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Quantitative Tissue Identification by the Use of Different Medical Imaging Modalities

A Thesis Submitted for the Degree of Doctor of Philosophy
in Electronic Engineering
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ABSTRACT

Nowadays 30%–40% of all MRI examinations worldwide are performed with contrast agents (CA) to improve the sensitivity and specificity of diagnostic MRI scans, especially in abdominal (i.e. liver) imaging.

This thesis tackling quantitatively new dimension for optimizing (reducing) amount of contrast agent needed to be administrated to the magnetic resonance imaging patients to increase opportunities of tissue identification especially for hepatorenal patients. To reach our goal, this work was implemented on two experimental phases. The first phase focused on studying the changes occurred in signal-to-noise ratio for paramagnetic contrast agent gadodiamide when externally magnetized with a permanent magnet before being placed in phantoms and scanned in high field magnetic resonance machine (1.5 Tesla). Each of those phantoms has different contrast agent concentration, and scanned 0-5 hours after magnetization to consider the effect of aging of pre-magnetization as well. The second phase is a comparative study, between high (1.5 Tesla) and low (0.35 Tesla) field MRI, to assess the validity for our hypothesis on the low field open magnet because its favorability within patients.

Response Surface Modeling (RSM) used for presenting, modeling, and optimizing our data because we have different sources of variations' inherent in the process and cannot be accounted for in calculations (i.e. homogeneity of the MRI field, flow rate of the contrast agent during its magnetization, etc.).

Our experimental work in this thesis is very delicate. Before implementing the experimental work, to insure reliable experimental results, we implement complete static shimming to insure high level of field homogeneity.

This study proving that signal-to-noise ratio for paramagnetic contrast agent increases if we pre-magnetize it before scanning, and accordingly a remarkable reduction of CA dose could take place.