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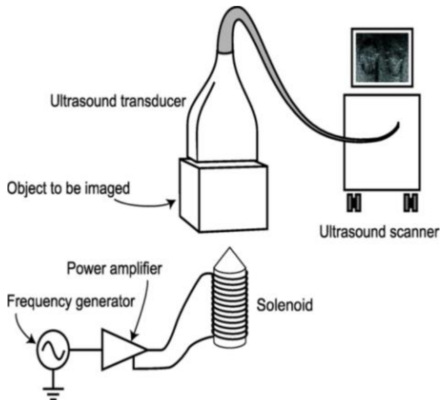
Simulations and Experiments of Magnetic and Mechanical Effects in Magneto-Motive Ultrasound Imaging

Ultrasound imaging is one of the most commonly used imaging techniques in the medical field. Magnetic nanoparticle (very small sized particle in a nano-meter scale having a magnetic nature) contrast agents have been tried to use for ultrasound imaging to enhance and improve the imaging quality, but due to their being small sized and inefficiency of ultrasound limited contrast and resolution it has become difficult to detect them directly. Therefore the technique called Magneto-motive ultrasound imaging is introduced. This project used this technique, to do both the experimental and simulation work.

Magneto motive ultrasound imaging uses a highly focused time dependent magnetic field to induce motion of magnetic nanoparticles labeled inside a tissue mimicking phantom (made of 5% by weight of polyvinyl alcohol). Ultrasound is then used to detect and image the motion. This motion basically happens because of the magnetic nature of the nanoparticles being attracted to the time dependent magnetic field coming out at the tip of a conically shaped iron core. However, the motion of the magnetic nanoparticles happens to provoke motion on the surrounding. We think that this is a mechanical reflection due to the conservation of mass within the phantom volume. We want to verify that and to understand what is really happening inside; therefore this project is undertaken. Doing so, we have managed to obtain simulation results similar to the experimental ones. Following the results, we have concluded that the magnetic nanoparticles and the surrounding regions both happen to move with twice the excitation frequency used, and the motion of the inserts are π out of phase with the region in between the magnetic nanoparticles. This in turn would help to localize the magnetic nanoparticles easily.



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"Frequency and Phase-Sensitive Magnetomotive Ultrasound Imaging of Superparamagnetic Iron Oxide Nanoparticles"

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