(129)

Nearfield Imaging for Noninvasive Monitoring of Hyperthermia Treatment

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Hyperthermia treatment has the potential to enhance cancer therapy and reduce the side effects associated with conventional therapeutic plans. Commercial systems depend typically on narrowband operation and exploit single element applicators to drive energy into treated tissue. In addition, monitoring of thermal distribution depends on invasive intraluminal or interstitial probes. This research aims at developing a proficient platform that addresses some challenges of hyperthermia therapy. A system is suggested that depends on multichannel wideband operation, and implements applicator array. The configuration of this system allows the control of energy localization at various depth of tumors. In addition, the information associated with scattered wideband signals allow performing nearfield imaging, to reconstruct tissue characteristics maps. To investigate system performance, a model is developed of the forward problem, incorporating dispersive wideband models of tissue properties. A tool is developed to generate a dictionary that relates scattered signals to material features. Solution of the inverse problem is conducted based on compressed sensing techniques. Orthogonal matching pursuit OMP models are developed to enhance the resolution of image reconstruction. With the dependence of tissue electrical properties on temperature, thermal maps are generated.

Practical aspects of the nonlinearity associated with wideband power amplifiers are incorporated in the model. Analysis of the reconstructed images reveals the validity of the proposed techniques. In particular, encouraging results are obtained of thermal mapping, denoting the potential of using nearfield imaging as a noninvasive thermometry tool, in monitoring hyperthermia treatment.

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