Dual band Wearable Antenna for ISM band Application

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***Abstract*-Wearable antenna has great application due to progress in wireless communication and usage in different field. Also application of dual band antenna in the area of telecommunication, WLAN application has been increased drastically. Most of the application are mainly focused on ISM band frequency (2.4 GHZ & 5.8 GHZ). In this paper we propose a dual band circular patch wearable antenna at ISM frequency band. Dual band characteristic is achieved by applying dual slot on patch and also by reducing the dimension of the ground structure. Antenna structure is made by using the substrate as jeans with dielectric constant 1.6. Results such as return loss and radiation pattern are presented in this paper.**

***IndexTerms*-Wearable antenna, dual band, ISM band, WLAN, Dual slot, circular patch**

I.INTRODUCTION

Wearable communication system a big importance in the field of wireless communication.[1]It is one of the dominant research topics in antennas for body-centric communications .Wearable antenna attached into the communication system making electronic devices more flexible. Recently wearable antenna has diverse application: pulse rate monitoring, RFID application, navigation support in car etc. Wearable antenna is realized using flexible substrate material. This textile material should meet following requirement: inexpensive, comfortable, lossless and easily available in market [2] .There are several different types of antenna suitable for wearable antenna application, which include PIFA's, micro strip antennas and planar monopoles [3]. Among these Micro strip antennas are most convenient choice for on-body wearable communication, because of their ease of construction and cost effectiveness.

The micro strip antenna have several advantages such as small size, low –cost , low profile, light weight, conformability, and ease of installation in networks.. These features are major design considerations for practical applications of micro strip antennas. Recent technologies enable wireless communication devices to become physically smaller in size. Antenna size is obviously a major factor that limits miniaturization .One of the main advantages of patch antenna as wearable application is that it reduces the back lobe radiation which is very important in wearable applications [4]. So patch antenna is preferable. With the development of wearable antennas, studies on patch antennas have mainly focused on flexible materials. The properties of the materials used in antenna had a great influence on the behavior of the antenna which is employed. For example, in planar antenna bandwidth and efficiency of the antenna mainly depend upon the permittivity and thickness of the substrate. [4]. The use of textiles in wearable antennas requires the characterization of their properties. Electro-textiles are conductive fabrics constructed by mixing conductive metal or polymer threads with normal textiles. These fabrics, which are wearable, durable and flexible, make it suitable for wearable contexts. The conductive textile is expected to have low and stable electrical resistance to minimize losses. The flexibility of the materials is also needed so that the antenna can be deformed over the cloth. Substrate selection is a critical step in designing a textile or wearable antenna, in order to be robust for a specific application. In general, textiles present a considerably low dielectric constant that reduces the surface wave losses and increases the impedance bandwidth of the antenna [5].

It is possible to design and fabricate microstrip wearable antenna with substrates such as cotton, jeans, ZELT ETC. As these substrates are cloth material, user can wear this as clothes. In some application we need to increase the bandwidth to operate in two separate frequencies. An effective alternative method to avoid use of two different antennas is to use a dual frequency patch antenna. If an antenna resonate at two different frequencies in single radiating structure, such type of antenna are called dual band frequency antenna [5]

In this work, a dual band wearable antenna in circular shape is designed and simulated.The dual band is achieved by using defective ground structure and by applying slot on the patch.

II.RELATED WORKS

Last decade has seen significant research interest in dual band wearable communications and various antenna models have been proposed [1, 2]. Performance of a dual-band patch antenna with an electromagnetic band gap substrate is described in [6]. The antenna structure is made by using common clothing fabrics and operates at the 2.45 and 5 GHz wireless bands. But it is quite complicated to design and fabricate.

Another dual band antenna designed by using jeans with arm structure is described in [7], but return loss affect the performance of that antenna [3].Another technique for achieving dual band is explained [8] by loading a slot antenna with two lumped variable capacitors (varactors) placed in proper locations along the slot. But it is not wearable one. Also efficiency is very poor.

A psi shape slotted wearable antenna probe fed micro strip patch antenna for dual band is presented in [8]. In this paper a new design of antenna that resonates at 2.5 GHz with the bandwidth of 139 MHz and also resonates at 4.87 GHz with the bandwidth of 251 MHz is presented. But this design doesn't helpful to resonate at our required frequency.

A dual narrow band wearable antenna is proposed to operate in the range of 2.4–2.5 GHz and 5.7–5.9 GHz for WLAN and telemedicine applications. The proposed design is achieved by simple modification to the rectangular patch antenna. The antenna design is low profile [5].

To overcome above shortcomings we try to implement a dual band circular patch wearable antenna .In this dual band achieved by applying square shaped slot on patch and reducing the ground dimension.

III. ANTENNA DESIGN ANALYSIS

The design process started with circular patch antenna operating at 5.8GHz .The substrate jeans has been used having permittivity 1.6 and thickness 1 mm. This substrate thickness was selected because it can be made conformal and worn on the body. Feeding technique used is direct feeding technique because it is easy to achieve impedance matching by adjusting the feeding position. Input impedance matching is critical requirement to achieve required result, if not it will affect the efficiency.

The patch width, length, and micro strip feed line width for characteristic impedance of 50 Ω is determined [6]. To achieve dual band surface current distribution on the patch may be altered.In order to obtain the dual band design proposed in this paper, few parameters are to be calculated. Initially we need to design a simple circular patch by using following equation.

Since the patch is circular in shape radius is obtained by using the equation

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

$$F = \frac{8.791\times10^{9}}{f_r\sqrt{\varepsilon_r}} \quad (2)$$

Equation (1) to find radius of the circular patch.

a=radius of the circular patch
h=height of the substrate
ε_r=dielectric constant of the substrate
f_r=Resonant frequency

Equation above does not take into consideration the fringing effect. Since fringing makes the patch electrically larger, the effective radius of patch is used and is given by (Balanis, 1982)

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

Where a_e *= Effective radius of the patch*

In order to achieve dual band characteristics, first we provide wider band width for some amount of shift in frequency. For that a partial ground plane is implemented in the simulation of this design. The size of the substrate we obtain is 30×30 with patch radius of 12mm. In ordered to enhance further frequency shift as well as optimizing the design, one opening at top of circular patch were implemented in the current design along with a square slot at the center of the patch with size 3×3 mm.To achieve dual band surface current distribution on the patch may be altered .so we provide double slot on the surface of the patch. With the introduction of a slit, new current path will obtain. As path length increases, frequency shift will achieve, which provide better result. Simulation has been carried out in HFSS Software package.

Figure 1 represent HFSS model of the proposed antenna

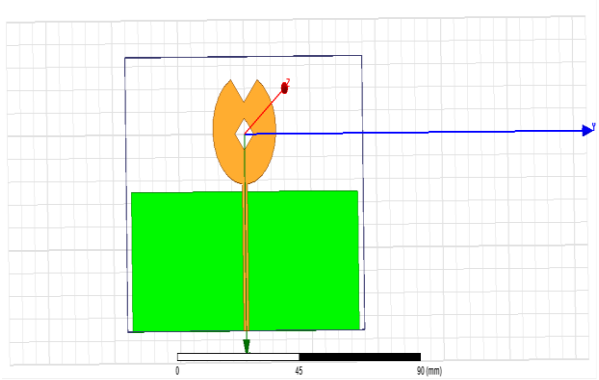

Fig 3.1 HFSS model of proposed antenna

All the dimension are illustrated in table 1

Parameter	Value in mm
Substrate Thickness	1mm
Substrate dimension	64×94mm
Patch radius	12mm
Partial ground plane Dimension	90×28
Upper slit dimension	5×5mm

IV. SIMULATION RESULTS

Simulated results are obtained using High Frequency Structure Simulator (HFSS) .It is observed that how antenna characteristics can be varied by changing the parameters and geometries of the antenna. This observation help us to optimize antenna parameters to get the desired results.

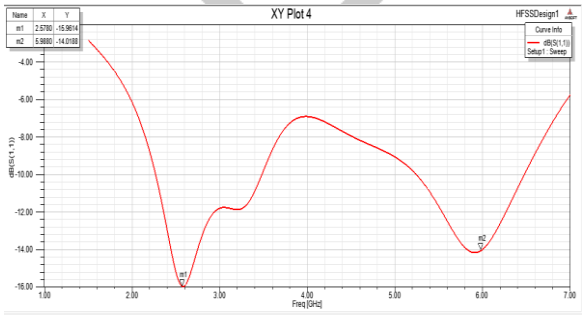

Fig 4.1 S11 plot of proposed antenna

The return loss minima are obtained at 2.45 and 5.75 GHz. From S11 Plot we got two frequencies with return loss -15dB and -14 dB.Also radiation patterns of both 2.4 GHz and 5.8 GHz shown in fig 4.1 & fig 4.2

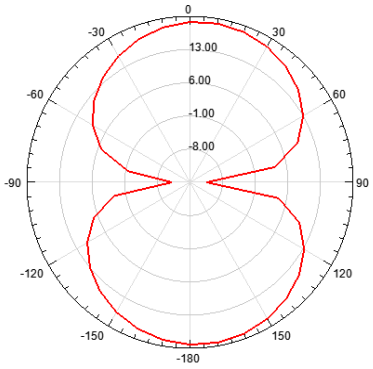

Fig 4.2 Radiation pattern of 5.8Ghz

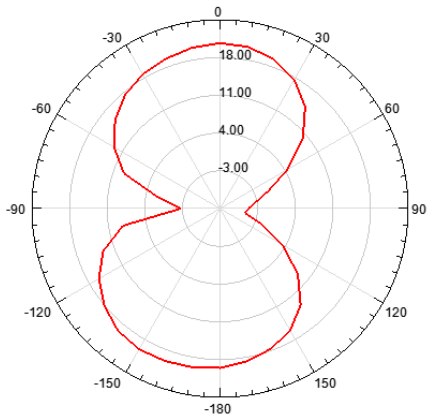

Fig 4.3 Radiation pattern of 2.4 Ghz

V.CONCLUSION

A new design of dual band wearable micro strip patch antenna is presented in this paper using jeans cloth as substrate. A slotted circular shaped micro strip patch antenna fed by direct feed has been proposed in this paper. Also slot of square shape reduces the size of patch to some extent that leads to light weight and easily wearable. The proposed antenna is suitable for ISM band frequency applications of wireless communication as the design resonates at frequencies 2.4 GHz and 5.8 GHz .

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