Wu, Dagang, “Numerical Analysis of Interactions between Electromagnetic Fields and Human Bodies”

Advisor: J. Chen

Numerous electronic devices operate in the close vicinity of humans. Such proximity can lead to a fraction of the electromagnetic energy being deposited into human bodies. If the power absorbed by human body is sufficiently large, it may lead to tissue damage. Consequently, interactions of electromagnetic fields with human subjects have been a subject of scientific interest and public concern. On the other hand, some electronic devices taking advantage of such interactions have been developed and applied as effective medical treatment. The research presented in this thesis aims at providing numerical approaches to study the interactions of electromagnetic fields, ranging from low frequency to radio frequency (RF), with the human body.

Realistic human subject models are necessary in numerical investigations. Nine pregnant woman models, based on the magnetic resonance scans, were developed for electromagnetic analysis. In addition, a realistic male model was also used for electromagnetic analysis.

A novel transcranial magnetic stimulation (TMS) structure is proposed to overcome the limitations of conventional TMS coils. This proposed structure is capable of achieving reconfigurable, multi-channel and time-sequence magnetic stimulation. The validation of this novel TMS system was verified by numerical simulations and experiments.

The induced current density and induced electric fields within pregnant women exposed to walk-through metal detector (WTMD) emissions were investigated. Through comparison to the current safety limit given for low frequency exposure, it is shown that the internal tissues might experience potentially hazardous effects due to external magnetic fields.

The electromagnetic and thermal simulations were combined to study the heating effects on internal tissues within pregnant woman models exposed to magnetic resonance imaging (MRI) RF coil radiations. Simulation results demonstrated that fetus tissue might

have higher specific absorption rate and resultant temperature rises than recommended safety limitations.

The safety of metallic implants within MRI scan was investigated by performing numerical modeling. The heating effects, caused by the interactions between metallic implants and electromagnetic fields from MRI coil, were significant.