Metamaterials for Improving Magnetic Resonance Imaging

PROJECT DESCRIPTION

Magnetic resonance imaging (MRI) uses radiofrequency (RF) electromagnetic fields to excite and detect the signals from which cross-sectional images of the body are reconstructed. Traditionally, the RF fields are produced by resonant structures ("coils") which can only generate near fields that are limited in spatial extent. The resulting images are shaded by these spatial inhomogeneities, and in extreme cases large portions of the anatomy become invisible. A novel solution to this problem combines two recent advances: (1) the development of the traveling-wave technique [1], in which the MRI bore is treated as a circular waveguide excited by external antennas, and (2) metamaterials, which are artificial materials exhibiting properties that are unavailable in nature. Specifically, metamaterials exhibiting certain exotic properties are used to line the interior of the MRI bore [2],[3], which reduces its cutoff frequency enough to permit the propagation of traveling waves. This concept has been proven in theory and simulations, and metamaterial liners have been designed. What remains is the experimental validation, which has several challenges. These include design using commercially available materials and components, and tuning for the sensitive properties being sought. Finally, excitation of these metamateriallined MRI bores must be accomplished using circularly polarized antennas tuned to specific frequencies. The proposed experimental validation will be conducted on a model of the 4.7 tesla whole-body scanner currently housed at the P.S. Allen MR Research Centre at the University of Alberta.

[1] Brunner et al. Nature, vol. 457(7232), pp. 994-998, 2009.

[2] Pollock et al. Proc. Int'l Soc. Magnetic Res. Med., 2012.

[3] Hosseini et al. Proc. Int'l Soc. Magnetic Res. Med., 2018

FACULTY-DEPARTMENT

Engineering - Electrical and Computer Engineering

OPEN TO STUDENTS FROM THE FOLLOWING INSTITUTIONS

Chinese universities participating in the *Double First-Class Initiative*.

DESIRED FIELD OF STUDENT STUDY

microwave engineering, electromagnetic theory, advanced circuit theory, experimental methods in microwave engineering (microwave test/lab course), antenna theory (an asset)

INTERNSHIP LOCATION

Edmonton Campus

NUMBER OF INTERNSHIP POSITIONS

2

INTERNSHIP DATES

Start: July 2, 2019

End: October 2, 2019

ARE THE DATES FLEXIBLE?

Yes, I am flexible regarding the internship dates. Selected students can contact me to request a date change.