

## ABSTRACT

### SEMANTIC SEGMENTATION OF ROAD CRACKS USING HED-UNET MODEL WITH IMAGE PRE-PROCESSING

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Road damage, particularly cracks, is a serious problem affecting transportation safety. Early detection is essential to prevent further damage that could endanger traffic. Traditional manual and image processing-based detection methods have limitations in efficiency and complexity, while deep learning algorithms offer flexibility as well as better generalization capabilities. This research proposes the application of the HED-UNet deep learning model for semantic segmentation of road cracks. The model is supported by an image pre-processing stage that includes data augmentation, light intensity normalization using Contrast Limited Adaptive Histogram Equalization (CLAHE), and noise reduction with median filter. The results show that the combination of the U-Net semantic segmentation model with the HED edge detection model, as well as the application of data augmentation pre-processing, is able to improve the accuracy of HED-UNet segmentation. The improvement is shown by the increase of mIoU value by 36% compared to U-Net and 33% compared to U-Net with attention mechanism. These results confirm that the integration of edge detection and semantic segmentation, supported by appropriate pre-processing methods, can improve the model's performance in detecting road cracks more accurately and effectively.

**Keywords:** Road Cracks, Semantic Segmentation, Edge Detection, HED, U-Net, HED-UNet, Deep Learning, Image Pre-processing

## INTISARI

### SEGMENTASI SEMANTIK RETAKAN JALAN MENGGUNAKAN MODEL HED-UNET DENGAN PRA-PEMROSESAN CITRA

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Kerusakan jalan, khususnya retakan, merupakan masalah serius yang mempengaruhi keselamatan transportasi. Deteksi dini sangat penting untuk mencegah kerusakan lebih lanjut yang dapat membahayakan lalu lintas. Metode deteksi manual dan berbasis pemrosesan citra tradisional memiliki keterbatasan dalam efisiensi dan kompleksitas, sedangkan algoritma *deep learning* menawarkan fleksibilitas serta kemampuan generalisasi yang lebih baik. Penelitian ini mengusulkan penerapan model deep learning HED-UNet untuk segmentasi semantik retakan jalan. Model ini didukung oleh tahap pra-pemrosesan citra yang mencakup augmentasi data, normalisasi intensitas cahaya menggunakan *Contrast Limited Adaptive Histogram Equalization* (CLAHE), dan pengurangan *noise* dengan median filter. Hasil penelitian menunjukkan bahwa kombinasi model segmentasi semantik U-Net dengan model deteksi tepi HED, serta penerapan pra-pemrosesan augmentasi data, mampu meningkatkan akurasi segmentasi HED-UNet. Peningkatan tersebut ditunjukkan dengan kenaikan nilai mIoU sebesar 36% dibandingkan U-Net dan 33% dibandingkan U-Net dengan *attention mechanism*. Hasil tersebut mengonfirmasi bahwa integrasi deteksi tepi dan segmentasi semantik, didukung dengan metode pra-pemrosesan yang tepat, dapat meningkatkan performa model dalam mendeteksi retakan jalan secara lebih akurat dan efektif.

**Kata Kunci:** Retakan Jalan, Segmentasi Semantik, Deteksi Garis, HED, U-Net, HED-UNet, Deep Learning, Pra-pemrosesan Citra