(1)

Performance of an implanted electrically coupled loop antenna inside human body

Ali Ahmed Younis Ibraheem, Majid Manteghi

Abstract:

|Implanted antennas are widely used in hyperthermia and biomedical applications. The antenna needs to be extremely small while maintaining a permissible Speci¯c Absorption Rate (SAR) and being able to cope with the detuning e®ects due to the dielectric properties of human body tissues. Most of the proposed antennas for implanted applications are electric ¯eld antennas such as Planner Inverted-F Antennas (PIFA) and micro-strip patch antennas. By minimizing the size of an electric ¯eld antenna, the near zone electric ¯eld will increase, resulting in higher SAR. This work is devoted to design a miniaturized magnetic ¯eld antenna to overcome the above limitations. The proposed electrically coupled loop antenna (ECLA) has high magnetic ¯eld and low electric ¯eld in the near zone and therefore, has a small SAR and is less sensitive to detuning e®ects. ECLA is designed at the Medical Implanted Communication Service (MICS) band with dimensions of (5£5£3 mm3). ECLA has been simulated inside one-layer human body model, three-layer spherical human head model, human head and human body. From the simulation results, ECLA inside the human body has a 5 MHz{3 dB bandwidth, ¡14 dB gain, and radiation e±ciency of 0.525%. The 1 g average SAR inside the human body for 10 mW input power is about 1W/kg which is 7 times lower than the SAR for a patch antenna of the same size with the same accepted power.

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(2)

On the study of the near-fields of electric and magnetic small antennas in lossy media

Majid Manteghi Ali Ahmed Younis Ibraheem

Abstract:

n this communication, the near-field radiation characteristics of electric and magnetic antennas when surrounded by a lossy dielectric medium are described. This study is relevant for cases such as implanted antennas, submarine or underground communications where the antenna's near field consists of lossy dielectric media such as human tissues, minerals or saline water. Theoretical results for both types of small antennas are presented and expressions to show the differences in stored energy and radiated power in the radian sphere around the antenna are formulated. It is found that magnetic antennas give much better performance when surrounded by a lossy dielectric..

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(3)

Performance of Electrically Coupled Loop Antenna inside human body at different frequency bands

Ali Ibraheem, Majid Manteghi

Abstract:

Recently there has been a growing interest in the design of implanted antennas for biotelemetry, e-healthcare, and hyperthermia applications. The implanted antenna needs to be extremely small while maintaining a low Specific Absorption Rate (SAR). Most of the proposed antennas for implanted applications are electric field antenna such as Planner Inverted-F Antenna (PIFA). These types of antennas have high near zone electric field intensity and high SAR value. In this work, an Electrically Coupled Loop Antenna (ECLA) is proposed as a magnetic loop antenna, which has a relatively low near zone electric field intensity and therefore, small SAR values. An ECLA is designed in the Medical Implanted Communication Services (MICS) band (402-405 MHz), Industrial Scientific and Medical (ISM) band (2.4-2.5 GHz), and Ultra Wide Band (UWB) communication band (3.5-3.6 GHz) with dimensions (5×5×3mm3), (3×3×3 mm3), and (2×2×2 mm3) respectively. Using High Frequency Structure Simulation (HFSS), the performance of ECLA inside one-layer human body model will be analyzed at three frequency bands.

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(4)

Path Loss inside human body using Electrically Coupled Loop Antenna at different frequency bands

Ali Ibraheem, Majid Manteghi

Abstract:

In-body communication channels are of increasing interest for a number of telemetry applications such as Wireless Body Area Network (WBAN). Knowledge of the propagation media is a key step towards a successful transceiver design, and such information is typically gathered by physical experiments. In the case of medical implants, this could be extremely difficult if not impossible. In this paper, the Path Loss (PL) between implanted antennas will be investigated using High Frequency Structure Simulation (HFSS). The PL will be studied using Electrically Coupled Loop Antenna (ECLA) with dimensions (5×5×3mm3), (3×3×3 mm3), and (2×2×2 mm3) at the Medical Implanted Communication Services (MICS) band (402-405 MHz), Industrial Scientific and Medical (ISM) band (2.4-2.5 GHz), and Ultra Wide Band (UWB) communication band (3.5-3.6 GHz) respectively.

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(5)

Intra and inter-body cognitive communication system

Ali Ibraheem, Taeyoung Yang, Majid Manteghi

Abstract:

Summary form only given. Improving health care, while managing and reducing costs, requires a more efficient health care system. Adopting smart health-monitoring sensors, in- or on-body, will play a key role in successfully addressing the challenges. Currently, smart health-monitoring sensors and medical devices exist in implantable, ingestible, and wearable forms. On the other hand, artificial organs, such as artificial hearts and limbs, are now becoming a reality to replace unhealthy organs. Together all these devices are about to transform the medical care that once was either unimaginable or was categorized as a science fiction.Given their expected abundance and large number utilization in the future health care, it is imperative that these devices to wirelessly communicate to each other with utmost reliability, security, and efficiency both in power consumption and spectrum utilization. In addition, the coming paradigm shift in spectrum sharing and management calls for a robust cognitive wireless system that is aware of its spectral environment, learns from the environment, and adapts in real-time to its operating parameters with respect to its changing environment and mission objectives. We propose an intra and inter-body cognitive communication system that will be the next generation of body area network to respond to these demands. The proposed cognitive communication system will allow implanted and internal devices to communicate securely and seamlessly with on body medical devices for future healthcare applications. We envision that the intra and inter-body cognitive communication systems will enable a cost-effective in-home medical care by reducing number of admissions and readmissions to a hospital. As the first step, we considered the human body as a sophisticated inhomogeneous lossy communication channel, using extremely small antennas in near-field and far-field regimes. Some preliminary results for the inter-body communication channel characterizati- n will be presented. Challenges and requirements for the intra and inter-body cognitive communication system will also be discussed.

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(6)

Electrically Coupled Loop Antenna as an implanted antenna

Ali Ibraheem, Majid Manteghi

Abstract:

There are many challenges involved with the implanted antenna designs including but not limited to the miniaturization of a wideband antenna and reducing the specific absorption rate, SAR, of a miniaturized antenna. Most of the proposed antennas for implanted applications are electric antennas such as planar inverted-F antenna, PIFA. By miniaturizing the size of an electric antenna the electric field intensity in the antenna near zone will increase resulting in higher SAR. This work is trying to design a miniaturized magnetic type antenna to overcome the SAR limitations for small implanted antennas.

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(7)

Intra-Body Propagation Channel Investigation Using Electrically Coupled Loop Antenna

Ali Ahmed Younis Ibraheem, Majid Manteghi

Abstract:

Knowledge of propagation media, typically gathered through physical experiments and simulations, is absolutely critical in successful transceiver design. In the case of medical implants, physical experiments are extremely difficult. Therefore, we rely on simulations in most studies. In this paper, Path Loss (PL) between implanted antennas, as a measure of propagation channel characteristics, is investigated using High Frequency Structure Simulator (HFSS) and Remcom's XFDTD 7 (XF7). An Electrically Coupled Loop Antenna (ECLA) is designed to study PL inside human body models at different frequency bands: Medical Implanted Communication Services (MICS) band (402-405 MHz), Industrial Scientific and Medical (ISM) band (2.4 2.5 GHz) and 3.5 GHz band (3.55-3.65 GHz). The ECLA has dimensions (5×5×3 mm3), (3×3×3 mm3) and (2×2×2 mm3) at MICS, ISM and 3.5 GHz respectively. ECLA performance inside human body models is studied at the allowed frequency bands. The effects of frequency bands, human model electrical properties, and distance between implants on PL are considered. Simulation results are validated with experimental work. Our results show that the ECLA at MICS band has the lowest Specific Absorption Rate (SAR) and the highest allowed input power. Also, the MICS band has the lowest PL inside the human body model, shown to be less than 90 dB in the worst case scenario.

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(8)

New Innovative Millimeter-Wave Antenna/Array Solutions for Future Next Generation of 5G Cellular Communications

O. M. Haraz, A. A. Younis

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