Early Breast Cancer Detection Using Fluorescence Mediated Tomographic Imaging

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Development of reliable technologies for early detection and screening of breast cancer is significant since the overall accuracy of traditional mammography remains low for diagnosis of benign and malignant lesions. *In vivo* imaging of targeted molecular probes, or molecular imaging, is an emerging field for early detection of cancer. Nuclear molecular imaging modalities such as positron-emission tomography (PET) and single-photon-emission computed tomography (SPECT) have been used for obtaining functional information of cancerous tissue. However, these technologies are limited with low resolution for detection of subcentimetric tumor deposits and lack of an anatomical reference frame to accurately locate molecular events. On the other hand, MRI has high spatial resolution but relatively low sensitivity to targeting probes. Although several multimodality imaging technologies are being developed, the systems are highly incomplete and expensive. Optical imaging is particularly well suited for molecular imaging, as fluorescent probes are sensitive and can be specifically conjugated to small molecules, antibodies and proteins. Optical imaging has the advantages of being non-invasive, non-ionizing, and having high sensitivity for optical-labeled probe, relatively low cost and rapid imaging time.

The primary objective of this project is to develop a three-dimensional fluorescence mediated tomography (FMT) system based on a frequency domain heterodyne technique that uses an image-intensified CCD camera. The proposed technique provides the highest resolution and sensitivity and faster acquisition rates in the measurement of the phase and amplitude for frequency domain diffuse photons. The fluorescence tomography system will be used within PET and MRI scanners for dual imaging of molecular targets of cancer cells. The proposed research will develop/refine a combined FMT/PET/MRI technology utilizing FMT as a bridge to integrate PET and MRI and form a multimodal imaging platform. The developed frequency domain heterodyne imaging system will gain a factor of 10 in sensitivity via reducing phase-amplitude cross-talk compared to a homodyne system using ICCD. The proposed multimodality imaging system FMT/PET will improve spatial resolution with a factor of 4. The technology developed in this proposal can be used in the development of tumor targeting pharmaceuticals for cancer diagnosis and therapy.