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Body Worn Antenna for Telemedicine Applications

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Abstract: In this paper we present the body worn antenna for remote monitoring the human body specifically designed for telemedicine applications. The conventional antennas are not flexible & difficult for mobile users. There is a need of antennas which can be worn and part of user clothing defined as wearable micro strip patch antennas. The proposed antenna design is based on Coplanar waveguide feeding technique with inverted Double-U shaped connected slots on rectangular shaped radiating patch which is resonated at 1.85 GHz to regularly monitoring the human body for good health care services. The antenna parameters are Radiation pattern, Gain & VSWR are analysed using HFSS for inverted Double-U shaped antenna. The antenna with compact size of 21mmx28mmx1.6mm provides the VSWR value as < 2 and the gain of about 1.0466 dB. The reflection loss is about -20.0725 dB at 1.85 GHZ.

Keywords: Body worn antenna, CPW-Fed antenna, Inverted Double-U shaped antenna.

I. Introduction

Emergency responses to natural disaster automatically records the information in telecommunication technology. But, use of telemedicine presenting medical offerings remotely via telecommunication-based exchanging digital information has been suggested especially on occasion. During the last decade, the navy, space communication, and diverse governmental corporations have progressively developed telemedicine applications and tested them in actual and simulated civilian disaster emergencies. This manuscript opinions the records of telemedicine alertness at some point of real failures and associated conditions, offers insight into troubles that should be addressed, and summarizes improvements that are probable to improve future catastrophe results.

Telemedicine systems goal to provide superior health care services to humans. In current scenario, Telemedicine plays a major role due to the inconvenience of remote monitoring of human health. The major role of antenna for remotely monitoring the human body is to place in close proximity which presides high dielectric constant. The body area network is categorized as PIFA, micro strip antennas and planar Monopole antennas and the most preferable antenna is micro strip patch antenna. Due to their reduction in construction and cost. The placement of metallic ground plane between the body and the radiating elements leads to lower energy absorption in the body. The body worn antenna should essentially have higher bandwidth. As the monopole and dipole antennas does not have ground plane which lead to the radiating pattern effect to the body. So the patch antenna is preferred over these antenna.

In this proposed system a compact CPW feeding technique with inverted Double-U shaped antenna which has been analysed. The potential interference has been efficiently deduced by designing inverted Double-U shaped patch and a rectangle slot in the CPW ground.

A. Body Worn Antenna

In the last decade, the body area antenna shown a rapid growth in the research with huge developments in the measurement of human parameters such as heart beat, movement of foetus recognition, blood pressure and temperature. The body area antenna system can be implemented in future day's garments with enhanced functionalities to have rapid quality of life.

B. Micro Strip Patch Antenna

The micro strip patch antenna comprises patch, substrate and ground plane. The copper, silver or gold are some of the conducting material which is used as radiating patch. The patch antenna can be in any form of shapes like rectangle, circle etc. The dielectric substrate is photo etched with patch and feed line. In body area antenna with Double-U shaped is having Fr_4 substrate ξ_r=4.2, a loss tangent of 0.008 at 3 GHZ and a thickness of 1.6 mm.

C. Antenna Design and Geometry

Step I) Calculation of Patch Width

$$w = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where, c is speed of light (m/s)

f_r is the resonant frequency (GHZ)

w is the width of the patch (mm)

Step II) Finding the Effective Dielectric Constant

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12h/w\right]^{-1/2}$$

Where, ξ_r is the relative permittivity

h is the height of the substrate (mm)

Step III) Finding the Effective Length of the Patch

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}}$$

where, ε_{reff} the effective dielectric constant,

f_r is the resonant frequency (GHZ)

Step IV) Length of the Patch

$$L = L_{eff} = -2\Delta L$$

where

$$\Delta L = 0.412h\frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{w}{h} + 0.8\right)}$$

Step V) Frequency of Operation

$$f_c = \frac{c}{2L\sqrt{\varepsilon_r}}$$

where f_c is the cut-off frequency

D. Proposed Antenna Design

A compact body worn CPW fed micro strip patch antenna is designed with dimensions of 21mmx28mm. The Double-U shaped connected slots in radiating patch with rectangular slot in infinite ground plane antenna is resonating at the frequency of 1.85 GHz. The width of the rectangular slot in ground plane is 0.8 mm and the width of U shaped connected slots are 0.2 mm each. The antenna substrate with the thickness of 1.6 mm is having relative permittivity 4.4 and loss tangent 0.02.

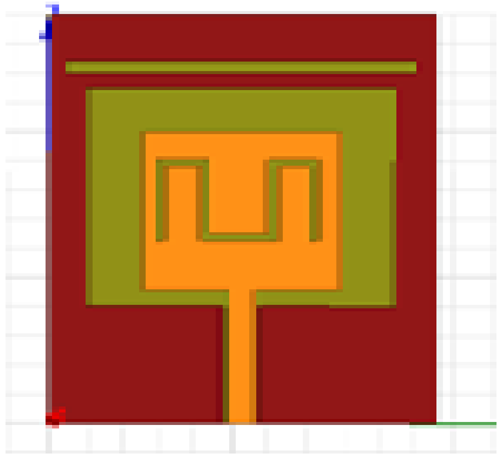

Fig. 1: Design of Compact Body Worn Patch Antenna with Inverted Double-U Shaped Connected Slots

Fig. 1 shows the geometry of compact body worn antenna with inverted Double-U shaped connected slot antenna. The dimensions of the body worn antenna are 28mmx21mmx1.6mm. The dimensions of the radiating patch are 15mmx16.8mm respectively. The total length of the inverted Double-U shaped slots are 5.6 mm. The space between the radiating patch and CPW ground plane is 1.2 mm.

II. Results and Discussion

A. Return Loss

The patch antenna is simulated by using High Frequency Structural Simulator. The proposed antenna had CPW feed with a full port impedance of 50 ohm. The bandwidth of the proposed antenna has been increased by having rectangular slot on the ground plane. The frequency response of inverted Double-U shaped antenna is shown in Fig. 2.

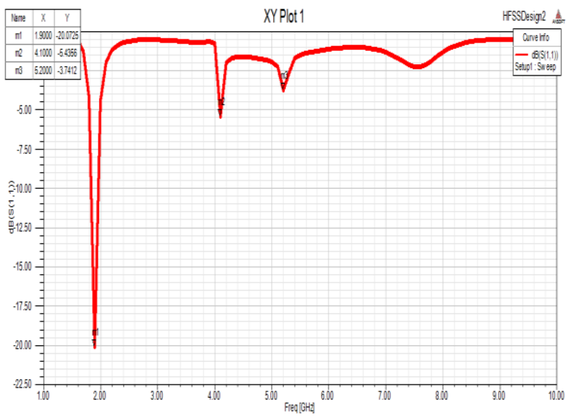

Fig. 2: Return Loss Curve of Patch Antenna with Inverted Double-U Shaped Connected Slots

B. Gain

The gain describes how well the antenna converts the input power into radio waves headed in a specified direction. The gain of the body worn antenna with resonating frequency 1.85 GHz is 1.0466 dB. Fig. 3 shows the gain of the inverted Double-U shaped connected slot antenna.

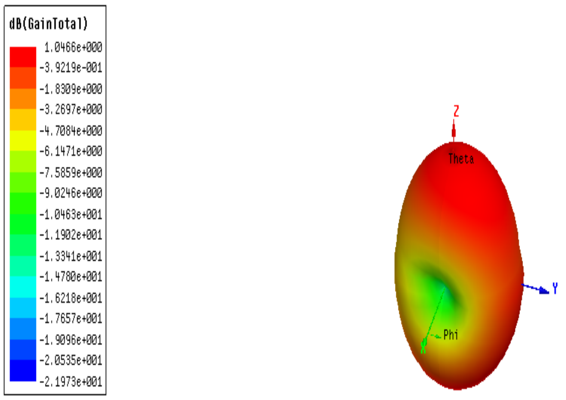

Fig. 3: Gain of the Antenna

C. Radiation Pattern

The antenna radiation pattern describes how the antenna radiates energy out into space and how it receives energy. The proposed antenna having the bi-directional radiation pattern. The radiation pattern of the antenna is shown in Fig. 4.

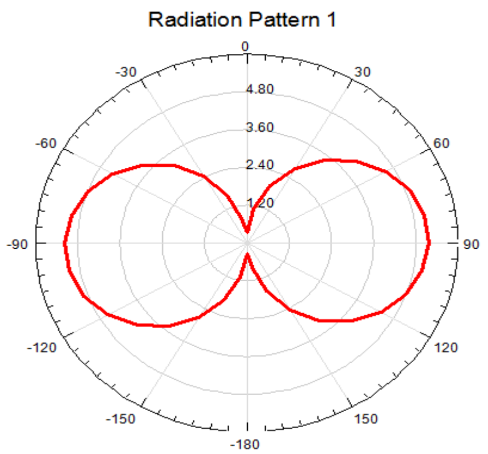

Fig. 4: Radiation Pattern of the Antenna

D. VSWR

The Voltage Standing Wave Ratio is the measure of how efficiently the radio frequency power is transmitted from the power source trough transmission line into a load or an antenna. The proposed antenna having the VSWR value as <2.

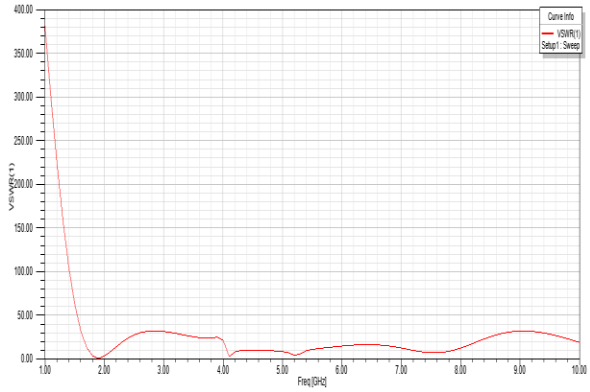

Fig. 5: VSWR of the Antenna

III. Conclusion

A CPW fed patch antenna with inverted Double-U shaped connected slots with rectangular slot resonating at the frequency of 1.85 GHz with gain 1.0466 & return loss is about 20.0725 dB. The designed antenna has provide a bandwidth ranging from 1.8 GHz to 5.2 GHz used for various wireless applications with a -20 dB return loss. The results shows that the antenna produces good radiation pattern which is suitable for body area network & telemedicine applications. In future, the frequency of band can be increased to cover several applications by incorporating different shapes of patches on flexible substrate material. To further reduce the size of the antenna structure, the ground plane can be modified.

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