

INTISARI

Telah dilakukan penelitian tentang implementasi *Pipeline for Advanced Contrast Enhancement* (PACE) 2.0 untuk meningkatkan kualitas citra radiografi digital pada sistem *Direct Digital Radiography* (DDR) Madeena. Citra DDR Madeena berpotensi ditingkatkan kualitas kontras dan visualnya melalui pemrosesan pasca-akuisisi. Penelitian ini bertujuan mengimplementasikan PACE 2.0 serta membandingkan kualitas citra sebelum dan sesudah pemrosesan berdasarkan metrik kualitas citra. Manfaatnya adalah tersedianya program pasca-pemrosesan yang dapat menjadi acuan pengembangan kualitas citra pada sistem radiografi digital. Data yang digunakan berupa 40 citra radiografi toraks hasil *beta testing* menggunakan alat DDR Madeena. Pengolahan awal dilakukan melalui *Flat Field Correction* (FFC) dan kalibrasi spasial untuk mengoreksi ketidakseragaman intensitas dan distorsi geometrik. Citra yang telah dikalibrasi diproses dengan PACE 2.0 melalui dekomposisi FABEMD, filter homomorfik, filter non-linier, koreksi gamma, CLAHE, dan optimasi parameter. Kualitas citra dievaluasi secara kuantitatif menggunakan tujuh metrik, yaitu SNR, CNR, CII, ENT, EME, BRISQUE, dan SSIM. Hasil evaluasi menunjukkan nilai sebelum dan sesudah pace adalah sebagai berikut: SNR dari $1,9 \pm 0,2$ menjadi $2,0 \pm 0,2$, CNR dari $1,0 \pm 0,4$ menjadi $1,1 \pm 0,4$, nilai CII $1,0 \pm 0,1$, ENT dari $7,2 \pm 0,1$ menjadi $7,0 \pm 0,2$, EME dari $2,5 \pm 0,6$ menjadi $3,5 \pm 0,6$, BRISQUE dari 68 ± 3 menjadi 60 ± 3 , dan nilai SSIM $0,97 \pm 0,01$. PACE 2.0 terbukti efektif meningkatkan kontras dan kualitas visual citra radiografi toraks DDR Madeena dengan tetap mempertahankan struktur anatomi utama.

Kata kunci: radiografi digital, DDR Madeena, peningkatan kualitas citra, PACE 2.0, metrik kualitas citra

ABSTRACT

A study was conducted on the implementation of Pipeline for Advanced Contrast Enhancement (PACE) 2.0 to improve digital radiographic image quality on the Direct Digital Radiography (DDR) Madeena system. DDR Madeena images still have potential for contrast and visual quality enhancement through post-acquisition processing. This study aimed to implement PACE 2.0 and compare image quality before and after processing based on quantitative image quality metrics. The benefit is the availability of a post-processing program that can serve as a reference for image quality development in digital radiography systems. The data used consisted of 40 chest radiographic images obtained from beta testing conducted using the DDR Madeena system. Preprocessing was performed through Flat Field Correction (FFC) and spatial calibration to correct intensity non-uniformity and geometric distortion. The calibrated images were processed using PACE 2.0 through FABEMD decomposition, homomorphic filtering, non-linear filtering, gamma correction, CLAHE, and parameter optimization. Image quality was quantitatively evaluated using seven metrics: SNR, CNR, CII, ENT, EME, BRISQUE, and SSIM. The evaluation results showed that the values before and after PACE 2.0 processing were as follows: SNR from 1.9 ± 0.2 to 2.0 ± 0.2 , CNR from 1.0 ± 0.4 to 1.1 ± 0.4 , CII of 1.0 ± 0.1 , ENT from 7.2 ± 0.1 to 7.0 ± 0.2 , EME from 2.5 ± 0.6 to 3.5 ± 0.6 , BRISQUE from 68 ± 3 to 60 ± 3 , and SSIM of 0.97 ± 0.01 . PACE 2.0 proved effective in enhancing the contrast and visual quality of DDR Madeena chest radiographs while preserving key anatomical structures.

Keywords: digital radiography, DDR Madeena, image enhancement, PACE 2.0, image quality metrics