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Dual Band Wearable Antenna for Medical Applications

V.Reji, C.T.Manimegalai

Abstract :In the modern world many sensor devices are designed for medical and industrial applications. This idea is designing a dual band wearable antenna at 2.4GHz, 5.8GHz and investigating the wearability of antenna for medical applications. The test is carriedout in multiple tissue structure. These wearable antennas are very small in size, directly it can be worn in wrist or abdomen and inside the body. Different feeding structure will be compared to reduce the heating of antenna due to an electromagnetic interaction with bodies. This design has two dual antennas, one act like an interrogator and the next acts like a receiver. Interrogator is an outside device and the receiver antenna is connected within the human body. The proposed antenna is simulated by high frequency simulation software .The advantage of this antenna is very small and comfort for wearing in human bodies.

Index Terms — Interrogator, receiver, body, switch, device, comfort

I. INTRODUCTION

In the medical field more devices are available to test a human body and track the objects. There are more test equipments available to check the blood sugar, blood pressure and pulse level of a human body. The accepted ISM bands for medical applications are 2.4GHz and 5.8GHz used in this method. Carlos Mendes, Custidio Peixeiro, are demonstrated On-body transmission performance of a novel dual-mode wearable microstrip antenna, but the path loss is high in onbody mode compared with the off body mode [1]. Asimina Kiourti, Konstantina S.Nikita are designed a wearable antenna for medical applications, this antenna thickness is higher than other demonstrated antennas [2]. A switchable antenna operating at 2.45GHz is shown by Xuanfeng Tong,Changrong Liu,Xueguan and Guo in IEEE transaction on antennas and propagation,Vol.66,with high powerless[3] and an implanted antenna is demonstrated with ultra wide bandwidth operating in the medical device radio communication service band at(401-406)MHz by Jinchen Wang,Mark Leach,Eng Gee Lim ,it shows large bandwidth and more powerloss[4].The proposed wearable antenna will be used to test the biological conditions [7][8] of the human body and also track the human object on spots and war times. The equipments which are available already only can measure the glucose, pressure and pulse level externally. But the proposed antenna will be implanted inside the body to sense the biological conditions of the body and there changes continuously. The wearable antennas are classified in to two types (i).External wearable antennas (antennas are connected in to the cloths or writs)[9] (ii).Implantable antennas (antennas are directly connected in to the human body).These implanted antennas can also be connected directly in to the human body or connected along with the pacemaker device and an endoscopic [4] capsule. The return signal of implantable antenna can be collected and registered by a recorder device. These wearable antennas are very useful when the patients are undergoing on critical operation condition and the patients under monitoring conditions.

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II. ANTENNA DESIGN AND METHODOLOGY

The proposed antenna has three parts (i).The External antenna or interrogator (single or Dual) will be operated at 2.4GHz and 5.8GHz frequencies, (ii) Implantable dual antenna for 2.4GHz and 5.8GHz, (iii) Recorder or display and switch[5][6]. A very big challenge of the implanted antenna is their feeding mechanism. This proposed implantable antenna is not having a direct feeding, But the antenna feeding is directly applied to the external interrogator antenna at 2.4GHz; the implanted dual antenna will be excited through the electromagnetic radiation from the interrogator at 2.4GHz[7][10]. This received signal is combined with the biological signal of the body and return back to the external interrogator at 5.8GHz like a parasitic element [10][11]. The internal nuropotential changes can be recorded by an outside recorder which is connected with the external interrogator.

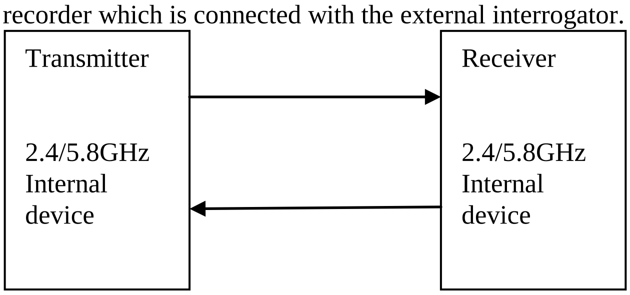

Fig1.Wearable Antenna Structure

III. RESULT AND DISCUSSION

Fig 2 shows the outside interrogator antenna design with 2.4GHz, The simulated reflection co-efficient of this antenna is -35 dB at Vacuum. The antenna is miniaturized by 20% and Rogers R03210 substrate is used with Thickness h=0.6mm. Antenna infinite [8] grounding is assigned under the substrate and the outside antenna is fed by centre fed probe feed method.

The same substrate material is used for designing 5.8GHz antenna with different dimensions shown in table II and III. Fig 4 shows the simulated output reflection parameter at 5.8GHz with 20%miniaturization and fig 5 shows the s11 parameter at 5.8GHz with 30% miniaturization.

Fig 6 shows the implantable dual band antenna with minimum thickness(Roger TMM3) and the dielectric constant 3.37, It shows the reflection parameter of the antenna is -20dB[9] .The implantable antenna has no direct feeding, feeding applied to only through interrogator antenna, This radiation is received by the receiver antenna. The implanted antenna is checked by two conditions, One radiation boundary is created for 5mm thickness tissue structure with maximum dielectric constant 40.72 and the next radiation boundary created for multiple tissue structure 10mm. The result shown in fig 7 and 8.The fist radiation pattern shows the radiation at 2.4GHz and the second radiation pattern diagram shows the radiation at 5.8GHz.

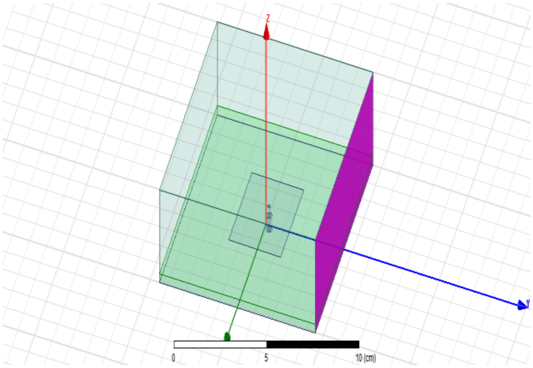

Fig 2. External Interrogator antenna at 2.4GHz

TABLE I
Dimensions of 2.4GHz External Antenna

Substrate length	80mm
Substrate width	75mm
Patch length	23.2mm
Patch width	16 mm
Probe feed position	1.6mm

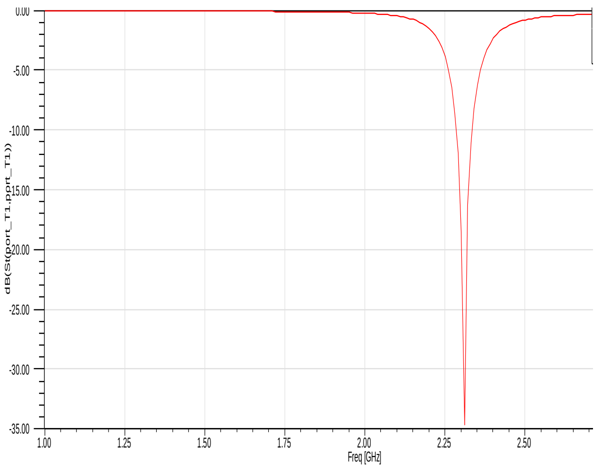

Fig 3. Simulation Result Of Interrogator Antenna at 2.4GHzWith Reflection Loss -35dB

Table II
Dimensions of 5.8GHz external antenna with feed position 1.6mm

Substrate length	75mm
Substrate width	60mm
Patch length	23.2mm
Patch width	16 mm
Probe feed position	1.4mm

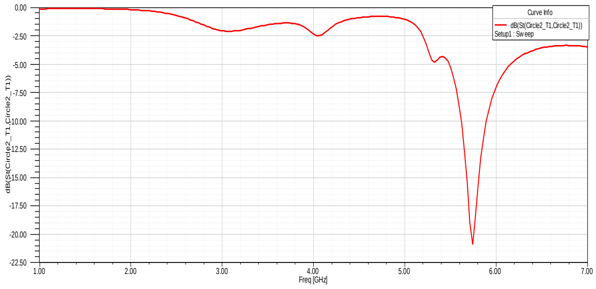

Fig 4. Simulation Result of Interrogator Antenna at 5.8GHz with Reflection Loss -22dB

TABLE III
Dimensions of 5.8GHz external antenna with feed position 1.4mm

Substrate length	80mm
Substrate width	75mm
Patch length	40mm
Patch width	30mm
feed	Probe feed 1.6mm

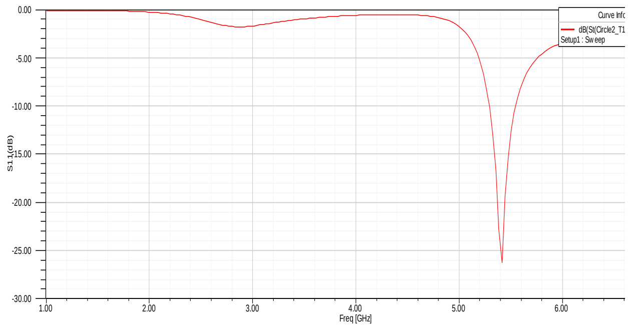

Fig 5. Simulation Result of Interrogator Antenna at 5.8GHz with Reflection Loss -30dB

Table IV
Dimensions of internal dual band antenna with 5mm,10mm radiation boundary

Substrate length(L1)	75mm
Substrate width(W1)	60mm
Patch length(L2)	23.2mm
Patch width(W2)	16 mm
Probe feed position	1.4mm
Slot1	2.5mm(l3),1(w3)mm
Slot2	3mm(l4),2(w4)mm

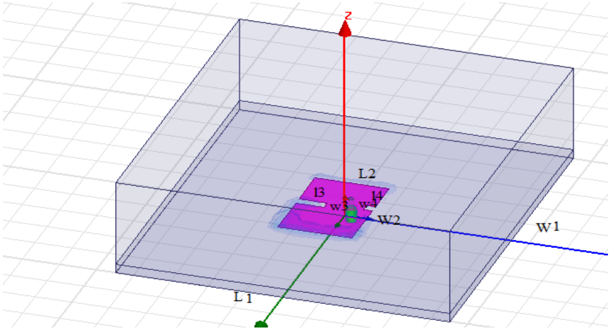

Fig 6. Simulated Dual Band Antenna

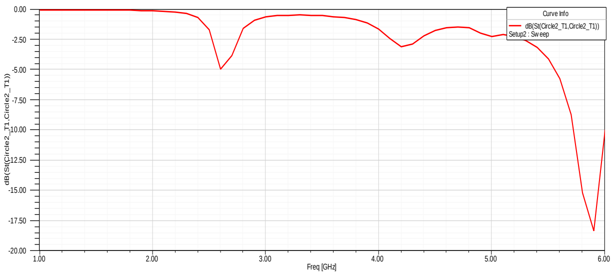

Fig7. Simulation Result of Receiver Antenna at 2.4GHz and 5.8GHz with 5mm Radiation Boundary

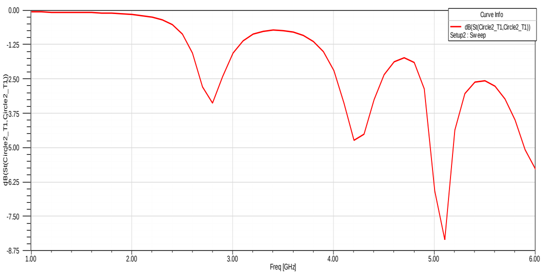

Fig 8. Simulation Result of Receiver antenna at 2.4GHz and 5.8GHz with 10mm Radiation Boundary

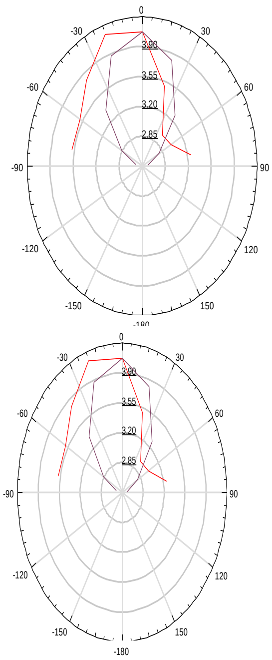

Fig 9. A) Radiation pattern of antenna at 2.4GHz B) Radiation pattern of antenna at 5.8GHz

IV.CONCLUSION

The wearable antenna radiations are compared here with different dimensions for both external interrogator and internal implantable antenna at 2.4GHz and 5.8GHz .The body skin is assumed like a lossy dielectric material with high dielectric constant. Two skin tissue structures are created here for simulation one at 5mm and another at 10mm and their reflection parameters are compared. The implantable antenna will be simulated with multilayer body skin structure and their performance will be analyzed in future.

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