

ABSTRACT

This study aimed to compare the detectability index (d') between human observer (HO) measurements using the 2-alternative forced choice (2-AFC) technique and advanced model observer (AMO) measurements using both non-pre whitening (NPW) and NPW with eye filter (NPWE) models for low-contrast object detection in computed tomography (CT) images. Task-transfer function (TTF) and noise power spectrum (NPS) information was obtained from ACR 464 phantom images acquired at tube currents of 100 mA and 200 mA. The task object was defined with a contrast of 6 HU, a diameter of 5 mm, and a field of view (FOV) of 15 mm. Flat, Gaussian, and Designer task object profiles were used. For each configuration, d' was measured using both the NPW and NPWE models. For HO, d' was obtained using a 2-AFC method, consisting of 200 images (100 signal-present and 100 signal-absent) per configuration. The NPWE model demonstrated a substantially stronger agreement with HO performance than the NPW model across the evaluated task conditions. The correlation between NPWE and HO detectability indices was very strong ($r = 0.931$), whereas the correlation between NPW and HO was moderate ($r = 0.725$). These findings indicate that incorporating an eye filter improves the ability of model observers to predict human performance of low-contrast detection in CT images. The NPWE model is a clinically valuable surrogate for human performance in low-contrast CT detection tasks compared with the NPW model of AMO. The strong correlation between NPWE and HO measurements validates the critical role of the eye filter in objective image quality assessment. Hence, the NPWE model of AMO provides a reliable and resource-efficient tool to optimize CT protocols and ensures that improvements in physical metrics translate directly into enhanced diagnostic detectability.

Keywords: Detectability index, Human observer, Model observer, Advanced model observer