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Hazardous Electro-Magnetic Radiation from Mobile Phones

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Abstract: *In this digital world mobile phones has become the most common used electronic device by human beings. According to Telecom Regulatory Authority of India (TRAI) mobile phone usage has been increasing 10% every year and the radiation emitted from the mobile phones has been rising from day to day. Specific absorption rate (SAR) refers to the amount of the radiation absorbed by the human body and SAR increases due to the interaction with the human head. This paper aims in limiting the hazardous radiation from the mobile phones and there by safely using the telemetry devices.*

Keyword: *Antenna Measurements; Antenna Radiation Pattern; Electromagnetic Wave Absorption; Mobile Antenna; Specific Absorption Rate.*

1. INTRODUCTION

Now a day's mobile phone usage has been drastically increased to a greater extent [5]. Within a short period of time, mobile phone has created a great impact on people all over the world According to the report of World Health Organization (WHO) about 4.6 billion of people around the world are using mobile phones. The mobile phones are usually operated at a frequency range between 450 and 2700 MHz [15]. The transmitting power of mobile phones will be around 0.1 to 2 watts. The electromagnetic radiation emitted by the mobile phones will lead to a lot of health hazards. The radiation emitted from the mobile phone is transmitted in all the directions [25]. 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 [20]. Therefore, it can cause incurable diseases to human like brain tumor, cancer, etc. Based on how close the mobile antenna is located near your head, the rate of absorption of radiation energy by the tissues will vary in the range between 20% and 60% [30]. The objective of this paper is to limit the radiation level being emitted by the Planar Inverted

F-Antenna (PIFA) antenna by varying the antenna size like length, width or height using trial and error method to achieve a sustainable output. Limiting the side lobe level will automatically curtail the radiation being emitted by the mobile antenna [31]. The simulation tool we are going to use is advanced system design (ADS) .From the output obtained using ADS tool, we can find whether the insertion loss has been decreased or increased by trial and error method.

2. EXISTING SYSTEM

Already a huge number of studies have been carried out for limiting the hazardous EM radiation from mobile antenna [2]. But, still now no method has been proposed for completely eliminating the SAR. The methods so far proposed have significantly limited the SAR within a specific value [1]. EBG structure can act as a perfect magnetic conductor surface which will reduce the radiation from mobile antenna by reducing the surface wave [6]. Metamaterials can be used to study the SAR reduction using finite-difference time-domain (FDTD) method [11]. By placing the metamaterial between the human head and mobile antenna the

SAR can be reduced. Instead of keeping the mobile antenna at the top, it can be placed at the back side of the hand-held terminal [9]. This result in the radiation pattern faced away from the human head regardless of

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the antenna type. Our work in this paper is to limit the EM radiation emitted from mobile antenna by varying the antenna size.

3. PROBLEM FORMULATION

The effect of mobile phone radiation on human health is the subject of recent interest and study, due to the enormous increase in mobile phone usage throughout the world [13]. When a person uses cell phone, most of the heat gets dissipated onto the surface of his head. The radio waves emitted by a GSM handset can have a peak power of 2 watts, and a US analogue phone had a maximum transmit power of 3.6 watts [19]. Other digital mobile technologies, such as CDMA2000 and D-AMPS, use lower output power, typically below 1 watt. Though the brain's blood circulation is capable of disposing this excess heat by increasing the flow of blood, this is not in the case of cornea, which does not have this temperature regulation mechanism and it leads to cataract [17].

In addition to causing brain tumors, the usage of cell phones cause disturbed brain functioning which leads to lack of concentration and work and also it leads to severe damage to genes which affects the health of future generations too more over it causes an increased blood pressure which is due to the fast flow of blood circulation in order to dispose the heat generated [16]. This blood pressure caused is a main factor which paves way for heart attack to enter into the body [18].

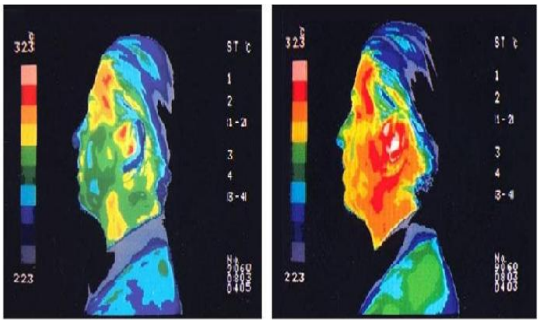

Figure 1(a) Before using Mobile phone *1(b) After using Mobile phone for 15 minutes*

Also, the immune system of our body gets weakened due to the radiations emitted [22]. The heat emitted also gets transmits to the skin and results in burning skin on face, hot ears, head ache and fatigue [26]. The radiation also affects the part of memory which is responsible for short term memory storage. Figure.: 1(a) shows the scan image of a common human head before the usage of mobile phone. From this image we can observe that the temperature of this human is within the range of standard temperature [24].Thus, it is obviously found that the heat produced inside the human head is fairly constant. Figure 1(b) shows the scan image of a common human after the usage of mobile phone for 15 minutes. From this we can observe that heat generated inside the head is massive when compared to the previous image [23]. This clearly shows that the interaction of EM radiation with human head is the fact behind the cause for this massive increase in temperature. Another fact says that an hour of continuous exposure to radiation emission from mobile phone can cause severe threat to the safety barrier in blood causing the proteins and toxins to leak into the brain [29]. Even exposure to low level radiation causes the RBC to leak hemoglobin which leads to heart and kidney stone formation [28].

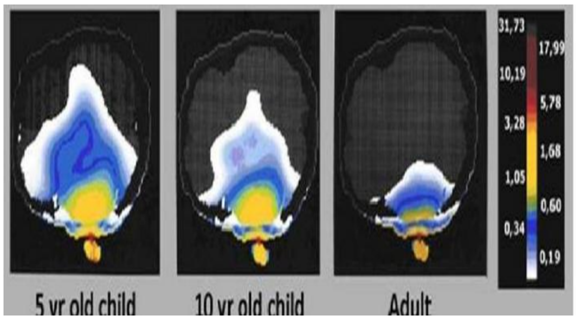

Figure 2 Penetration of Electromagnetic Radiation into human skull

Since the skulls of adults are grown up when compared to that of children, the radiation effects is worse in children than in adults [21] and it is found that the children aged below 5 years are very much exposed to the radiation effect when compared to the adults [29]. Since their head is small and skull is underdeveloped, about 75% of the total radiation penetrates into their skull and poses the above mentioned threats to them. Whereas children of age around 10 years, about 50% of the total radiation emitted penetrates into their skull. However it is only 25 % in the case of an average adult [31].

4. PROPOSED WORK

When considering about the mobile antenna to be used, we have gathered some mobile antennas that are frequently used. They are Rectangular micro strip antenna, Planar inverted F-antenna (PIFA), Inverted F-antenna (IFA) and Folded inverted coupled antenna (FICA).

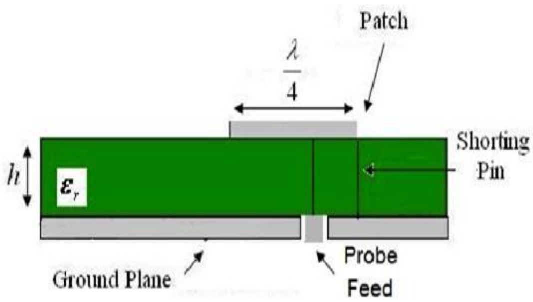

Figure 3 Planar Inverted F- Antenna (PIFA)

We have chosen PIFA 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.

4.1 Planar Inverted F-Antenna

PIFA is a type of linear Inverted F-Antenna in which the wire radiator has been replaced with a plate to increase the bandwidth [12]. PIFA is the widely used mobile antenna structure in large number of mobile phones. It also reduces the required space in the mobile phones as the antenna is resonant at a quarter wavelength. By keeping the shorting pin at the end PIFA can be made to resonate at quarter wavelength. The position of the feed controls the input impedance which is placed between open and shorted ends. PIFA is placed on the top of the dielectric medium of permittivity [14].

4.2 Antenna Size

Basically there are various number of antenna parameters like antenna size, gain, directivity, radiation pattern, efficiency, polarization and impedance matching. For our convenience we have chosen antenna size as the parameter to be varied. By varying the antenna size (length, height, width), we can vary the specific absorption rate (SAR) of mobile antenna [27].

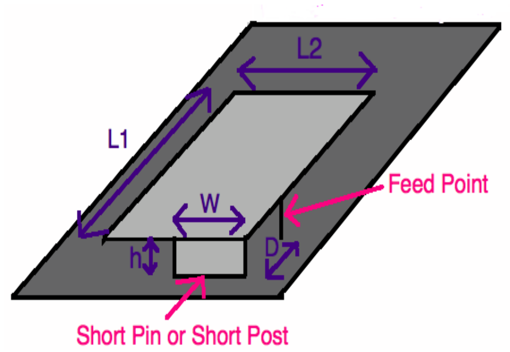

Figure 4 Planar Inverted F- Antenna with sorting plane

From the Figure.: 4. The parameters of PIFA are given as follows.

Where,
L1 – length of PIFA
L2 – 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

The distance (D) between the feed and the shorting pin is used to control the impedance of PIFA. Based on the distance D the impedance of PIFA can be increased or decreased.

If D is small, then the impedance will decrease.

IF D is large, then the impedance will increase.

The PIFA has resonant frequency whose value depends on W.

When W = L2, i.e. the width of the PIFA is equal to the length of the shorting pin, then the PIFA is resonant at

$$L1 = \lambda / 4 \quad (1)$$

When W = 0 i.e. The shortin pin is removed, then the PIFA is resonant at

$$L1 + L2 = \lambda / 4 \quad (2)$$

In general the resonant length of PIFA can be approximated based on the function of its parameter as

$$L1 + L2 – W = \lambda / 4 \quad (3)$$

4.3 Specific Absorption Rate (SAR)

Reduction of insertion loss will automatically educe the SAR.SAR is defined as the measure of radiation energy absorbed by human tissues emitted from mobile phones [3]. It can be calculated mathematically by the following expression.

$$SAR = \frac{\sigma Ei2}{\rho} \quad (4)$$

where,

E_i – rms value of the electric field strength in the tissue V/m

σ – conductivity of body tissue in S/m

ρ – density of body tissue in Kg/m^3

SAR can be measured on two types of standards.

1) American standard: SAR should be equal to or below 1.6 W/Kg measured over a mass of 1g of tissue.

2) European standard: SAR should be equal to or below 2.0 W/Kg measured over a mass of 10g of tissue [4].

In this paper we have considered American standard for measuring the SAR. Lower the SAR, better the prevention from the Health Hazards. Reduction of SAR level will automatically reduce the insertion loss and return loss.

4.4 Varying the Antenna Size

In order to achieve a superior SAR, the antenna size is varied by using trial and error method. By keeping any two dimensions of mobile antenna as constant and varying the leftover antenna dimension, the radiation pattern is obtained and the readings are tabulated [10].

4.5 Insertion Loss Minimization

There are large numbers of simulation tools available for designing mobile antenna. We have decided to use Advanced Design System (ADS) due to its advantages such as multi-technology co design, high speed data link and easy integration to other components [7-8]. From the simulation result, we can observe that as the peak grows on negative side, insertion loss can be minimized.

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5. RESULTS AND DISCUSSION

5.1 Numerical Analysis

The SAR rating for various mobile phones can be defined using number of standards. 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 I 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 the 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.

TABLE II THE RADIO FREQUENCY (R.F.) SOURCES IN INDIA

RF Source	Operating Frequency	Transmission Power	Availability in numbers
AM/FM Tower	540 KHz-108 Mhz	1 KW-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.

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, Wi-Fi (Wireless Fidelity), Wi-max and other wireless devices.

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.

TABLE. III REFERENCE LEVELS FOR THE GENERAL PUBLIC AT 900MHZ

Country or Organization	Document	900 MHz	
		Electric field (V/m)	Power density W/m2
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 1,1998b	20	1.0
Italy/I Ministry of Environment	Italy 2,1998b	6	0.1
Switzerland/Schweizer Bunndesrat	NISV,1999	4	0.04
Local recommendations, based on precautionary approaches			
Austria Local	SvorGW	0.6	0.001

TABLE IV ICNIRP GUIDELINES ADOPTED BY INDIA

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

The SAR value from the Table: 4 have been averaged using 10g of average mass over a period of 6 minutes.

6. CONCLUSION

The progress in science and technology is a non-stop 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 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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REFERENCES

[1] Sang il Kwak, Dong-Uk Sim, Jong Hwa Kwon ,"Design of Optimized Multilayer PIFA With the EBG Structure for SAR Reduction in Mobile Applications", Electromagnetic Compatibility, IEEE Transactions , Volume: 53 Issue: 2 , On page(s): 325 – 331, May 2011.

[2] S.Palanivel Rajan, "A Significant and Vital Glance on "Stress and Fitness Monitoring Embedded on a Modern Telematics Platform", Telemedicine and e-Health Journal, ISSN: 1530-5627 (Online ISSN: 1556-3669), Vol. No.: 20, Issue No.: 8, pages: 757-758, 2014.

[3] Islam, M.R. Ali, M. ," Ground Current Modification of Mobile Terminal Antennas and Its Effects", Antennas and Wireless Propagation Letters, IEEE, Volume: 10 , On page(s): 438 – 441, May 2011.

[4] S.Palanivel Rajan, K.Sheik Davood, "Performance Evaluation on Automatic Follicles Detection in the Ovary", International Journal of Applied Engineering Research, ISSN No.: 0973-4562, Vol. 10, Issue 55, pp. 1-5, 2015.

[5] Pascaud, R. Gillard, R. Loison, R. Wiart, J. Man-Fal Wong," Exposure Assessment Using the Dual-Grid Finite-Difference Time-Domain Method ", Microwave and Wireless Components Letters, IEEE, Volume: 18 Issue: 10, page(s): 656–658, Oct. 2008.

[6] S.Vijayprasath, R.Sukanesh, S.Palanivel Rajan, "Assessment of relationship between heart rate variability and drowsiness of post operative patients in driving conditions", JoKULL Journal, ISSN No.: 0449-0576, Vol. 63, Issue 11, pp. 107 – 121, 2013.

[7] Kwak, S.I. Sim, D.U. Kwon, J.H. Choi, H.D." Experimental tests of SAR reduction on mobile phone using EBG structures" ,Electronics Letters ,Volume: 44 Issue: 9, On page(s): 568 - 569 , April 2008 .

[8] S.Palanivel Rajan, R.Sukanesh, "Viable Investigations and Real Time Recitation of Enhanced ECG Based Cardiac Tele-Monitoring System for Home-Care Applications: A Systematic Evaluation", Telemedicine and e-Health Journal, ISSN: 1530-5627 (Online ISSN: 1556-3669), Vol. No.: 19, Issue No.: 4, pp. 278-286, 2013.

[9] Hamblin, D.L. Anderson, V. McIntosh, R.L. McKenzie, R.J. Wood, A.W. Iskra, S. Croft, R," EEG Electrode Caps Can Reduce SAR Induced in the Head by GSM900 Mobile Phones ", Biomedical Engineering, IEEE Transactions, Volume: 54 Issue: 5, On page(s): 914 – 920, May 2007.

[10] Dr.C.Vivek, S.Palanivel Rajan, "Z-TCAM : An Efficient Memory Architecture Based TCAM", Asian Journal of Information Technology, ISSN No.: 1682-3915, Vol. No.: 15, Issue : 3, pp. 448-454, 2016.

[11] Jiunn-Nan Hwang; Fu-Chiarng Chen, "Reduction of the Peak SAR in the Human Head With Metamaterials", Antennas and Propagation, IEEE Transactions, Volume: 54 Issue:12, On page(s): 3763 – 3770, Dec. 2006.

[12] Folayan, O. Langley, R.J, "Wideband reduced size electromagnetic band gap structure", Electronics Letters, Volume: 41 issue:20 ,On page(s): 1099 - 1100, Sept. 2005.

[13] S.Palanivel Rajan, Sukanesh, R, et.al., "Performance Analysis Of Mobile Phone Radiation Minimization Through Characteristic Impedance Measurement", International Journal of Computer Science Issues, Vol. 9, Issue 2, pp. 540-544, 2012

[14] M. Hosntalab,R.A Zoroofi, A.A Tehrani-Fard and G. Shirani, " Automated dental recognition in MSCT images for human identification", conference on Intelligent information hiding and multimedia signal processing, IIH-MSP' 2009,pp1318-1321.

[15] S.Palanivel Rajan, R Sukanesh, S, Vijayprasath, "Performance Evaluation of Mobile Phone Radiation Minimization through Characteristic Impedance Measurement for Health-care Applications", IEEE international Conference on Advanced Communication Control and Computing Technologies (iCACCCT), ISBN 978-1-4673-2048-1/12, IEEE 2012

[16] S.Palanivel Rajan, T.Dinesh, "A Systematic Review on Wearable Driver Vigilance System with Future Research Directions", International Journal of Applied Engineering Research, ISSN No.: 0973-4562, Vol. 10, Issue No.1, pp. 627-632, 2015.

[17] Beard, B.B.; Kainz, W.; Onishi, T.; Iyama, T.; Watanabe, S.; Fujiwara, O.; Jianqing Wang; Bit-Babik, G.; Faraone, A.; Wiart, J.; Christ, A.; Kuster, N, "Comparisons of computed mobile phone induced SAR in the SAM phantom to that in anatomically correct models of the human head ",Electromagnetic Compatibility, IEEE Transactions , Volume: 48 Issue:2 , On page(s): 397 – 407, May 2006.

[18] Kwak, S.I. Sim, D.U. Kwon, J.H. Choi, H.D." Experimental tests of SAR reduction on mobile phone using EBG structures" ,Electronics Letters ,Volume: 44 Issue: 9, On page(s): 568 - 569 , April 2008 .

[19] M. Momeni and R. A. Zoroofi, "Automated dental recognition by wavelet descriptors in CT multi-slices data", Int J CARS, vol. 3, 2008, pp. 533-542.

[20] S.Palanivel Rajan, R.Sukanesh, "Experimental Studies on Intelligent, Wearable and Automated Wireless Mobile Tele-Alert System for Continuous Cardiac Surveillance", *Journal of Applied* Research and *Technology*, ISSN No.: 1665–6423, Vol. No. 11, Issue No.: 1, pp.133 - 143, 2013.

[21] P.L.Lin,Y.H.Lai and P.W.Huang,"An effective classification and numbering system for dental bitewing radiographs using teeth region and contour information", Pattern Recognition,sep 2009,pp.1-13

[22] S.Palanivel Rajan, "Review and Investigations on Future Research Directions of Mobile Based Telecare System for Cardiac Surveillance", *Journal of Applied* Research and *Technology*, ISSN No.: 1665–6423, Vol. 13, Issue 4, pp. 454-460, 2015.

[23] M.Akhoondali, R.A Zoroofi, and G. Shirani, "Fully automatic extraction of panoramic dental images from CT-scan volumetric data of the head", conference and Intelligent processing center of excellence ,2009,pp2106-2114.

[24] S.Palanivel Rajan, T.Dinesh, "Analysis of Human Brain Disorders for Effectual Hippocampus Surveillance", International Journal of Modern Sciences and Engineering Technology, ISSN 2349-3755, Vol. No.: 2, Issue No.: 2, pages: 38-45, 2015.

[25] S.Palanivel Rajan, R.Sukanesh, S.Vijayprasath, " Design and Development of Mobile Based Smart Tele-Health Care System for Remote Patients", European Journal of Scientific Research, ISSN No.: 1450-216X/1450-202X, Vol. No. 70, Issue 1, pp. 148-158, 2012.

[26] Vo Phong-Dinh and Le Bac-hoai,"Dental radiographs segmentation based on Tooth anatomy", conference on Research, innovation for the future in computing and communication technology, Jul 2008

[27] S.Palanivel Rajan, R.Sukanesh, S.Vijayprasath, "Analysis and Effective Implementation of Mobile Based Tele-Alert System for Enhancing Remote Health-Care Scenario", HealthMED

Journal, ISSN No. : 1840-2291, Vol. No. 6, Issue 7, pp. 2370–2377, 2012.

[28] S.Vijayprasath, S.Palanivel Rajan, "Performance Investigation of an Implicit Instrumentation Tool for Deadened Patients Using Common Eye Developments as a Paradigm", International Journal of Applied Engineering Research, ISSN No.: 0973-4562, Vol. 10, Issue No.1, pp. 925-929, 2015.

[29] Angus C. K. Mak, Corbett R. Rowell, Ross D. Murch, and Chi-Lun Mak "Reconfigurable Multiband Antenna Designs for Wireless Communication Devices", IEEE Trans. Antennas Propag., Vol. 55, NO. 7, Jul 2007 pp.1919-1929

[30] A. Mansoul, F. Ghanem, Member, IEEE, Mohamad Rijal Hamid, Member, IEEE, and Mohamed Trabelsi "A Selective Frequency-Reconfigurable Antenna for Cognitive Radio Applications" IEEE Antenna and wireless propagation letters.,Vol. 13, 2014 pp.515-518.

[31] S.Palanivel Rajan, S.Vijayprasath, Performance Analysis on Web based Traffic Control for DDoS Attacks, International Journal of Engineering Research and General Sciences, ISSN: 2091 - 2730, Volume 3, Issue 1, 2015.