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Design and Analysis of Wearable Textile Jean Antenna for ISM Band Applications

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Abstract

The chosen fabric and the radiation patch helps the antenna to work within the frequency range of 2.4-5.8 GHz. With the development of body centric wireless communication more and more communication systems contains antenna integrated in clothing called wearable antenna. The electromagnetic raditation has increased manyfold because of the developments in Wireless Communication Technologies. These EM radiations can cause severe harm to living organisms especially to humans. To prevent our body from this radiation, our proposed antenna can be used. The textile material that is conductive and which is equally wearable, and at the same time works as a filter, preventing the toxic radiations to enter the human body.

This antenna is not only wearable but also can be attached to our clothes for serving various purpose such as tracking a person's location, Navigation, Monitoring a person's health and it serves a crucial role in military field. The fabric that is conductive must be fulfilling some of the criteria such as, the fabric must have low electrical resistance so as to decrease the ohmic losses of the fabric, the entire fabric should have homogeneous surface resistivity i.e. the change in resistance need to be very less and the chosen fabric should be highly flexible in order to act like a wearable antenna.

For textile, the nonconductive material is taken based on criteria such as high thickness and low permittivity

Keywords: Aperture coupled microstrip feed, textile antenna, ISM band application

1. Introduction

Wearable textile substrate namely jean is utilized to prepare flexible antenna. This antenna is portable and also can be easily placed upon our dress materials. The preparation of this antenna is done using a normal microstrip patch antenna. In this paper, a new coupling method called aperture coupled microstrip feed technique is illustrated which helps the antenna to operate on ISM band (2.4 – 5.8 GHz) and can also operate on dual band frequency (1.5 GHz and 2.45 GHz). The main advantage of wearable antenna is less weight, easy to fabricate and low cost. Usually a probe feed technique is used for textile antennae, to overcome this a new coupling method called aperture coupled microstrip feedline technique is proposed. This consists of two substrates i.e, top and bottom substrates and in between the two substrates there is a ground plane with an aperture slot.

This slot helps to couple energy between the feedline and top patch and provides the antenna to work in its desired frequency for the use of health monitoring, military applications etc.,

In this project a new patch antenna with array using aperture coupled feed technique is to be designed and simulated using Microwave CST Studio with the operating frequency of 2.4-5.8 GHz. Selecting a suitable conductive and non-conductive material is very essential. The material (conductive) is subjected to patch, feedline, and ground plane, whereas the non-conductive material is subjected to the two substrates. The top substrate consist of a jean material. The bottom substrate is used as felt (hard substrate) to overcome the disadvantage of wearable antenna, i.e, since by using soft textile substrate there might be dimension inaccuracy and is insensitive to the human body while wearing it, so felt is chosen because of its relative hard nature.

A. Aperture coupled feeding technique

Aperture coupled feeding technique for wearable textile antenna includes an electromagnetically paired microstrip line and it is coupled to a patch conductor. The patch conductor goes through a ground plane that is small electrically Aperture coupled antenna minimizes the electrical connections that are directly connected between the feed conductors and radiating patch, ground plane separates the two structures electrically with an air gap of and thereby reducing the number of electrical connections.

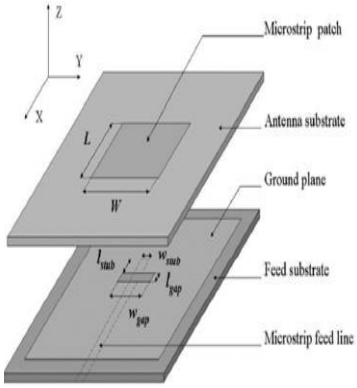

Fig 1: Aperture coupled feeding technique

B. Layout

We have designed 98*98 mm wearable textile antenna using jean and felt as the fabric substrates for the top and bottom substrate respectively.

Among fabric materials namely cotton, jean, fleece fabric, tween, leather and Neoprene rubber, the fabric jean provides better dimensional conformity and efficiency. Hence jean is selected for the top substrate. The bottom substrate is used as felt (hard substrate) to overcome the disadvantage of wearable antenna, i.e; since by using soft textile substrate there might be dimension inaccuracy and is insensitive to the human body while wearing it, so felt is chosen because of its relative hard nature.

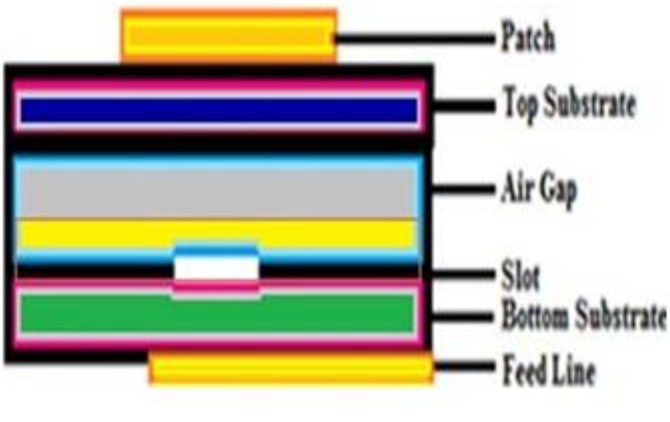

Fig. 2. Layout of the aperture coupled textile antenna

C. Design of Jean textile antenna:

We have designed 98*98 mm aperture coupled textile antenna using CST Studio. The 3D dimension of the antenna is about 98*98*2.6 mm.The material used for conduction is self-adhesive copper foil tape which has a thickness of 0.035 mm and it also enables us to have a low surface resistivity Rs < 0.03 Ω/sq It is utilized in the ground plane, radiating patch and the ground plane

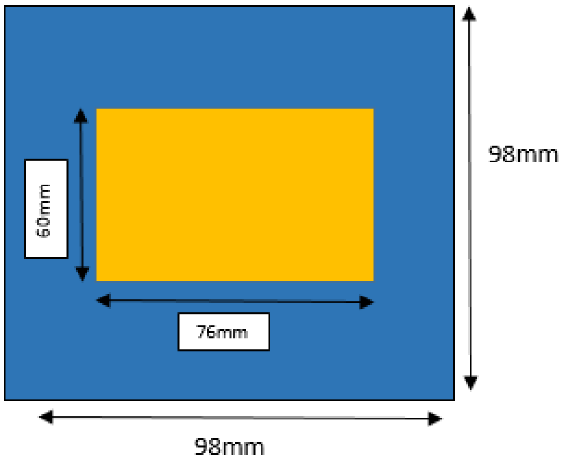

Fig 3: Layout of top substrate top view

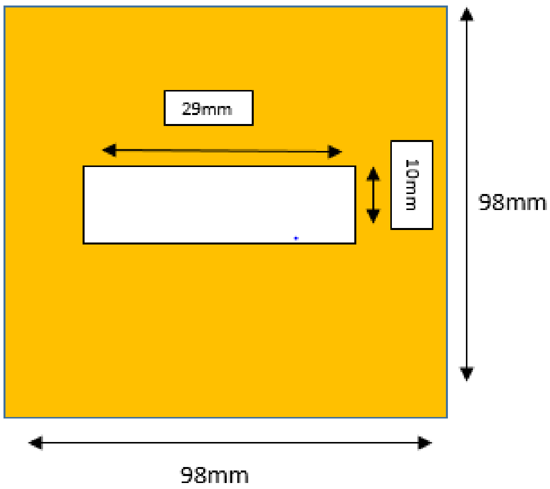

Fig 4: Layout of ground plane top view

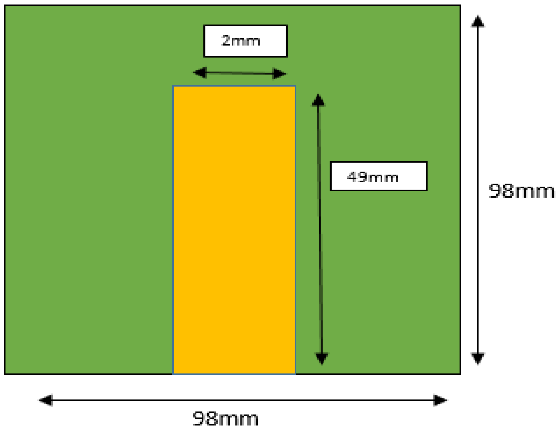

Fig 5: Layout of feed substrate bottom view.

D.Simulation results

We obtained a return loss of -33.502 dB for the aperture coupled textile antenna.

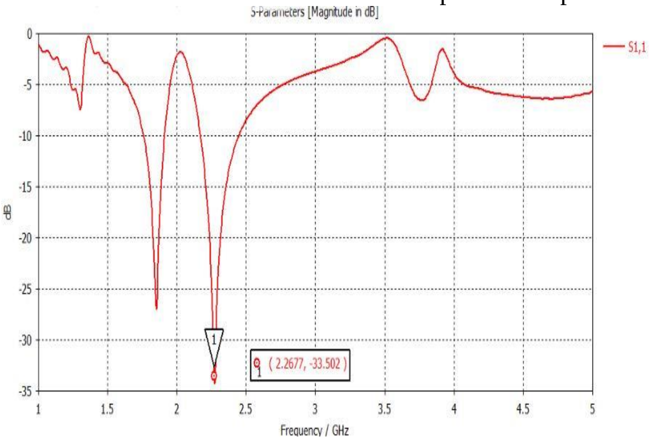

Fig. 6. Return loss of -33.502

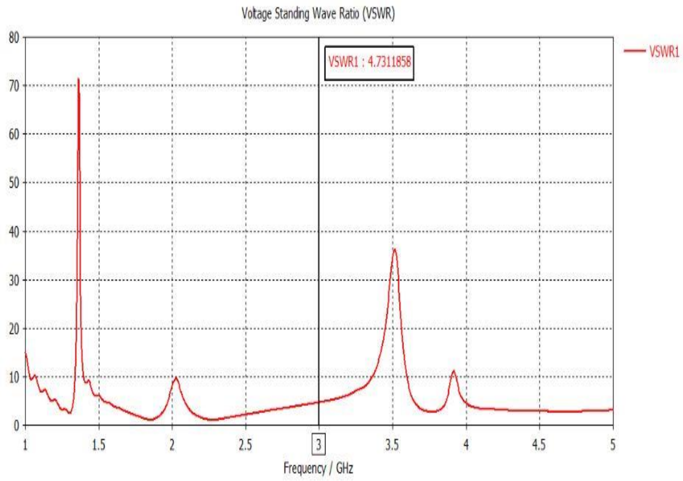

Fig. 7 VSWR of simulated antenna

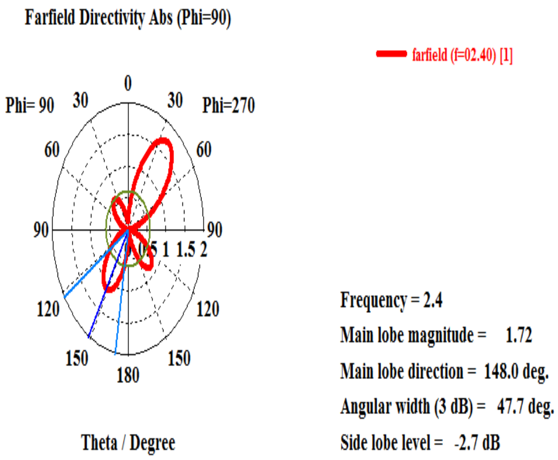

Fig. 8 Directivity of Jeans at frequency 2.4 GHz

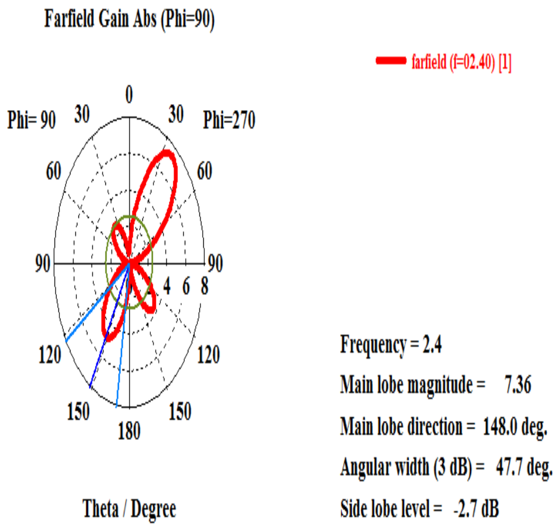

Fig 10: Gain of Jeans at frequency 2.4 GHz

The designed textile patch antenna is simulated digitally with the help of Computer Simulation Technology (CST) Microwave Studio a software for designing the antenna. Figure 6 denotes the output obtained from return loss by changing the top layer substrate of the textile material.The textile material used is Jean for top substrate and Felt for bottom substrate which functions at a frequency of 2.4 GHz and as a return loss of -33.502 dB , Voltage Standing Wave Ratio of 1.7311 and it has a high efficiency which is around 62%.

2. CST Microwave Studio

CST microwave Studio offers accurate efficient for electromagnetic dialysis. It is a user friendly 3D emulation software. It enables to choose the most appropriate method for design and optimization of antenna and devices operating in wide range frequencies.

Applications:

This antenna can be integrated into clothing and can be used for protection against harmful EM radiation by cascading filters with the antenna. It can also be utilized for tracking, navigation, military application and health monitoring systems. It can also be used in wireless PAN (Personal Area Network) devices to provide reliable wideband operation and produce high data rate.

3. Conclusion:

The aperture coupled microstrip patch antenna has been successfully developed. Here the substrate and the patch (radiating) are kept one on top of the other forming multiple layers and also has a few aperture slots positioned on the ground, it has been designed and simulated result was achieved by using CST Studio software. Thus, with jean achieved maximum efficiency of 70 % with a return loss of -31.724 dB

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