APPLICATIONS OF MICROWAVES IN MEDICINE

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Abstract Submission Form

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Applications of radiofrequency and microwave fields in medicine are not new, but recent advances in computer modeling, component fabrication and decrease in cost have resulted in new and old ideas coming to fruition. The non-ionizing nature of this part of the electromagnetic spectrum makes it particularly attractive for diagnostic applications. On the other hand, heating, the well-known interaction with biological tissues, enables some therapeutic uses. Because of the heterogeneous electrical properties of the human body and irregular shapes, the finite difference time domain (FDTD) is extensively employed to model interactions of fields with tissues and to design effective devices. The finite element method (FEM) is also used, although less popular, as most human body models consist of cubic voxels, and are thus directly compatible with FDTD.

One of the most promising diagnostic methods is the breast cancer detection. This application is based on differences in electrical properties between a healthy and diseased tissue. Two approaches have been explored, a classical tomography, and a wideband radar-based technique. Tomography provides complete maps of tissue properties and involves the solution of inverse scattering problems, which are not unique; furthermore, the wave penetration depth limits resolution. Despite these inherent difficulties, promising results have been reported and there is at least one system in clinical trials in the USA. The radar-based approach considers illumination of the breast with ultra-wideband pulses, typically from 0.5 to 15 GHz, from several antenna locations and observation of the scattered returns by the same antenna. The critical issues involve processing of the return signals to ensure coherent addition of these returns from the same tissue location for different antenna positions. In practical implementations of this approach, the system operates in the frequency domain with wide range of frequencies, and the data are converted into the time domain in post processing. Excellent results promising detection of sub-millimeter tumors have been reported by two research groups.

Several highly successful therapeutic applications have been reported. They include highly localized, as well as regional heating. Examples of localized heating include angioplasty, cardiac ablation to treat arrhythmias, esophageal ablation and cornea shaping. Regional heating has been achieved with implanted antennas, and surface arrays. What made a significant difference in efficiency of these treatments in recent years is the extensive modeling and simultaneous temperature evaluation, and thus control of the heating profile.

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2. A - Electromagnetic Metrology

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4. I - Invited Paper

5. No special instructions