ABSTRACT

DEVELOPMENT OF A COMPUTER-AIDED DETECTION AND DIAGNOSIS (CAD) SYSTEM: BREAST CANCER MAMMOGRAM ANALYSIS BASED ON POSSIBILISTIC FUZZY C-MEANS (FPCM) AND TRANSFER LEARNING USING PSEUDO-STADIUM LABELING

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Breast cancer is one of the leading causes of cancer-related mortality among women, making early detection and accurate assessment of tumor severity critically important. Mammography, as the primary screening modality, faces challenges related to the high workload of radiologists and limitations in diagnostic consistency. Therefore, this study develops an integrated mammogram-based Computer-Aided Detection and Diagnosis (CAD) system that combines the Computer-Aided Detection (CADe) and Computer-Aided Diagnosis (CADx) phases within a single pipeline. In the CADe stage, the Possibilistic Fuzzy C-Means (PFCM) method is employed to perform automatic tumor area segmentation that is robust to noise and variations in image intensity. The resulting segmentation outputs are then utilized to generate semi-automatic pseudo-stadium labeling based on tumor size estimation, which is mapped to T1–T4 stages according to the AJCC–TNM standard. The CADx stage applies a transfer learning (TL) approach to classify breast cancer severity levels. System evaluation includes cluster validation metrics at the CADe stage as well as classification metrics and ROC–AUC analysis at the CADx stage. Experimental results demonstrate that the DenseNet121 model achieves the best performance, with an accuracy of 0.9000, an F1-score of 0.8996, a micro-average AUC of 0.9804, and a macro-average AUC of 0.9783. These findings indicate that the proposed CAD system has strong potential to support automated early diagnosis and severity assessment of breast cancer.

Keywords: Breast Cancer, Mammography, Computer-Aided Detection and Diagnosis, Possibilistic Fuzzy C-Means, Transfer Learning.

ABSTRAK

PENGEMBANGAN SISTEM *COMPUTER-AIDED DETECTION AND DIAGNOSIS* (CAD): ANALISIS CITRA KANKER PAYUDARA BERDASARKAN *POSSIBILISTIC FUZZY C-MEANS* (PFCM) DAN *TRANSFER LEARNING* MENGGUNAKAN *PSEUDO-STADIUM LABELING*

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Kanker payudara merupakan salah satu penyebab utama kematian akibat kanker pada perempuan, sehingga deteksi dini dan penilaian tingkat keparahan tumor menjadi sangat penting. Pemeriksaan mammografi sebagai metode skrining utama menghadapi tantangan berupa beban kerja radiolog yang tinggi serta keterbatasan konsistensi diagnosis. Oleh karena itu, penelitian ini mengembangkan sistem *Computer-Aided Detection and Diagnosis* (CAD) terintegrasi berbasis citra mammogram yang menggabungkan fase *Computer-Aided Detection* (CADe) dan fase *Computer-Aided Diagnosis* (CADx) dalam satu *pipeline*. Pada tahap CADe, metode *Possibilistic Fuzzy C-Means* (PFCM) digunakan untuk melakukan segmentasi area tumor secara otomatis dan adaptif terhadap noise serta variasi intensitas citra. Hasil segmentasi selanjutnya dimanfaatkan untuk membentuk *pseudo-stadium labeling* secara semi-otomatis berdasarkan estimasi ukuran tumor yang dipetakan ke stadium T1–T4 sesuai standar AJCC–TNM. Tahap CADx dilakukan menggunakan pendekatan *transfer learning* (TL) untuk mengklasifikasikan tingkat keparahan kanker payudara. Evaluasi sistem mencakup metrik validasi klaster pada tahap CADe serta metrik klasifikasi dan ROC–AUC pada tahap CADx. Hasil eksperimen menunjukkan bahwa model DenseNet121 memberikan performa terbaik dengan *accuracy* 0.9000, *f1-score* 0.8996, *micro-average* AUC 0.9804 dan *macro-average* AUC sebesar 0,9783. Hasil ini menunjukkan bahwa sistem CAD yang dikembangkan berpotensi mendukung diagnosis dini dan penilaian tingkat keparahan kanker payudara secara otomatis.

Kata-kata kunci: Kanker Payudara, Mammografi, *Computer-Aided Detection and Diagnosis*, *Possibilistic Fuzzy C-Means*, *Transfer Learning*.