A novel 3D Monte Carlo framework to investigate light intensity distributions in anatomical structures

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The interpretation of optical measurements carried out on bio-medical systems, e.g. in the near infrared (NIR) range, requires a thorough understanding of light propagation in highly scattering media. A heuristic description is given by the radiative transport equation (RTE). A solution of the RTE in arbitrary geometries can only be obtained by numerical simulations, where a popular and flexible approach is offered by the Monte-Carlo method. We present a fully three dimensional Monte-Carlo implementation with a novel method to obtain spatially resolved absolute photon fluence rate maps. Additional new simulation analysis features allow for a direct comparison to measurement results.
The Monte-Carlo method presented in this work is applied to simulate light propagation in a head model and to analyze the results and their implications for non-invasive NIR extinction measurements in detail. The use of segmented MRI data allows simulating the light propagation in a realistic head model.