

PhD Thesis title: ‘Pulsed Magneto-motive Ultrasound Imaging’

Author: Mohammad Mehrmohammadi, Ph.D.

Email: Mehrmohammadi@utexas.edu

Institution: University of Texas at Austin

Supervisors: Stanislav Y. Emelianov

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Available on line: –

ABSTRACT:

Unraveling of the molecular pathways of diseases and thus detecting pathology at early stages of development are possible through monitoring the cellular and molecular mechanisms of diseases. Thus, significant efforts have been directed toward the design and development of new imaging techniques capable of visualizing biologic events at the molecular and cellular levels. Nano-sized particles are widely regarded as a tool to study biological events at cellular and molecular levels. Small sized nanoparticles are proper for binding to a biologic entity of interest and thus provide cellular and molecular information. Currently, there are only a few imaging modalities such as magnetic resonance imaging (MRI), radionuclide imaging (PET and SPECT), and some optical imaging modalities that can visualize interactions between nanoparticles and living cells.

Ultrasound, due to its notable advantages, represents a suitable candidate for molecular imaging. A new technique – pulsed magneto-motive ultrasound imaging, capable of in vivo imaging of magnetic nanoparticles in real-time and at sufficient depth is introduced in this study. In pulsed magneto-motive ultrasound imaging, an external high-strength pulsed magnetic field is applied to induce motion within magnetically labeled tissue and ultrasound is used to detect the induced internal tissue motion. A laboratory-based prototype system was built and subsequently optimized through experimental studies. The results of this study, ranging from tissue mimicking phantoms to in vivo small animal imaging, demonstrated a sufficient contrast between normal and iron-laden tissue labeled with ultra-small magnetic nanoparticles for ultrasound detection of magnetic nanoparticles. Moreover, the ability of the developed technique to detect intracellular accumulation of magnetic nanoparticles was investigated.

References to author publications that relate specifically to the dissertation:

- [1] Mohammad Mehrmohammadi, Junghwan Oh, Srivalleesha Mallidi and Stanislav Emelianov, “Pulsed magneto-motive ultrasound imaging using ultra-small magnetic nanoprobe”, *Molecular Imaging Journal*, vol. 10, No. 2, pp 102-110
- [2] M. Mehrmohammadi, K.Y. Yoon, M. Qu, K. P. Johnston, S.Y. Emelianov, “Enhanced pulsed magneto-motive ultrasound imaging using superparamagnetic nanoclusters”, *Nanotechnology* 22 (2011) 045502,
- [3] M. Mehrmohammadi, L. L. Ma, M. Qu, D. Romanovisz, K. P. Johnston, K. V. Sokolov and S. Y. Emelianov. “Pulsed magneto-motive ultrasound imaging to detect intracellular accumulation of magnetic nanoparticles”, *Nanotechnology* 22 (2011) 41510