Defense Announcement

A Transmission Line Model for Active Implantable Medical Devices Under MRI

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The use of magnetic resonance imaging (MRI) is widely restricted for patients with active implantable medical devices (AIMDs) due to safety concerns. Some of the major MRI safety concerns come from the interaction between the electromagnetic fields generated by the MRI radio-frequency (RF) coil and AIMDs.

In this dissertation, a transmission line model is proposed to describe the electromagnetic properties of AIMDs. The model is derived using simplified leads and generalized to practical AIMD leads. Numerical and experimental validations were performed. A method to use a simplified equivalent solid lead to replace the complex AIMD lead is also proposed.

Based on the model, various studies were performed. The analytical relation between the MRI RF safety and impedances in the transmission line model is derived and validated. The influences of various physical parameters on the transmission line parameters are analyzed. An approach to search for the best tissue simulating medium is proposed, and an approach to determine the MRI RF-induced voltage transfer function scaling factor is proposed.