

ABSTRAK

Pneumonia merupakan penyebab utama kematian akibat infeksi saluran pernapasan, terutama di negara berkembang, dengan tantangan diagnosis yang dipengaruhi keterbatasan fasilitas kesehatan, kualitas citra *x-ray* yang bervariasi, dan kebutuhan interpretasi ahli. Penelitian ini mengembangkan sistem deteksi pneumonia berbasis citra *x-ray* menggunakan *Convolutional Neural Network* (CNN) yang dipadukan dengan *Convolutional Block Attention Module* (CBAM) untuk memfokuskan analisis pada area relevan, serta model verifikasi berbasis MobileNetV2 guna memastikan hanya citra valid yang diproses. Dataset publik terdiri dari 5.856 citra *x-ray* untuk klasifikasi dan 2.400 citra untuk verifikasi, diuji pada berbagai variasi resolusi dan augmentasi, lalu dievaluasi menggunakan akurasi, presisi, recall, F1-score, dan ROC-AUC. Konfigurasi terbaik pada resolusi 256 piksel dengan augmentasi menghasilkan akurasi 92,79%, F1-score 94,51%, dan ROC-AUC 98,10%. Interpretabilitas model dianalisis menggunakan Grad-CAM++ dan divalidasi oleh tenaga medis, memperoleh *Intersection over Union* (IoU) 0,8958 dan Dice Coefficient 0,9450. Sistem diimplementasikan melalui antarmuka Telegram Bot untuk memudahkan interaksi dan akses pengguna tanpa perangkat khusus. Integrasi mekanisme perhatian dan antarmuka interaktif ini membuktikan bahwa sistem mampu memberikan deteksi pneumonia yang akurat, dapat ditafsirkan secara visual, dan mudah diakses, sehingga berpotensi menjadi solusi praktis untuk mendukung diagnosis yang lebih efektif.

Kata Kunci: Pneumonia, Citra *X-ray* Paru-paru, *Deep Learning*, CNN, *Attention Mechanism*, CBAM, Grad-CAM++, Telegram Bot.



ABSTRACT

Pneumonia is the leading cause of death due to respiratory infections, especially in developing countries, with diagnostic challenges influenced by limited healthcare facilities, varying quality of X-ray images, and the need for expert interpretation. This study developed a pneumonia detection system based on x-ray images using Convolutional Neural Network (CNN) combined with the Convolutional Block Attention Module (CBAM) to focus analysis on relevant areas, as well as a verification model based on MobileNetV2 to ensure only valid images are processed. The public dataset consists of 5,856 X-ray images for classification and 2,400 images for verification, tested across various resolutions and augmentations, and evaluated using accuracy, precision, recall, F1-score, and ROC-AUC. The best configuration at a resolution of 256 pixels with augmentation achieved an accuracy of 92.79%, F1-score of 94.51%, and ROC-AUC of 98.10%. Model interpretability was analyzed using Grad-CAM++ and validated by medical professionals, obtaining an Intersection over Union (IoU) of 0.8958 and a Dice Coefficient of 0.9450. The system was implemented through a Telegram Bot interface to facilitate user interaction and access without special devices. The integration of attention mechanisms and an interactive interface demonstrates that the system can provide accurate pneumonia detection, visually interpretable results, and easy access, making it a practical solution to support more effective diagnosis.

Keywords: *Pneumonia, Chest X-ray Image, Deep Learning, CNN, Attention Mechanism, CBAM, Grad-CAM++, Telegram Bot.*

