Senior Honors Thesis

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Investigations in Diffuse Optical Tomography

Abstract

Diffuse Optical Tomography (DOT) is a medical imaging technique that is used for breast imaging, brain tumor detection, and arthritic joint imaging, amongst other applications. In this study, we optimize the optode arrangements in the physical apparatus for DOT in order to maximize information content obtained from the apparatus under varying numbers of sources and detectors. Approaching the problem through analyzing simple geometries in which the analytical forward model solutions can be obtained, we use Bayesian inference to handle the uncertainty in the inverse problem. Using a measure based on the volume of the posterior probability density function (PDF), we assess the relative improvement in the quality of our reconstructed image.

Our findings indicate that equal numbers of sources and detectors resulted in the best image, with relative improvement in image equality decreasing as we increased the number of optodes in the system. The difference between different spatial arrangements, when holding constant the number of optodes in the system, was found to be significant. When considering equal numbers of optodes with an unequal configuration, we find that the equal configuration offers an order of magnitude higher information content in the reconstructed image. Our results provide both useful guidelines and an algorithm to determine optimum arrangements of optodes in DOT imaging systems.