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An Optimized Dual Band Antenna for Wireless Body Area Network

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ABSTRACT

Recent technological developments and advancements in wireless communication spread over different areas. Body Area Network (BAN) is a system of devices in close proximity to a person's body that cooperate for the benefit of the user. It is still an emerging technology, and as such it has a very short history. BAN technology emerges as the natural byproduct of existing sensor network technology and biomedical engineering. In this paper, a compact dual Band high gain Microstrip Patch antenna is designed for Wireless Body Area Network Applications. A reflecting Surface is added at a distance s from the antenna to enhance the gain. A significant result has been obtained to support the applications such as medical application, communication as well as wireless monitoring.

Keywords : Dual Band Antenna, Wireless Body Area Network, Return Loss, Radiation Pattern.

I. INTRODUCTION

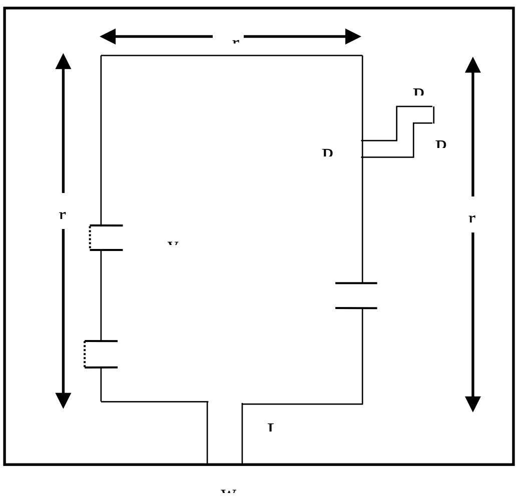
Future applications in the area of telecommunications are being driven by the concept of being connected or able to communicate anywhere and at any time. A Wireless Body Area Network consists of small, intelligent devices attached on or implanted in the body which are capable of establishing a wireless communication link (Chen *et. al.,* 1998). Wireless body area networks (WBAN) are expected to be a breakthrough technology in healthcare areas such as hospital and home care, telemedicine, and physical rehabilitation. Because the human body has a complex shape consisting of different tissues it is expected that the nature of the propagation of electromagnetic signals in the case of WBAN to be very different than the one found in other environments, e.g. offices, streets, etc. The idea is to monitor several vital signs parameters recorded by different sensors placed on the body surface, or even by implanted sensors; and that all signals are collected by a wearable receiver or wireless gateway to transmit the recordings to the doctor.

Continuous, everyday, wearable monitoring and actuating is part of this change. In this setting, sensors that monitor the heart, blood pressure, movement, brain activity, dopamine levels, and actuators that pump insulin, "pump" the heart, deliver drugs to specific organs, stimulate the brain are needed as pervasive components in and on the body. They will tend for people's need of self-monitoring and facilitate healthcare delivery (Durney *et. al.,* 1986 ; Gabriel *et. al.,* 1996 ; Pethig 1987 ; Gaandhi 1990 ; Yazdandoost *et. al.,* 2007).

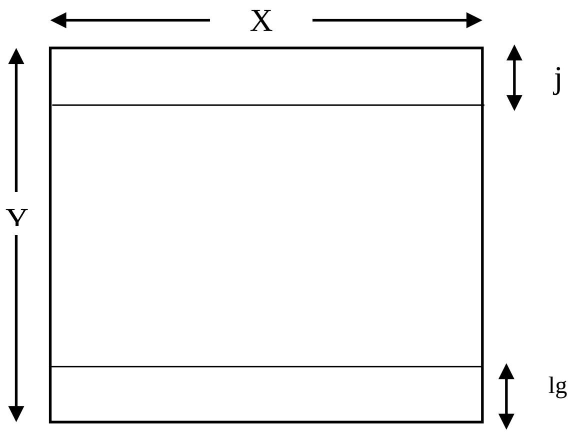
An antenna placed on the surface or inside a body will be heavily influenced by its surroundings (Chen *et. al.,* 1998). The consequent changes in antenna pattern and other characteristics need to be understood and accounted for during any propagation measurement campaign. The human body is not an ideal medium for radio frequency wave transmission. It is partially conductive and consists of materials of different dielectric constants, thickness, and characteristic impedance (Movassaghi *et. al.,* 2014 ; Baek *et. al.,* 2013 ; Sabrin *et. al.,* 2015 ; Karthik *et. al.,* 2017 ; Chamaani *et. al.,* 2015 ; Sukhija *et. al.,* 2017 ; Shakib *et. al.,* 2017). Therefore depending on the frequency of operation, the human body can lead to high losses caused by power absorption, central frequency shift, and radiation pattern destruction. The absorption effects vary in magnitude with both frequency of applied field and the characteristics of the tissue.

II. DESIGN OF PROPOSED ANTENNA

The proposed antenna is designed with the following materials and the dimensions of the antenna before optimization and after optimization is given in Table 1. The proposed geometry is shown in Figure 1. The optimization has been done for the dimensions of the antenna using particle swarm optimization which is inbuilt with the antenna simulation software.



(a)Front View



(b)Back View

Figure 1. Geometry of the proposed antenna (a) Front View (b) Back View

Table 1. Dimension of the parameters of the proposed antenna

Variable	Without Optimization (mm)	With Optimization (mm)
X	30	30
Y	38	38
t	0.035	0.035
h	0.8	0.82
lf	4	4
wf	2.8	2.8
lg	2	1.8487
r	8.5	8.7960
rl	32	32.2593
j	4	4.1005
u	2	2.0818
v	2	2.0732
s	9	8.7877
p	1	1
p1	6.5	6.9707
r1	3	2.85
p2	1	0.9873

Material = RT Duroid 5880 . Semi flexible material. Er= 2.2; loss tan = 0.0009

SAR value is calculated by placing the antenna on a heterogeneous rectangular phantom.

3 layers of phantom are skin, fat and muscle with the thickness of 2mm, 2mm, 6mm.

Dimension of phantom = 60×60 mm^2.

Resonance frequency = 5.5 Ghz and 7.5 Ghz

III. RESULTS AND DISCUSSION

The results of the proposed antenna is described in this section as it is required to be implanted in the body the SAR value has been evaluated based on the following relation.

$$SAR = \int \frac{\sigma(r)|E(r)|^2}{\rho(r)} dr$$

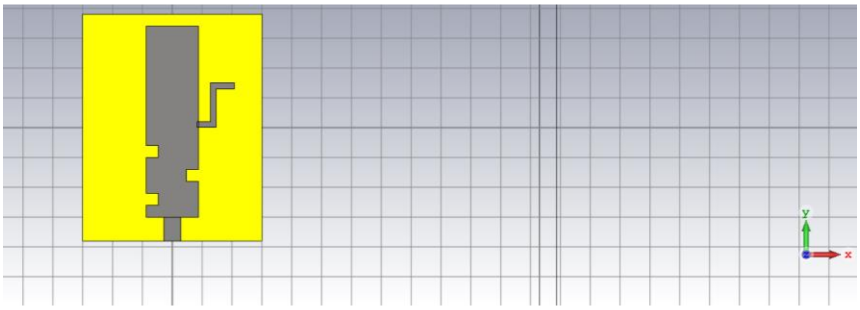
Where E(R)= electric Field

σ(R) = Conductivity of human tissue

ρ (R) = mass volume density of tissue.

The simulation results for the antenna, radiation pattern and the return loss are shown in Figure 2 through Figure 5. Also it satisfies two bands as 5.5 GHz and 7.5 GHz. The performance table is shown in Table 2. The Simulation software is CS.

Front View



Back View

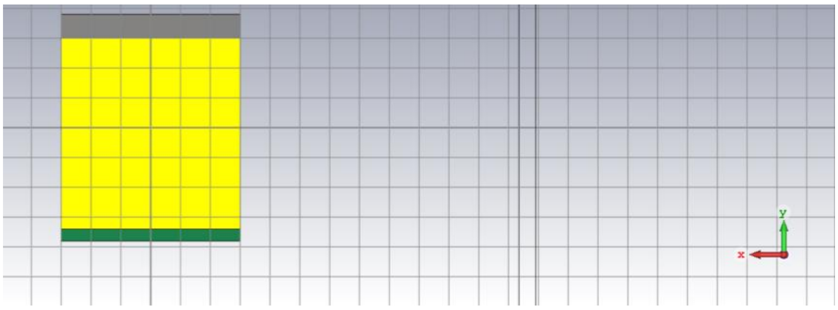


Figure 2. The proposed Antenna (a) Front View (b) Back View

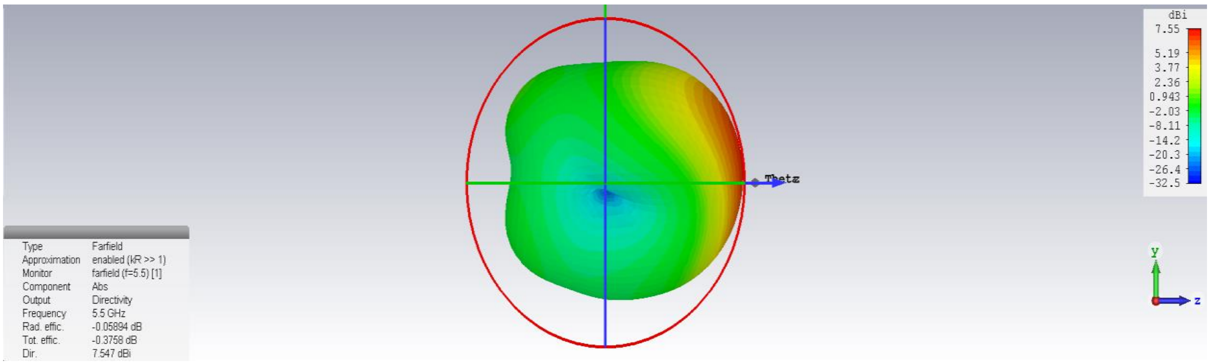


Figure 3. the 3-D radiation Pattern of the proposed antenna

S parameters

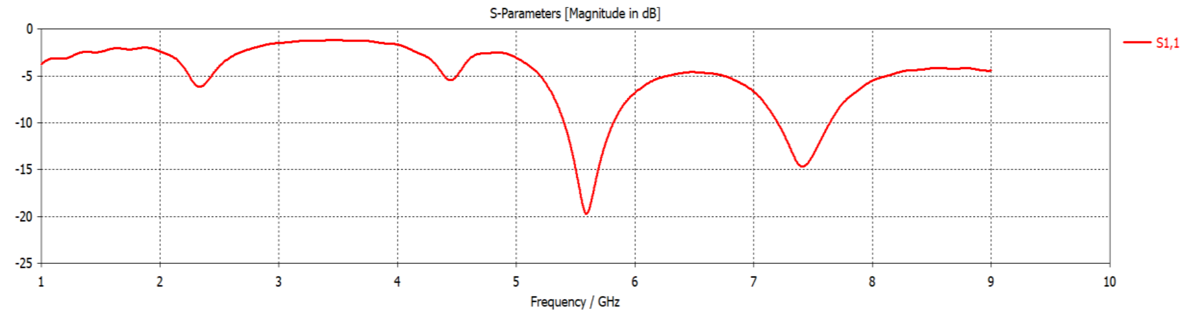


Figure 4. Return Loss of the proposed antenna

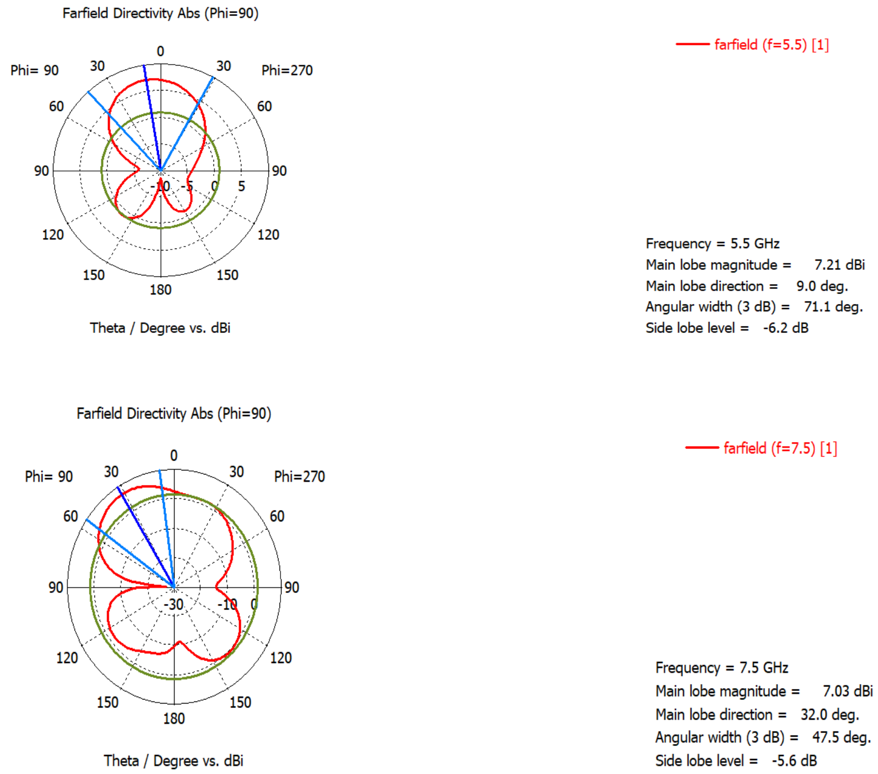


Figure 5. the 2-D radiation Pattern of the proposed antenna

Table 2. Performance Table for dual-band

Parameter	**Frequency (5.5GHZ)**	**Frequency (7.5 GHZ)**
Gain	7.21dBi	7.03dBi
Return Loss	-19.344dB	-14.667dB
Total Efficiency	90% (On Body)	80% (On Body)
VSWR	Less than 2	Less than 2

IV. CONCLUSION

In this piece of work, a dual band antenna has been designed for the use of wireless body area network to achieve two different bands. As Table 2 and Figure 4 two distinct frequency notches have been reflected where the bandwidth is 900 MHz approximately. The antenna is simulated in the platform of CST studio. The proposed antenna is an attractive candidate for wireless body area application. It can be fabricated and optimized using other algorithms to enhance the results.

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