A Perceptually Relevant Channelized Joint Observer (PCJO) for the Detection-Localization of Parametric Signals

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Résumé en anglais	Many numerical observers have been proposed in the framework of task-based approach for medical image quality assessment. However, the existing numerical observers are still limited in diagnostic tasks: the detection task has been largely studied, while the localization task concerning one signal has been little studied and the localization of multiple signals has not been studied yet. In addition, most existing numerical observers need a priori knowledge about all the parameters of the underdetection signals, while only a few of them need at least two signal parameters. In this paper, we propose a novel numerical observer called the perceptually relevant channelized joint observer (PCJO), which cannot only detect but also localize multiple signals with unknown amplitude, orientation, size and location. We validated the PCJO for predicting human observer task performance by conducting a clinically relevant free-response subjective experiment in which six radiologists (including two experts) had to detect and localize multiple sclerosis (MS) lesions on magnetic resonance (MR) images. By using the jackknife alternative free-response operating characteristic (JAFROC) as the figure of merit (FOM), the detection-localization task performance of the PCJO was evaluated and then compared to that of the radiologists and two other numerical observers-channelized hotelling observer (CHO) and Goossenss CHO for detecting asymmetrical signals with random orientations. Overall, the results show that the PCJO performance was closer to that of the experts than to that of the other radiologists. The JAFROC1 FOMs of the PCJO (around 0.75) are not significantly different from those of the two experts (0.7672 and 0.7110), while the JAFROC1 FOMs of the numerical observers mentioned above (always over 0.84) outperform those of the experts. This indicates that the PCJO is a promising method for predicting radiologists' performance in the joint detection-localization task.
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