Analysis of a Planar Inverted-F mobile handset Antenna with reduced radiation towards human head

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Abstract: This paper present the analysis of a new mobile handset antenna structure which reduces the value of the specific absorption rate (SAR). The antenna is based on the PIFA structure and operates at 900 GHz. The simulation and analysis of SAR and temperature distribution induced by a Planar Inverted-F Antenna on human head model is done using COMSOL Multiphysics. The SAR and temperature distributions of Omni directional PIFA with that of a modified PIFA with reduced radiation towards human head, both operating at 900 MHz are compared in this paper.

Keywords: PIFA, SAR, Omni directional PIFA

1. Introduction

Because of the widespread use of mobile phones throughout the world, the effect of mobile phone radiation on human head has become a matter of concern and hence this subject needs more attention, interest and study. The safety standards are regulated in terms of the peak specific absorption rate (SAR) value of tissue. *P*ower absorption of electromagnetic energy in human tissues induces heat in the tissues and results in temperature increases which induce adverse physiological effects. Therefore in order to provide information on levels of exposure and health effects from mobile phone radiation, it is essential to simulate both electromagnetic field and heat transfer within an anatomically based human head model to represent actual processes of heat transfer within the human head. In this simulation we used the RF module of the COMSOL software. In this study, a three-dimensional realistic human head model with the PIFA antenna, which is designed for low SAR and temperature increase in the human head is designed and compared with an Omni directional PIFA antenna. An analysis of heat transfer in human head exposed to electromagnetic wave was calculated using the bio heat equation. The bio heat equation models the heating of the head with a heating loss due to the blood flow. This heat loss depends on the heat capacity and density of the blood, and on the blood perfusion rate. The frequency of 900 MHz chosen for simulations in this study, as they have wavelengths in the microwave band and are used frequently in area of mobile phone usage.

2. Methods and model

Fig.1 shows the geometry of proposed antenna. The antenna is simulated on an FR4 substrate of thickness 1.6mm and relative permittivity 4.3 and has an overall dimension of $50\times100\times11.6$ mm^3. The radiation pattern is shown in Fig 2.

Fig1.PIFA antenna

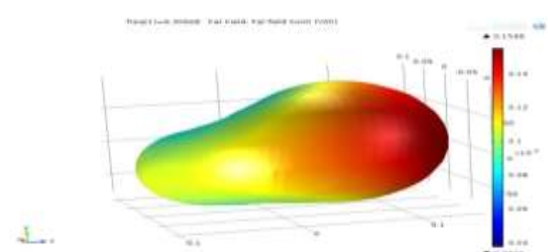

Fig.2 Radiation pattern

Fig.2 (a) shows the three-dimensional finite element mesh of human head model with antenna including the perfect matching layer (PML).The distance between the antenna and head model is selected as 7mm. Fig.2 (b) shows the electric field distributions on the antenna.

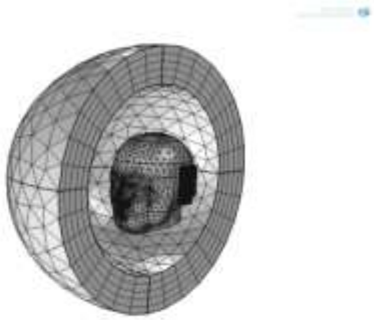

Fig.2 (a) Three-dimensional finite element Mesh of Human head model with PML.

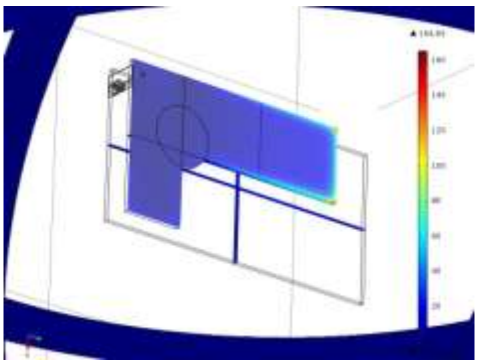

Fig.2 (b) Electric field distribution

3. Results and discussion

The analysis of the SAR values and distributions and temperature increases (ΔT) in a human head model for the proposed PIFA antenna are compared with that due to an Omni directional PIFA antenna with the same dimensions and same gap distance.

Fig. 3(a) shows color maps of the distribution of local *SAR* values. Fig. 3(b) shows the localized maximum temperature increases (^{o}C) in human head exposed to the radiation

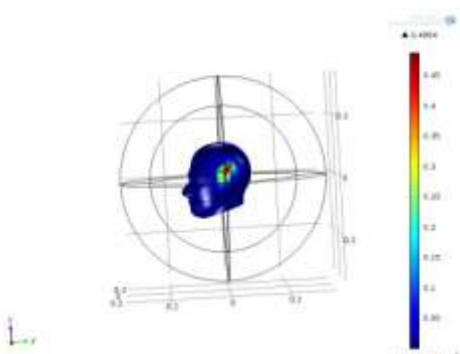

Fig.3 (a) Plot of SAR (W/Kg) distribution in human head exposed to the radiated power of 1W at the frequency of 900 MHz

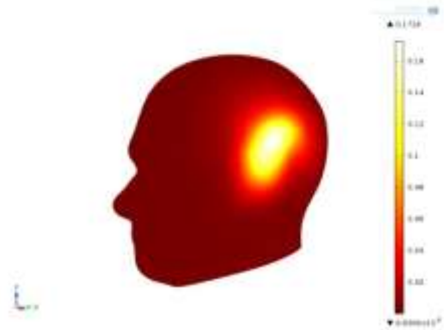

Fig 3(b) plot of temperature increase (^{o}C) exposed to the radiated power of 1W at the frequency of 900 MHz

In order to study the effects of the radiation characteristics of a mobile phone antenna radiation exposure to a human head model we compared our simulated result with an Omni directional antenna with the same operated frequency. The simulation of electric field distribution and the temperature profiles within the human head exposed to the two antenna radiation along the same extrusion line Fig.3(c) show the extrusion line for the proposed PIFA antenna and the Omni directional PIFA antenna respectively

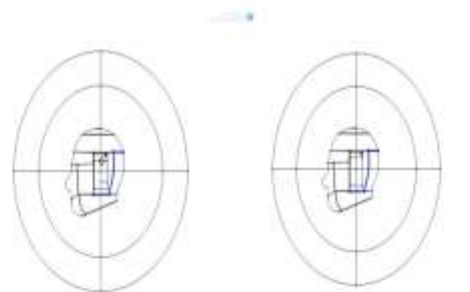

Fig 4(C)1 Extrusion line of proposed antenna   Fig 4(C)2 Extrusion line of Omni directional antenna

Fig.3(c) Extrusion line

The Fig 3(d) and 3(e) represents the SAR variation of the two antennas through the extrusion line we can see that there is a large variation of the SAR peek from 0.4 (SAR of proposed antenna) to 5.5 (SAR of Omni directional antenna)

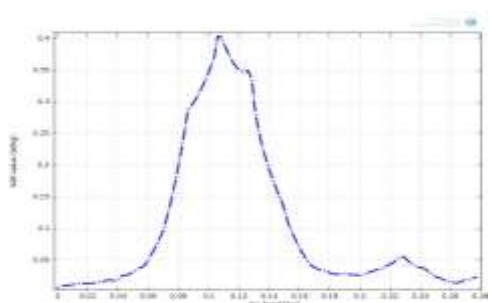

Fig 3(d).SAR variation of proposed Antenna

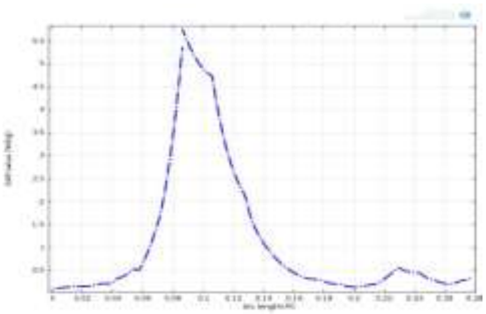

Fig 3(e). SAR variation of Omni directional Antenna

The Fig 3(f) and 3(g) represents the temperature increase of the two antennas through the extrusion line. The maximum temperature increase of proposed antenna is about 0.04 ^{0}C and in the case of Omni directional antenna it is increased as 0.75^{0}C

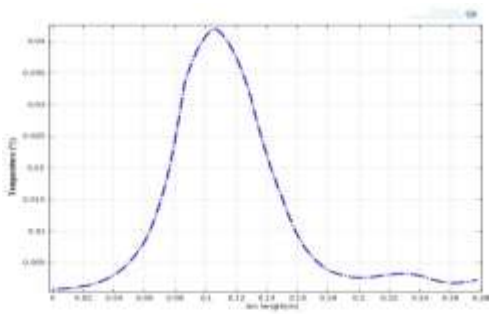

Fig 3(f). Temperature increase of proposed Antenna

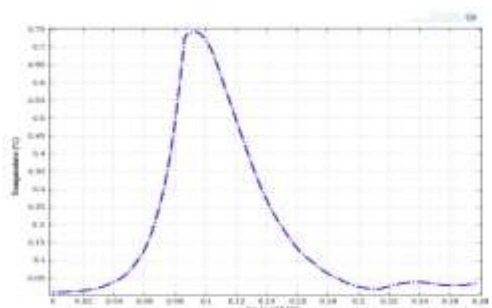

Fig3 (g). Temperature increase of Omni directional antenna

4. Conclusions

This study presents the numerical simulation of SAR and temperature distribution in the realistic human head model exposed to mobile phone radiation at the frequency of 900 MHz with various gap distance of 0.7 cm between the mobile phone and the human head using COMSOL software. This study also includes the comparison of SAR and temperature increase of proposed PIFA antenna to the Omni directional PIFA antenna with the same operated frequency and same gap distances. The results show that there is a significant increase in SAR and temperature increase in Omni directional PIFA antenna than the proposed antenna

5. References

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