

Antennas in Communications, Biotelemetry and Medical Applications: Cellphone, Wearable, Implantable and Ingestible

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At no time in history have antennas come so close to human. Nowadays they are even finding their ways into human bodies! Modern applications demand antenna usages in cellphones near one's head, wearable antennas integrated into one's clothing, implantable antennas attached to medical devices and finally ingestible antennas integrated with capsules. In this invited talk we will provide an overview of some the recent activities in the author's laboratory addressing these classes of antennas. Typical common factors in designing these antennas are: (a) miniaturization, (b) antenna designs that effectively operate in the surrounding body environment, (c) safety issues based on SAR distributions, and (d) communication link characteristics.

Recent advances in modelling and optimizing these classes of antennas near and in human tissues are presented. The antenna characterization is carried out using both the simplified multi-layered planar/spherical models and the sophisticated anatomical model. The dyadic green's function, finite difference time domain (FDTD) and finite element techniques are applied and compared. Additionally applications of modern optimization techniques such as Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) will be highlighted. It will be shown how the hybridization of optimization parameters in terms of both real and binary will provide an effective way for seeking for the best designs.

These computational and optimization techniques are used to design tailored antennas with improved performances. The importance of designing antennas to match their surrounding environment is shown. Representative examples are presented for diversity/MIMO cellphones, wearable antennas with multi band functionality, implanted antennas for use in biomedical therapy, and ingestible antennas for medical diagnostics. Simulations results and measured results will be shown including comparative studies for various designs.