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A simulation platform for virtual clinical trials in chest X-ray imaging

Optimization of chest radiography aims to ensure that image quality remains adequate for the clinical tasks undertaken, while patient exposure is kept as low as possible. Establishing good image quality is a complex subject as this is strongly linked to clinical task. Additionally, the evaluation of a large number of system parameters is necessary. While clinical trials offer the gold standard in terms of tasks, realism and observer performance, aspects such as cost, duration and the patient to patient variation are limitations. In contrast, virtual clinical trials (VCT), in which computer simulations are used to model the image acquisition, processing and reading process, constitute a more practical alternative. Anthropomorphic computational phantoms can be used as anatomical models of real patients.
This work describes the creation of a simulation platform for VCT of chest X-rays. A methodology for simulating the imaging chain was developed and validated in terms of image quality and dose using simple homogeneous structures. Radiographic images were generated via Monte Carlo modelling together with ray tracing methods. Measured detector imaging characteristics, given by presampling modulation transfer function (MTF) and the noise power spectrum (NPS) were used to apply realistic degrees of sharpness and noise to the simulated images. This simulation platform has now been extended to include a focused anti-scatter grid. A set of chest anthropomorphic phantoms were created and diverse clinical tasks were added: lung nodules, catheter and rib fractures. Future evaluation will include an observer study, where the generated image dataset will be evaluated by radiologists.

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