

INVESTIGATIONS ON LOOP ANTENNA FOR DESIGNING BRAIN-MACHINE INTERFACE SYSTEM

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Abstract: Loop antenna initially reform the system design that depends on the method of Radio Frequency Identification (RFID) and it basically increases in lower frequency and decreases in higher frequency. The antenna system operates at the frequency range of 400-500MHz. The additions of this work are branched into five main peripherals, that consists of the enhanced loop antenna and identification with different antenna designs, calculation appraisals, SAR interpretations placed on entire wave simulations absorbing human head model, the consumption of noise models are recommended for the noise investigation of receiving antennas in biological arrangements and the complete capacity of the channel evaluation in conditions of both data and power. The designed antenna is fabricated on the Rogers RT/Duroid 5880 substrate which is based on the biomedical applications.

Keywords: Brain Machine Interfaces (BMI), Specific absorption rate (SAR), Antenna noise analysis, Far-field and near-field inductive coupling, Radio Frequency Identification (RFID), tiny loop antennas.

1. Introduction

This system examines health affect from human hazards to RF communication antennas. It signifies that mobile appliances are needed to support different technologies and achieve in different frequency bands. So, the performance of Long Term Evaluation (LTE) is very high for air interface standard in terms of cellular mobile communication systems. It is one of the 4th generations for radio automation in order to increase the quantity and speed of mobile telephone networks. The various hazards are usually identified in terms of Specific Absorption Rate (SAR). The SAR restriction is defined in IEEE C95:1:1999 is 1.6 W/Kg in a 1gm averaging mass of SAR as long as that specified in C95:1:2005 which has been updated to 2 W/Kg in a 10gm averaging mass SAR. Further, it is used for most suitable measures for deciding the hazards of EM effect in the near field of the radio frequency (RF) source.

Specific Absorption Rate (SAR): SAR is a value of defining the amount of power that consumed in biological tissue when the body is disclosed to electromagnetic radiation. The mathematical equation is

$$SAR = \frac{\sigma_{eff} * E_{rms}^2}{\rho} \text{ W/Kg}$$

Real time difference between the human brain and mechanical cosmetic surgery can accomplish the fantasy of many patients suffering from depression, spinal-cord abuse, stroke, and harshly damaging the neurological terms to use cosmetic surgery limbs in the same manner as biological limbs. Such system needs neural sensors for neural recording process and brain incentive. It provides a way of link to an internal and external unit that translates neural data and manages the imitation actuators, such as breast implant.

The device backscattering of RFID techniques has been used for most of the sensing applications in wireless, namely biomedical signal recording and remote health sensing. This components revised the most RFID based Brain Machine Interface antenna scheme growths by executing (i) revise and reform of the 1mm³ loop and distinction with different substitute designs containing single turn wireless loops, (ii) briefly reckoned computations and decisions on SAR by using the complete recognition process of finding stroke in the human head tissue (iii) operational enactments consists of an absolute measurement links in RFID, (iv) the noise measurements for receiving antennas in various equipment particularly on two novel noise models that are present in the power absorption of biological conditions (v) the outcome channel admiration of the data and power has been used for the various link measurements.

The head model process in RFID is analyzed on the method of assuming the frequency in relative permittivity and conductivity. The identification results provide accurate information about the stroke that is occurred in the human head layer. Thus for the method of assuming the fixed frequency for ensuring the brain stroke, Electrocardiography (ECOG) technique is used.

2. Literature Survey

A. Design of Brain Machine Interface (BMI) Loop Antenna Structure

To design the Brain Machine Interface loop antenna in the layer of the human head model by characterizing a single layered lossless dielectric circle in conditions of electric field properties contains membrane, plump, scalp, cranium, cerebro spinal fluid and human brain by using a simulation of wave signal investigation. The layers of the head tissue model are designed by a permittivity and conductivity of the absolute frequency range. By applying direction loss and local limited (SAR) distinctive standards of the human head tissue and the consequence are distinguished and reviewed. Yet the optimum frequency around 400MHz are associated with highest link output.

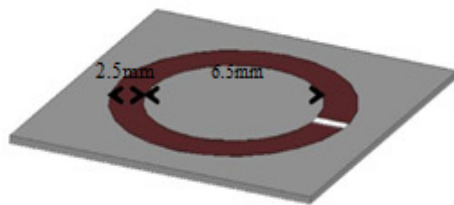


Figure 1. One – turn planar loop antenna

To classify the maximal receiving power which contains the flexible demerits of an (SAR) we measure those segments with the ultimate SAR accomplished on the wave signal analysis and the head model process are simulated by using An soft HFSS with the testing method of reader loop antenna port from which the values are assigned as 1 W.

Here, the path absorption and entire wave absorption scheme is involved to identify the noise temperature. By simulating this approach there are some constraints appears by using a limited (SAR) which are provoked in the tissue that may increase and decrease the maximal frequency power. [2]

B. Structure of Loop Antenna Based On Multipolarized RFID Reader For UHF Near Field and Far Field Applications

This system considered the structure and depiction of the loop antennas on the body-centric anticipating scheme, including with an insistence on IN and OUT body UHF RFID functions. The layout of loop antennas for an arrangement of wireless Brain Machine Interface, acknowledges the complex concerns and faults that occurs due to abnormal conditions in human brain. Maintaining an explicit wireless communication procedure among the brain and extrinsic mechanisms,

wireless setup of the Brain Machine Interface can confess the patients anguishing from the slowness of an injury in spinal cord and more strongly exhausting the neurological terms instead of communicating the more independent lives in an multipolarized reader of an RFID.

It exists on the minimum plentiful equipments enclosing the neurological sensor terminals, combined transistors and also a declamatory of a loop antenna with an independent ideal transistor. The given RFID loop antenna structure provides active competitor for the subsequent recognition of the wireless schemes in brain machine interface. A frequency link is attained for parameter S_{11} is less than -10dB varies from 875 to 950 MHz that covers the UHF RFID process shown in Fig.2. is simulated in Ansoft HFSS.

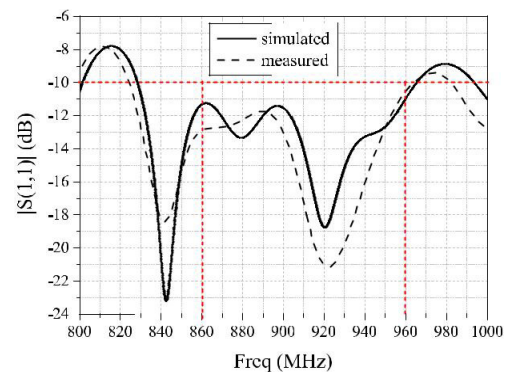


Figure 2. Simulated and verified results of the S_{11} parameters

It is one of the important steps for developing the sufficient loop antennas for the entity of essential body-centric scheme. Hence, the various prospective methods are used in this design in order to improve the ideal frequency range of 450MHz. [3]

C. A High Neuro Sensing System Of Fully Passive Monitoring For Wireless Brain Signal

Here the embedded and investigator antennas are principally arranged to execute best EM coupling in between the far field region. In order to outcome the large communication incident among 2.4 GHz and 4.8 GHz at the distance of 10mm apart from the antennas, it explains narratively for the concept model of human head (epidermis, peel, and sheath) which is present beyond those investigated antennas. It contributes more frequency range particularly in 4.8GHz where it reduces the long term losses that exist in the reported sensual signals. Whereas in the immense of high frequency, it affords 2.4GHz in the minimum carrier signal. It is a critical factor for conserving patient's freedom across the EM impedance. Further, the width of some investigated antenna performs from 0.6 to 6

GHz which are simulated in ansoft HFSS are shown in Fig.3. (a) and (b).

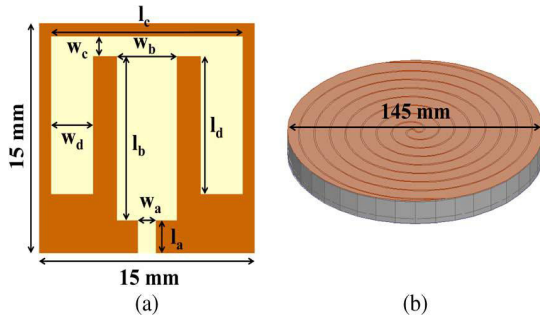


Figure 3. (a) proposed system of neural signal implanted on loop antenna and (b) investigated spiral antenna

In terms of 4.8 GHz, the most transmitted power are derived to be 20dB and in an 2.4 GHz, it is calculated to be 25dB transfers an signal resolution of 4dBm which is not incorporated upon the embedded antenna. The signal transformed at the investigator can be 23dBm. Thus the range for a layer of head model includes (cranium and epidermis) that insist beyond those embed and extraneous investigator. High S21 parameters among 4.8 GHz reduces the entire loss that imported on the entered neural system, thus enhancing the awareness of the system and also the high S21 parameters in the 2.4 GHz says that the optimum neural signal power involves to spin ON the zener diodes carries lower signal. [13]

D. Backscattering Neural Tags For Wireless Power and Data Telemetry In Brain-Machine Interface Systems

In this method, the pattern of the patch antenna are formed in the tiny loop antenna for an cortical inserts and low- contour independent investigator loop antennas are used for contributing big enough merging for an external body transformer in order to execute wireless signal and telemetry process of data in the BMI of the wireless channel scheme. The external body transform loops predicates the transformation of thousands of microwatts of power.

Here the backscattering facility is used to represent the human layer which is occurred in the wireless transmission link beyond a tactile sensor loop antenna and an peripheral transmit antenna signal. For an mm size patch loop antenna, the ideal frequency is present between 100MHz and 1 GHz. The geometry of transforming patch loop antenna can be revised to

achieve the outcome efficiency of the telemetry signal at the fixed antenna within the frequency over 1 GHz.

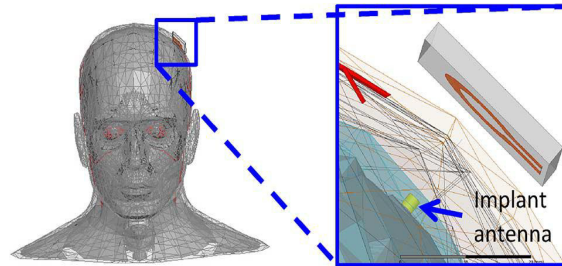


Figure 4. simulation of man's head model and a buzz image of transport and embed antennas arranged in model

In this entity, the particular shapes of embed loop antennas is slashed using the software of Ansoft HFSS. During simulation, human head model can be used to identify the strokes occurs in the tissues of the head layer. It recognizes the buzz image of the man's head model that are present in the arranged embed antennas which are shown in Fig.4. In the process of simulation, the embed antennas are consumed in the cerebro spinal fluid that encloses the human brain. The exterior transmitting antennas are inserted in between the 6mm aside from the membrane. The essential protective layer side of the brain is designated as the specified embed antenna region that express a movements of individual body parts. Hence, stimulation and neural recording of this area is the goal of BMI for the range of cosmetic surgeries. [5]

E. An Induced Analysis of EM Fields In The Emulated Human Head Tissue of Passive Neuro Recording Micro System

Here, the analysis of EM fields can be used in two methods they are calculation and experimental methods to verify the SAR present inside the human head identical figment of the imagination concurrently through the operation of a visual sensing microsystem. Thus the maximal range of the average SAR is evoked among the 1g of the tissue layer is 0.45 W/Kg. Which are not same in the threshold value of 1.6W/Kg.

The finite element method are analyzed in ansoft HFSS to calculate an SAR performed throughout the operation of multiple neuro recording scheme shown in Fig.4. The SAR transmitter is equipped for confined initial uplink nodes and inferior downlink nodes; the data power provides 50 mW. [7]

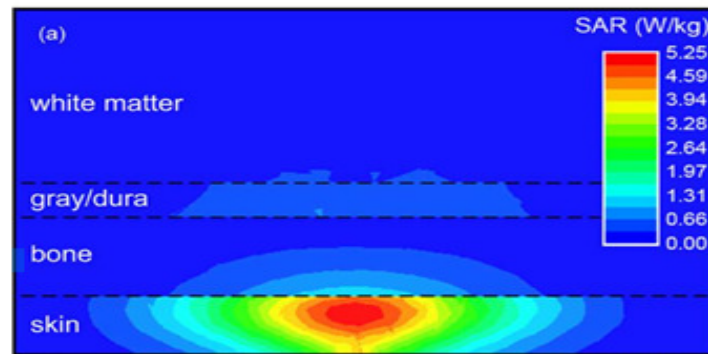


Figure 5. Computed SAR distribution

Table 1. Comparison of Literature Review

S.N O	METHODOLOGY	ADVANTAGE	DISADVANTAGE
1	RFID based backscattering	The SAR can be calculated, providing an inexpensive and rapid system for future testing.	Efficiency is low.
2	RFID based Electro Encephalo Gram (EEG)	Achieves good Electric Field impedance during simulation	It reduces an maximum allowed transmit power.
3	RFID inspired backscattering technique	Produce fast conductive patterns in the wireless platform	Transmitting power is low
4	RFID inspired wireless communication	Achieves uniform Electric Field & high Magnetic Field.	Allows high transmission power without violating SAR.
5	EM field simulator based on finite element method.	It provides a high data rate in the neural recording operations.	There is an unavoidable Electro Magnetic interactions occur during recording operations.

3. Conclusion

The overall design says that the fixed frequency is used for the simulation which is around 400-500MHz. The head tissue layers such as dura, skull, and skin that would present between the implant and the external interrogator are implemented by using local SAR which obviously reduces the maximum power and also the return loss achieved for the frequency band is from 825-960MHz by using UHF RFID. Whereas in high sensitivity BMI system, the length and width of the antenna are optimized over the frequency at 4.8GHz reduces the overall return loss and the frequency at 2.4GHz requires the minimum carrier signal for Electro Magnetic fields. The backscattering technique is used for wireless BMI by utilizing mm-size loop antenna

which requires coupling for an body transmitter to perform wireless data and power telemetry system. Based on the frequency reconfiguration the proposed antenna can find the radiation pattern and return loss for the required patch antenna for future wireless communications.

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