Sistem Peringatan Dini Kondisi Kantuk Pengemudi Motor Menggunakan Sensor IMU dan Support Vector Machine Untuk Deteksi Microsleep (*Early Warning System for Motorcyclist Drowsiness Using IMU Sensors and Support Vector Machine for Microsleep Detection*)
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ABSTRACT

Traffic accidents caused by drowsiness and microsleep among motorcyclists represent a significant road safety concern in Indonesia, with 299,479 accidents recorded in the 2023-2024 period, 95% of which were attributed to human error encompassing fatigue, inattention, and microsleep. This study aims to design and implement a real-time drowsiness early warning system integrated into a motorcycle helmet as a wearable device, utilizing an MPU6050 IMU sensor and a Support Vector Machine (SVM) algorithm for microsleep detection. An experimental approach was adopted, encompassing hardware design based on an ESP32 microcontroller embedded in the helmet, head movement data acquisition using a non-overlapping window segmentation method of 10 samples (1 second at 10 Hz sampling frequency), and a four-stage feature selection pipeline comprising statistical significance testing, Cohen's d discriminative power analysis, correlation-based redundancy elimination, and Recursive Feature Elimination with Cross-Validation (RFECV). Five time-domain statistical features were selected as inputs to an SVM model with a Radial Basis Function (RBF) kernel (C=1, gamma=1.0): *angleX_max*, *angleY_min*, *angleY_mean*, *gy_min*, and *gy_max*, extracted from a dataset of 4,750 samples. Model evaluation on the test set yielded an accuracy of 92.53% with a microsleep class recall of 92%, while field testing involving 5 subjects across 50 simulated microsleep events produced an overall detection rate of 86% and a mean computational latency of 21.4 ms per window. The developed helmet-based wearable early warning system demonstrates adequate real-time microsleep detection performance for road safety applications, though further generalization across diverse vehicle types and rider physical characteristics necessitates expanded training data collection in future research.

Keywords: microsleep, support vector machine, IMU sensor, wearable device, early warning system