

ABSTRACT

Traffic accidents caused by drowsy driving remain a serious problem in transportation safety in Indonesia, necessitating a real-time drowsiness detection system. This research aims to analyze the performance of the Face Mesh algorithm in detecting driver drowsiness based on the Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) parameters, measure the influence of image capture distance and lighting conditions on system accuracy, and evaluate the stability of Face Mesh performance without adding a deep learning model. The system was developed using the Python programming language with the main OpenCV and MediaPipe libraries, and utilizes a smartphone camera as the image acquisition device. Drowsiness detection was performed by setting an EAR threshold value of ≤ 50 as an indicator of closed eyes and an MAR of ≥ 60 as an indicator of yawning activity. Testing was conducted based on variations in distance, lighting conditions, and per-frame evaluation using manual ground truth as the initial baseline. The testing results on 325 frames yielded an accuracy of 89.85%, precision of 81.57%, recall of 54.38%, and an F1-score of 65.32%. The system showed optimal performance at a distance of 40–60 cm and in morning, midday, and evening lighting conditions, but was unable to detect facial landmarks in low lighting conditions. The results of this study indicate that the Face Mesh algorithm has potential as a lightweight and real-time facial landmark-based drowsiness detection system, with limitations in detection sensitivity and dependence on environmental conditions.

Keywords: Drowsiness Detection, EAR, Face Mesh, Image Processing, MAR

ABSTRAK

Kecelakaan lalu lintas akibat kantuk saat berkendara masih menjadi permasalahan serius dalam keselamatan transportasi di Indonesia, sehingga diperlukan sistem deteksi kantuk yang mampu bekerja secara *real-time*. Penelitian ini bertujuan menganalisis performa algoritma *Face Mesh* dalam mendeteksi kantuk pengemudi mobil berbasis parameter *Eye Aspect Ratio* (EAR) dan *Mouth Aspect Ratio* (MAR), mengukur pengaruh variasi jarak pengambilan citra dan kondisi pencahayaan terhadap akurasi sistem, serta mengevaluasi stabilitas performa *Face Mesh* tanpa penambahan model *deep learning*. Sistem dikembangkan menggunakan bahasa pemrograman *Python* dengan *library* utama *OpenCV* dan *MediaPipe*, serta memanfaatkan kamera *smartphone* sebagai perangkat akuisisi citra. Deteksi kantuk dilakukan dengan menetapkan nilai ambang $EAR \leq 50$ sebagai indikator mata terpejam dan $MAR \geq 60$ sebagai indikator aktivitas menguap. Pengujian dilakukan berdasarkan variasi jarak, kondisi pencahayaan, dan evaluasi per *frame* menggunakan *ground truth* manual sebagai *baseline* awal. Hasil pengujian terhadap 325 *frame* menghasilkan akurasi sebesar 89,85%, *precision* 81,57%, *recall* 54,38%, dan *F1-score* 65,32%. Sistem menunjukkan performa optimal pada jarak 40–60 cm serta kondisi pencahayaan pagi, siang, dan sore, namun tidak mampu mendeteksi *landmark* wajah pada kondisi pencahayaan rendah. Hasil penelitian ini menunjukkan bahwa algoritma *Face Mesh* memiliki potensi sebagai sistem deteksi kantuk berbasis *landmark* wajah yang ringan dan *real-time*, dengan keterbatasan pada sensitivitas deteksi dan ketergantungan terhadap kondisi lingkungan.

Kata Kunci : Deteksi Kantuk, EAR, *Face Mesh*, MAR, Pengolahan Citra