

ABSTRACT

CAR DETECTION IN PARKING LOTS USING BACKGROUND SUBTRACTION METHOD WITH MEAN SQUARED ERROR-BASED BACKGROUND CANDIDATE SELECTION

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Vehicle detection in parking areas is a crucial aspect of automated parking management systems, especially for providing real-time information on vacant slots. Background subtraction is commonly used due to its simplicity, but its performance may decline under varying lighting conditions and shadows. This study proposes a vehicle detection method in parking areas that is more adaptive to environmental conditions by utilizing background candidate selection based on Mean Squared Error (MSE) and an exclude foreground approach. Once the optimal background candidate is selected, the process continues with background subtraction, thresholding, blurring, perspective transformation on ROIs, and morphological operations such as opening and closing to improve vehicle segmentation quality. The method was evaluated on the CNRPark+EXT dataset using 2000 hyperparameter combinations, including median filter kernel size, Gaussian low-pass filter size, and threshold values at various segmentation stages. Experimental results show that the best configuration was achieved without applying exclude foreground, with a 3×3 median filter kernel, first threshold value of 30, 7×7 Gaussian filter kernel, second threshold value of 30, and a detection threshold of 0.2. The proposed method achieved an F1-score of 91.42%, outperforming the previous method by Pratomo et al. (2021). This research demonstrates that background candidate selection adaptive to lighting conditions, combined with morphological operations, can significantly improve vehicle detection accuracy.

Keywords: Digital Image Processing, Background Subtraction, Vehicle Detection, Mean Squared Error, Morphological Operations, Car Detection

INTISARI

DETEKSI MOBIL DI AREA PARKIR MENGGUNAKAN METODE BACKGROUND SUBTRACTION DENGAN PEMILIHAN KANDIDAT BACKGROUND BERBASIS MEAN SQUARED ERROR

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Deteksi kendaraan di area parkir merupakan aspek penting dalam sistem manajemen parkir otomatis, terutama untuk menyediakan informasi slot kosong secara *real-time*. Metode *background subtraction* sering digunakan karena kesederhanaannya, namun performanya dapat menurun akibat variasi pencahayaan dan bayangan. Penelitian ini mengusulkan metode deteksi mobil di area parkir yang lebih adaptif terhadap kondisi lingkungan dengan memanfaatkan pemilihan kandidat *background* berbasis *Mean Squared Error* (MSE) dan pendekatan *exclude foreground*. Setelah kandidat *background* terpilih, proses dilanjutkan dengan *background subtraction*, *thresholding*, *blurring*, transformasi perspektif pada ROI, serta operasi morfologi *opening* dan *closing* untuk meningkatkan kualitas segmentasi kendaraan. Evaluasi dilakukan pada *dataset* CNRPark+EXT dengan kombinasi 2000 *hyperparameter*, yang mencakup ukuran kernel *median filter*, *Gaussian low-pass filter*, dan nilai *threshold* pada tahap segmentasi. Hasil eksperimen menunjukkan bahwa konfigurasi terbaik diperoleh tanpa menerapkan *exclude foreground*, dengan ukuran kernel *median filter* 3×3 , *threshold* pertama 30, ukuran kernel *Gaussian filter* 7×7 , *threshold* kedua 30, dan *threshold* deteksi 0,2. Metode yang diusulkan menghasilkan *F1-score* sebesar 91,42%, yang lebih tinggi dibandingkan metode sebelumnya oleh Pratomo et al. (2021). Penelitian ini menunjukkan bahwa pemilihan kandidat *background* yang adaptif terhadap kondisi pencahayaan dan penerapan operasi morfologi mampu meningkatkan akurasi deteksi kendaraan secara signifikan.

Kata Kunci: Pengolahan Citra Digital, *Background Subtraction*, Deteksi Mobil, *Mean Squared Error*, Operasi Morfologi, Deteksi Kendaraan