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Design of a ISM Band Wearable Antenna for future Patient Monitoring systems

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Abstract:

This work aims to design an efficient and compact wearable antenna for future patient monitoring systems and telemedicine applications. The wearable radiating patch is built above a Jean cloth material and fed with suitable SMA connectors. Emphasis is given further to improve the performance parameters like Return Loss, Gain and radiation pattern of the antenna over the existing designs. It is observed that the Return Loss of the designed antenna is -46.29dB and the Gain hovers at about 7.13dB in the simulated meandered shape microstrip antenna.

Keywords — **Wearable Antenna, Telemedicine, ISM, ADS, SAR**

I. Introduction

Wearable Electronics have gained a lot of research in recent times. And as the trends predict, we are going to witness an exponential growth in demand for the wearable devices and their allied infrastructure development in the consumer electronics industry. In current scenario we have an array of wearable devices in the form of smart watches, which can measure the vital body parameters 24/7 all-round the year. Technological giants like Samsung, Apple, HTC have already launched a series of wearable electronic devices in the market. We have smart glasses from google which have Wifi and Bluetooth antennas embedded in the frame of the spectacles. On the other hand we have smart watches from the companies mentioned above, which have bluetooth antennas to pair with the consumer's smartphone, and exchange vital data. Then we also have modern day sensors, which can be placed on any body part and measure the bio signals whenever necessary, the sensors are embedded with Bluetooth antennas to connect to the smart phones and send in data in case of emergency. The motivation in carrying out the research works in wearable antenna design is the fact that these antennas have to packed into a relatively compact area in the wireless device, as compared to their mobile handset antenna counterparts. Further, receiving GPS Signals through such wearable antennas area different challenge altogether, as we know a GPS signal needs a wide view over the sky to make itself visible to constellation of satellites.

II. Literature Survey

Excessive light has already been thrown on the design methodologies and feasibility of the wearable rf circuits. The selection of the radiating patch material, making the antennas conformal, etc., are the various challenges addressed in the previous research in the field. [1] Studies the effects on human head by the radiation of the Microstripantenna in the ISM band and analyses the SAR, VSWR value for the same. Further in [2] effects of the radiating patch in case of tumor detection of breast cancer cases. Suitability of implantable antennas for medical applications have been widely discussed for different user cases, Interestingly [3] [4] a work on ISM bandRealtime data for pressure measurements using SAW wafers have also been carried out. Improvement in the antenna gain and bandwidth with the use of DGS and DMS structures has gained importance in case of complex RF solutions [5].Wearable antenna

are also considered for future Energy harvesting circuits in the UHF frequency band [6]. Low power antenna configuration forwireless power transfer circuits of IOT based application is discussed in [7].

III. Design Methodology

The proposed Microstrip Structure is designed based on the Transmission line theory. And the design equations (1) and (2) are taken up to arrive at the suitable structure for the wearable antenna. A meandered line design is desirable for the requirements for the patient monitoring as the patients should not feel the presence of the antenna in their clothing and make the wearable system aesthetic enough for commercial purposes.

$$f_0 = \frac{c}{2\sqrt{\epsilon_{reff}}}\left[\left(\frac{m}{L}\right)^2 + \left(\frac{n}{W}\right)^2\right]^{\frac{1}{2}} \quad \ldots.(1)$$

Equation (1) can be used to derive at the resonance frequency for the antenna based upont he design space present inside the proposed system, Once the resonance frequency is calculated, we cab derive an entire antenna dimensions based on the said theory.

$$W = \frac{c}{2f_0}\sqrt{\frac{2}{\epsilon_r+1}} \quad \ldots..(2)$$

Figure 1: Proposed Wearable Antenna Design

Parameters	Value (mm)

L1	7.75
L2	26.46
L3	19.33
L4	24.10
L5	2.80
L6	8.40
L7	2.28
L8	2.56
L9	17.56

Table 1: Calculated Antenna Dimensions

IV. Measured Parameters

A suitable EDA Tool was used for the realsidstion of a novel design of the proposed patient monitoring system. The radiatiing patch has been designed on a copper patch of thickness 35microns and the substrate choosen is Jean with suitable dieectric constant.

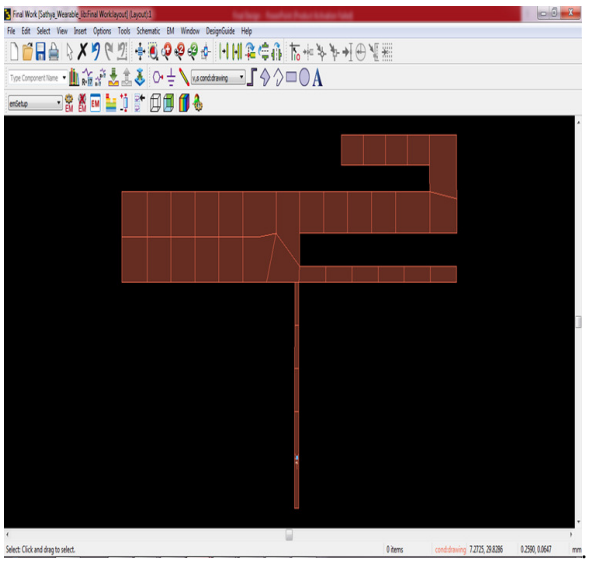

Figure: 2 Simulated View of the Proposed Antenna

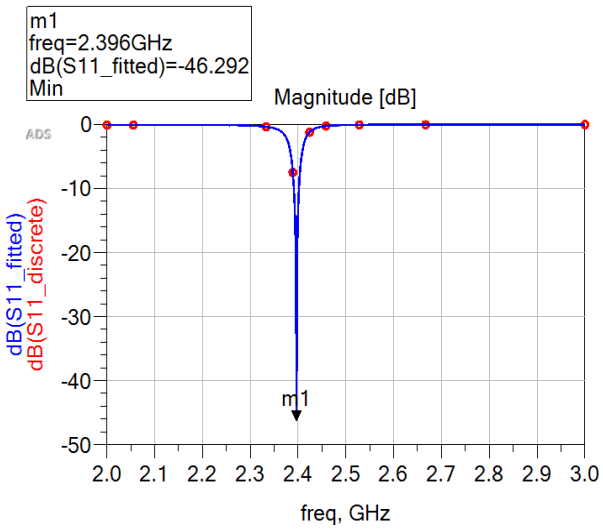

Figure 3: Simulated Return Loss of the Radiating Patch

It can be observed that the simulated antenna has performed as per the requirements, with a return loss -46.292dB, and a gain of 7.8dB which is quite appreciable (Figure 3). It can be observed that the current distribution (Figure 4) gives a fair idea about the radiating surface and we can be sure of the performance of the antenna in real time operations also.

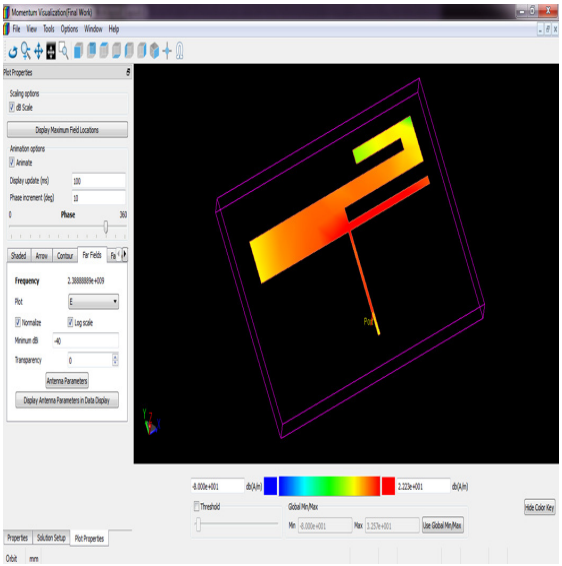

Figure 4: Current Distribution Pattern of the Wearable Antenna

The Simulated antenna has been fabricated on Jean cloth of the required ground dimensions (Figure 5)and suitable ports have been added to the antenna structure.

Figure 5: View of the Fabricated Wearable Antenna

Figure 6 shows the Test Results of the wearable antenna using a Network Analyzer. The fabricated antenna is characterized using the said test and measurement instrument and the performance is compared with the simulated results. And as it can be observed the simulated ant test results are more or less on the same page at -32.493. A little loss is observed din the test results owing to the connector losses and the soldering losses.

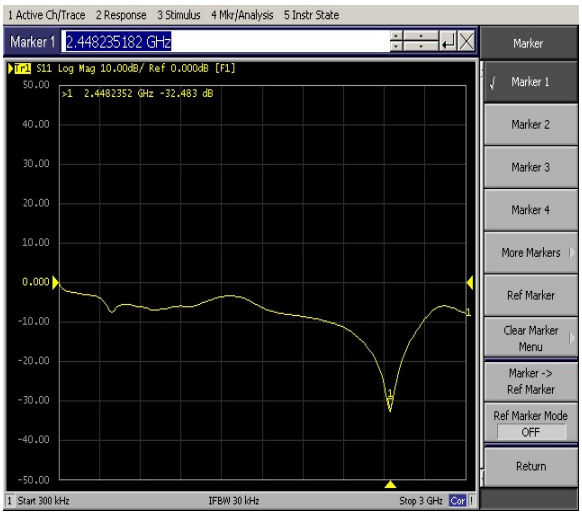

Figure 6: Network Analyzer Test Results of the Antenna

V. Conclusion

A novel wearable antenna is designed in this work for the future patient monitoring systems. The simulated results show that, the return loss for the wearable radiating patch hovers around -42.292dB and the test results using the test and measurement instruments provide the return loss at -32.493 dB in real time. Further the gain and directivity parameters can be improved with minor design corrections and proposed fabrication of the proposed design.

VI. References

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