Summary of the dissertation
Development of optical tomography methods with discretized path integral
(離散化経路積分による散乱トモグラフィー)

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In this thesis, we have developed an optical tomography method using discretized path integral as a forward model and solving a non-linear inverse problem with Log-barrier and Primal-dual interior point approaches. Optical tomography is urgently needed in medical area due to the fact that other tomography methods have their own disadvantages. For example, the radiation exposure in the X-ray Computed Tomography (CT) has always been a issue since the X-ray CT was invented; the Nuclear Magnetic Resonance Imaging (NMRI) has very limited working area.
In the forward problem , we use path integral to build a mathematical model for the light transport in the optical tomography. To simplify the model, as the first step, we discretizied path integral. The second step, we designed a Two-Dimesional layered material with specific scattering model. The third step, the phase function was approximated by a Gaussian model. After the above three steps, we obtained the forward model with a simplified expression.
Once we got the forward model, we formulated the inverse problem which is a inequality optimization problem with boxed constraints.
To solve the inverse problem, we implemented the Log-barrier interior point approach. The numerical results show our approach works well. The comparison results with DOT also point out our approach has advantage in accuracy.
In order to improve the performance, we introduced the Primal-dual interior point approach. We further form new efficient formulations for computing Jacobian and Hessian which consider as the most computational expensive partin the cost function of the constraint non-linear optimization problem.

Numerical experiments show that Primal-dual approach works well with the new efficient formulations, and the computation time was reduced four times than the Log-barrier interior point approach while the quality of the estimation results maintain the same.