Contributions of Medical Imaging Group (MIG)
http://cds.iisc.ac.in/faculty/phani/MIG/
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The Medical Imaging Group primary research focus is on medical image reconstruction related areas, specifically computational methods in biomedical imaging. The research contributions made by the group have been directed towards developing biomedical optical image reconstruction algorithms, where the emphasis is on making them deployable in real-time and computationally efficient. These efforts have led to 28 high impact international journal publications over the past seven years, where all of them have appeared in reputed journals in the area of biomedical optics. These can be found at: http://cds.iisc.ac.in/faculty/phani/MIG/Publications.html

Biomedical optical imaging enables continuous monitoring of disease (bed-side), which is highly desirable in the clinic, as optical imaging equipment are portable and non-ionizing. The challenging task here is that the quantitative accuracy provided by the reconstructed images depend on the reconstruction parameters, which used to be chosen heuristically. In this context, the contributions made by the candidate has enabled elimination of the bias introduced by these reconstruction parameters, and even more potently, facilitated their automatic setting through matching of experimental data with the computational models. Moreover, as image reconstruction involves repeated use of the computational model, the performed work during the review period involved developing these computational models, a notable example being the modeling of terahertz heating effects in realistic tissue.

As modern medical imaging equipment is multi-modal in nature, combining optical imaging with traditional medical imaging equipment, the work performed by the group involved developing of new pathways to incorporate the additional information provided by the traditional imaging modality into the biomedical optical image reconstruction procedure. The major contributions in this area include: (a) Utilisation of approximate refractive-index values of tissue to improve the diffuse optical image reconstruction; (b) Prior image constraining of the solution based on L_1-norm minimization for diffuse optical image reconstruction; (c) Utilisation of prior information to optimize the minimal required measurements in image-guided diffuse optical tomography; (d) Gradient-free efficient reconstruction methods for image-guided diffuse optical tomography; and (e). Model-resolution based deconvolution of diffuse optical and photoacoustic images.

Other major technical contributions include: (f) The first-ever acceleration of diffuse optical image reconstruction using graphics processing units; (g) Data-resolution based high-level optimization of data-collection strategies for diffuse optical tomography; (h) ℓ_1-norm-based sparse linear reconstruction method for better contrast recovery in dynamic diffuse optical imaging; (i) Identification of optimal regularization parameters using minimal residual method in diffuse optical tomography; (j) Analytical solutions for coupled partial differential equations encountered in diffuse fluorescence imaging using extrapolated boundary conditions.