Maged R. Kamel, “Cryogenic Single And Phased-Array Coils For Magnetic Resonance Imaging – Design And Implementation”

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- Magnetic Resonance Imaging (MRI) is now increasingly being used for fast imaging applications such as real-time cardiac imaging, functional brain imaging, contrast enhanced MRI, etc.. Imaging speed and resolution in MRI is mainly limited by the signal to noise ratio (SNR) that can be obtained from the imaged tissue. The SNR can be traded off for speed and/or resolution. Noise in the system can be reduced by using cryogenic coils or superconducting coils as long as the coils are in the coil noise regime where the coil noise dominates the body noise. Also, the SNR can be increased by optimizing the electronics and the cabling used in the system.
- Parallel imaging methods such as Sensitivity Encoding (SENSE) has helped to decrease the scan time quite a bit. As for the image resolution, that requires the enhancement of the receiving coil(s). Enhancing the performance of these coils can be done by using superconducting coils and cooling them down hence reducing their resistive losses. To accommodate for using more than one coil (arrays), capacitive coupling to coils has to be adapted to the system. The quality of electronics system for coupling, tuning, matching, and decoupling these coils has a great effect on the quality of the whole design.
- The primary objective of this thesis is to investigate and develop different designs for increasing the SNR of the MRI system using High Temperature Superconducting (HTS) and cryogenic copper coils for a single and array of coils. Also, the development of the electronics attached to these coils required for coupling, tuning, matching, and decoupling is discussed in details.
- Several coil designs for different field strengths were designed and implemented. Also, the development and fabrication of a 7T cryogenic system for a single HTS coil for rat brain and spinal cord MRI is described and followed by resulting images showing the superiority of this coil over the commercially used ones.
- The development and fabrication of room temperature copper coil array is shown and resulting images are shown. SENSE technique software was written in MATLAB and applied to the images acquired with the coil array to obtain faster imaging.
- By integrating both superconducting coils and coil arrays, a very high Signal to Noise Ratio (SNR) images can be obtained.