SYSTEMATIC REVIEW OF SAR REDUCTION TECHNIQUES FOR MINIMIZING MOBILE PHONE RADIATION

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ABSTRACT

In this mobile digital world cellular handsets and tablet pc's have become the common used devices .These devices use the Electromagnetic Frequency (EMF) Spectrum which is wide spread in our atmosphere. Electromagnetic fields of all frequencies represent one of the most common and fastest growing environmental influences, about which anxiety and speculation are spreading. All populations are now exposed to varying degrees of EMF, and the levels will continue to increase as technology advances. The World Health Organization (WHO) established the International EMF Project in 1996 to assess the scientific evidence of possible health effects of EMF in the frequency range from 0 to 300 GHz and possibly reducing the effects caused by them. Our project aims in limiting the hazardous EM radiation emitted from the mobile phones. This can be achieved by using the PIFA antenna in the Transfer electromagnetic (TEM) cell experimental setup.

Keywords

Antenna Measurements, Antenna Radiation Pattern, Electromagnetic Wave Absorption, Mobile Antennas, Specific Absorption Rate.

1. INTRODUCTION

Within a short period of time, mobile phone has created a great impact on people all over the world [3]. According to the report of World Health Organization (WHO) about 4.6 billion of people around the world are using mobile phones. The radiation emitted from the mobile phone is transmitted in all the directions [5]. A part of the energy will incident on human head. The electromagnetic radiation interacts with human head and produce heat. This heat will be absorbed by the skin and by some other special tissues within our head [7]. Therefore, it can cause incurable diseases to human like brain tumor, cancer, etc. The objective of this paper is to limit the radiation level being emitted by the Planar Inverted F-Antenna (PIFA) by varying the antenna length placed inside the TEM cell using trial and error method. The simulation tool we are going to use is computer simulation technology(CST) microwave studio software from which we can find the characteristic impedance and VSWR.

2. EXISTING SYSTEM

Already a huge number of studies have been carried out for limiting the hazardous EM radiation from mobile antenna. But, still now no method has been proposed for completely eliminating the SAR [9]. The methods so far proposed have significantly limited the SAR within a specific value [10-13]. EBG structure can act as a perfect magnetic conductor surface which will reduce the radiation from mobile antenna by reducing the surface wave [1]. Metamaterials can be used to study the SAR reduction using finite-difference time-domain (FDTD) method [8]. By placing the Metamaterials between the human head and mobile antenna the SAR can be reduced [6]. Our work in this paper is to limit the EM radiation emitted from mobile antenna by varying the antenna length.

3. PROBLEM FORMULATED

Figure: 1(a) shows the scan image of a common human head before the usage of mobile phone [15]. From this image we can observe that the temperature of this human is within the range of standard temperature [17]. Figure: 1(b) shows the scan image of a common human after the usage of mobile phone for 15 minutes [19-21]. From this we can observe that heat generated inside the head is massive when compared to the previous image. This clearly shows that the interaction of EM radiation with human head is the fact behind the cause for this massive increase in temperature.

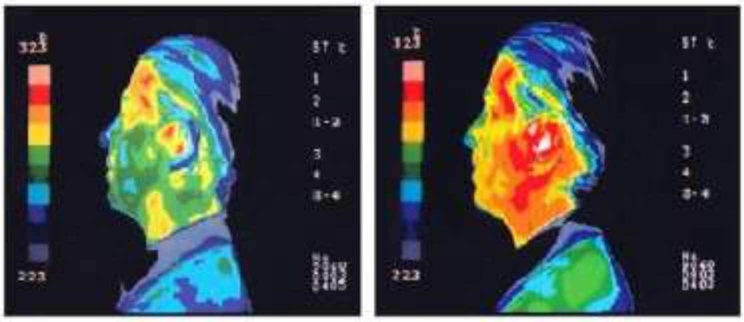
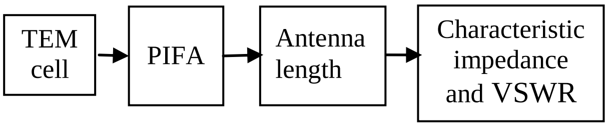


Figure 1(a) : Before using mobile phone 1(b) : After using mobile phone for 15 minutes

4. PROPOSED WORK FLOW



4.1 TEM (Transverse Electro Magnetic) Cell

Figure 2 : The rectangular TEM cell

The rectangular TEM is broadly used for testing of emission from electronic devices [2]. The TEM cell is made up of a rectangular coaxial transmission section which is tapered at both sides with coaxial connector, as shown in Figure : 2. It consists of two conductors. The inner conductor which is also called as septum acts as the positive conductor or hot line [4]. The outer conductor acts as a ground.

Figure 3: Experimental setup for characterizing the impedance of PIFA

This Figure: 3 shows the experimental setup for characterizing the PIFA's impedance and VSWR measurement. To measure the characteristic impedance of PIFA we have to place the PIFA inside the TEM cell. The one end of TEM cell is connected with a load of 50Ω [8]. The other end is connected to a HP 8791A network analyzer. The same experimental setup is used to measure VSWR.

4.2 Planar Inverted F-Antenna

Figure 4 shows that the Planar Inverted Fractal Antenna (PIFA) which is a type of linear Inverted F-Antenna (IFA) [14]. PIFA is the widely used mobile antenna structure as it is widely used in most type of mobile phones due to its characteristics like low profile, small size, built-in structure, easy fabrication, low manufacturing cost and simple structure [16].

4.3 Antenna Length

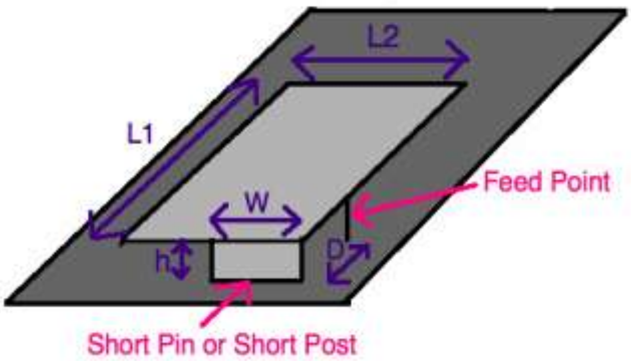


Figure 4: Planar Inverted-F Antenna, with a sorting plane

Where, L_1 – length of PIFA; L_2 – width of PIFA;W –width of shorting pin or shorting post; D –distance of feed from shorting pin; h –height of PIFA from ground plane.In this paper we have chosen length of PIFA (L_1) as the parameter which is to be varied in order to limit the SAR [6].

4.4 Characteristic Impedance and VSWR

There are large numbers of simulation tools available for designing mobile antenna. We have decided to use computer simulation technology (CST) microwave studio software due to its advantages such as multi-technology co design, high speed data link and easy integration to other components [18]. From the simulation result, we can observe the characteristic impedance and VSWR of PIFA.

5. RESULTS AND DISCUSSION

5.1 Numerical Analysis

The SAR rating for various mobile phones can be defined using number of standards [25]. Here we have concentrated on American standard of SAR rating as it is being followed in many foreign countries as well as accepted by wide range of people all over the world.

Table 1 : Comparison of SAR for various mobile phones

S.No.	Product name	SAR Rating (American standard) [1.6 W/kg]	SAR Rating (European standard) [2 W/kg]
1.	Apple	1.19	1.10
2.	Nokia	1.40	1.38
3.	Samsung	1.28	1.32
4.	G-Five	-	1.78
5.	Karbonn	-	1.97
6.	Micromax	-	1.94

From this Table :1 we can infer that Mobile phones manufactured by international branded companies have average SAR rating. But the mobile manufactured by some unbranded companies have high SAR rating [22-24].

Table 2 : Radio Frequency (RF) sources in India

R. F Source	Operating Frequency	Transmission Power	Availability in numbers
AM/FM Tower	540 KHz-108 MHz	1 - 300 KW	380
Wi-Fi	2.4 – 2.5 GHz	10-100 mW	--
Cell Towers	800, 900, 1800, 2450 MHz	20 W	5.4 Lacs
Mobile Phones	GSM-900	2 W	700+Million

From these Table : 2 we can infer about various R.F sources existing in India and their operating frequency range, transmission power as well as the availability of these sources [27]. The major sources of radio frequency in India are the transmitting towers such as AM/FM Tower, Cell Towers, Mobile Phones etc. emit EM radiation continuously. The EM radiation emitted from these sources has risen exponentially by rapid growth of wireless technology such as cell phones, Wireless Fidelity, Wi-max and other wireless devices [26].

Table 3 : Reference levels for general public at 900MHz

Country or Organization	Document	900 MHz	
		Electric field (V/m)	**Power density W/m^2**
International health based guidelines			
International commission of non ionizing radiation protection	ICNIRP 1998	41.25	4.5
International/ Institute of Electrical and Electronics Engineer	IEEE,1999 USA	47.6	6.0
European/ European Committee for Electro technical Standardization (Technical committee)	CENELEC,1995	41.1	4.5
National health based guidelines			
Australia/ Standard Association of Australia	AS/NSZ, 1998	27.5	2.0
East European health based guidelines			
Hungary/ Hungarian Standard Institution	Hungary, 1986	6.1	0.1
National guidelines based on precautionary approaches			
--	Belgiuma	20.6	1.1
Italy/ Ministry of Environment	Italy 1, 1998[b]	20	1.0
Italy/ Ministry of Environment	Italy 2, 1998[b]	6	0.1
Switzerland/Schweizer Bunndesrat	NISV, 1999	4	0.04
Local recommendations, based on precautionary approaches			
Austria Local	S vorGW 1998	0.6	0.001

This Table : 3 shows the various reference levels for the general public which are guidelines based at 900MHz.

The following ICNIRP guidelines have been adopted as standard by India for limiting the exposure to radio frequency energy produced by mobile phones . The SAR value from the Table : 4 has been averaged using 10g of average mass over a period of 6 minutes.

Table 4 : ICNIRP guidelines adopted by India

	Whole-body average SAR (W/kg)	Localized SAR head and trunk (W/kg)	Localized SAR limbs (W/kg)
General Public Exposure [25]	0.08	2	4

5.2 Numerical Results

5.2.1 VSWR Measurement

The reduction in the length of PIFA will results in a very complicated structure. The length of PIFA is varied between 9.4 cm and 1 cm using trial and error method and the VSWR readings are summarized as follows. From the following Table : 5, we can infer that if the length of PIFA is reduced then the VSWR is also reduced considerably. This shows that VSWR is directly proportional to the length of PIFA.

Table 5 : Various VSWR measured by significantly varying the length of PIFA

S.No	Length of PIFA (cm)	VSWR
1.	9.4	53.28
2.	8.5	52.64
3.	7.3	52.19
4.	6.8	51.94
5.	5.4	51.53
6.	4.6	51.11
7.	3.5	50.85
8.	2.6	50.31
9.	1.0	49.92

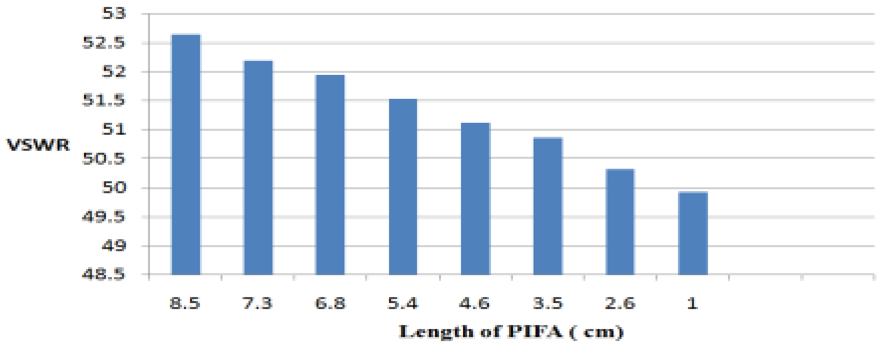


Figure 5 : Statistical analysis of VSWR by varying the length of VSWR

From the numerical and the graphical results plotted in Figure : 5, it shows as the length of the PIFA antenna decreases the VSWR also decreases and they are proportional to other.

5.2.2 Characteristic Impedance Measurement

Using trial and error method we have calculated characteristic impendence by varying the length of PIFA. From the following Table : 6 we can infer that if the length of PIFA is reduced then the Characteristics impedance(Ω) is also reduced considerably. Figure : 6 shows that Characteristics impedance (Ω) is directly proportional to the length of PIFA.

Table 6 : Measurement of characteristic impedance by varying the length of PIFA

S.no	Length of PIFA (cm)	Characteristics impedance (Ω)
1.	9.4	52.6819
2.	8.5	52.4350
3.	7.3	52.0189
4.	6.8	51.7998
5.	5.4	51.4668
6.	4.6	51.1421
7.	3.5	51.0214
8.	2.6	50.9273
9.	1.0	50.8427

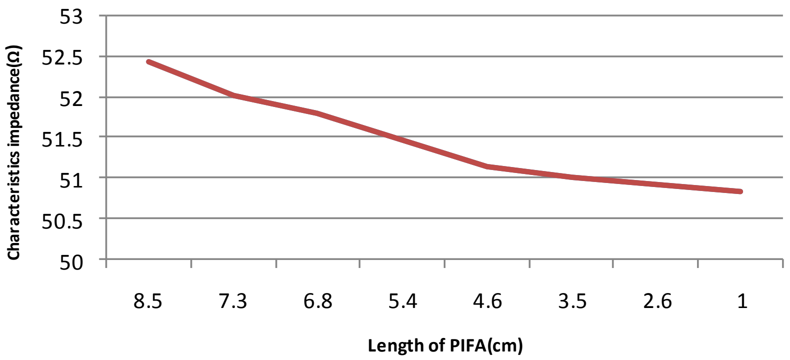


Figure 6 : Length of PIFA versus Characteristic impedance

The reflection coefficient can be calculated using the relation

$$|\Gamma| = (Z_L - Z_O) / (Z_L + Z_O) \quad (1)$$

Where, Z_O-source impedance & Z_L-load impedance

6. CONCLUSION

The progress in science and technology is a nonstop process. New things and new technology are being developed every now and then. The proposed work is based on investigating PIFA which is more reliable, compact and fewer complexes. Using the simulation tool, computer simulation technology (CST) microwave studio software the feasibility of the design has been studied. In future, this simulation result can be used to design low SAR PIFA.

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