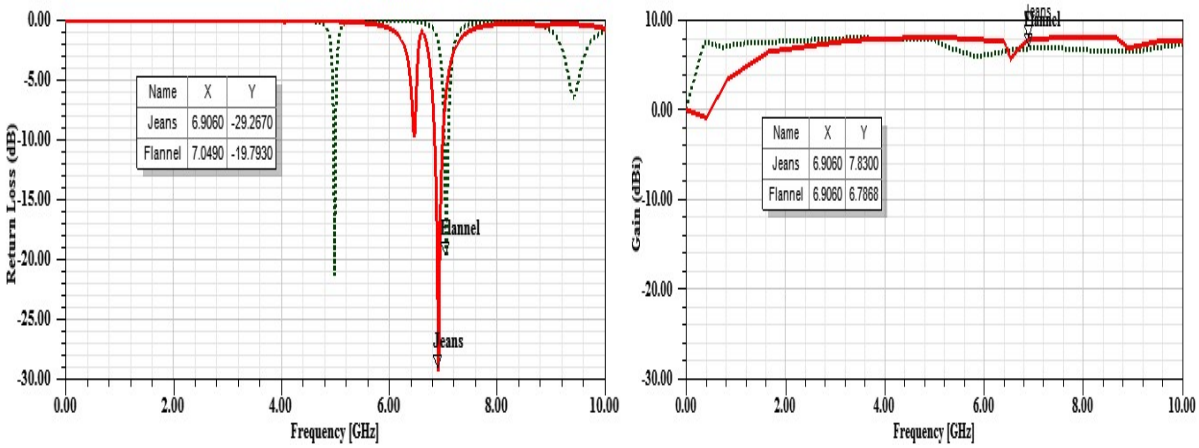
Figure 2 Simulated results of (a) Return Loss (b) Gain

Figure 2(a) shows the return loss plot of a proposed antenna structure for the materials jeans, foam and leather, which shows that the antenna element radiates at 7 GHz with an optimum return loss of -29.26 dB, -24.37 dB and -8.36 dB respectively. Figure 2(b) shows the gain at 7 GHz for jeans, foam, and leather are 7.83dBi, 7.51dBi, and 3.09 dBi respectively. Figure 3 (a) illustrates the directivity of the proposed antenna with different substrate materials. The obtained results show that the proposed structure on jeans material offers better directivity, gain and efficiency compared to foam and leather. The gain and directivity can be further improved by using different dielectric materials with high dielectric constant.



(a) (b)

Figure 3 Simulate results of (a) Gain (b) Efficiency



(a) (b)

Figure 4 Comparison of simulated results of (a) Return loss (b) Gain for the conventional and proposed antenna

Figure 4(a) and Figure 4(b) depict the comparison plot of return loss and gain for proposed and conventional antenna structure. The authors in literature [8] have been reported as the flannel is the suitable textile material for the conventional semi-circular slot textile antenna. Here, the concert of the projected antenna structure is compared with the existing model. It shows that the proposed antenna with jeans substrate is increased gain by more than 16% and increases return loss by more than 10dB at the resonant frequency 7GHz. The proposed antenna is fabricated which illustrates in figure 5 and the performance of the proposed structure is experimentally validated with the help of a network analyzer, the experimental validation of return loss of the jeans substrate trident shape antenna is shown in figure 6.

(a) (b) (c)

Figure 5 Proposed Trident shape antenna with different substrate materials: (a) Leather (b) foam (c) Jeans

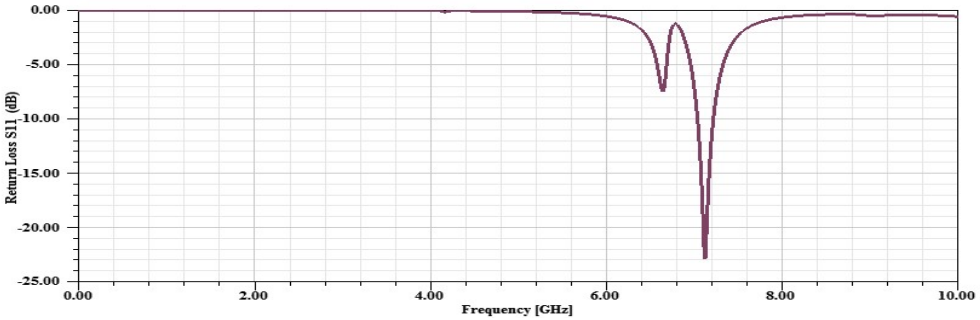


Figure 6 Measured Return loss of Proposed Textile antenna

IV.CONCLUSION

A novel textile antenna has been designed and proposed to cover the ultra-wideband frequency range3 GHz to 10GHz. The proposed antenna is simulated with the help of electromagnetic simulation tool Ansoft HFSS and fabricated. The proposed antenna provides a radiation efficiency of 80%. From the results, it is observed that jeans are the best textile antenna than other fabrics and FR4 substrate. The proposed textile antenna can be designed for health monitoring systems.

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