ABSTRAK

SISTEM DETEKSI DINI *MICROSLEEP* DAN KEBAKARAN KABIN MENGGUNAKAN YOLOV11 DENGAN INTEGRASI PARAMETER FISIOLOGIS PENGEMUDI BERBASIS IOT

(2026: + 95 Halaman + 46 Gambar + 19 Tabel + 30 Daftar Pustaka + Lampiran)

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Kecelakaan lalu lintas akibat *microsleep* dan kebakaran kabin merupakan risiko fatal bagi keselamatan berkendara. Penelitian ini bertujuan merancang sistem deteksi dini *multi-hazard* terintegrasi berbasis *edge computing* pada Raspberry Pi 4B yang menggabungkan visi komputer dan protokol *Internet of Things* (IoT). Sistem ini menggunakan algoritma YOLOv11n berformat *ONNX Runtime* untuk mengekstraksi fitur wajah (*drowsy_eye* dan *open_mouth*) melalui kamera *night vision*, serta sensor inframerah MLX90614 dengan fungsi ganda untuk *pre-screening* suhu tubuh pengemudi dan monitoring temperatur kabin. Guna meminimalkan alarm palsu (*false alarm*), diterapkan logika keputusan bertingkat (*multi-level decision logic*) yang mengirimkan notifikasi nirkabel via Telegram Bot pada fase Siaga, serta langsung memicu aktuator darurat (*buzzer*, LED, dan pompa air) saat mendeteksi fase kritis *microsleep* adan saat suhu kabin melebihi 40°C sistem mengaktifka buzzer dan LED serta notifikasi melalui telegram bot.

Hasil pengujian membuktikan model YOLOv11n sangat tangguh di berbagai kondisi pencahayaan dengan presisi 97,3%, *recall* 96,4%, dan mAP@0.5 sebesar 98,6%. Implementasi *edge computing* menghasilkan performa *real-time* tanpa *frame dropping* dengan kecepatan bingkai dinamis antara 22,8 FPS hingga 72,4 FPS. Integrasi ini sukses menghasilkan sistem asisten keselamatan berkendara yang presisi, taktis, dan andal.

Kata Kunci : *Microsleep*, YOLOv11, *Edge Computing*, *Internet of Things*, Sensor MLX90614, Keselamatan Berkendara.

ABSTRACT

EARLY MICROSLEEP AND CABIN FIRE DETECTION SYSTEM USING YOLOV11 WITH IOT-BASED DRIVER PHYSIOLOGICAL PARAMETER INTEGRATION

(2026: + 95 Pages +46 Figures + 19 Tables + 30 Bibliography + Appendices)

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Traffic accidents caused by microsleep and cabin fires pose fatal risks to driving safety. This research aims to design an integrated multi-hazard early detection system based on edge computing on a Raspberry Pi 4B platform, combining computer vision and Internet of Things (IoT) protocols. The system utilizes the YOLOv11n algorithm in *ONNX Runtime* format to extract facial features (*drowsy_eye* and *open_mouth*) via a night vision camera, alongside an MLX90614 infrared sensor double-functioned for driver body temperature pre-screening and cabin temperature monitoring. To minimize false alarms, a multi-level decision logic is implemented to transmit wireless notifications via a Telegram Bot during the Alert phase. It instantly triggers emergency actuators (a buzzer, LEDs, and a water pump) upon detecting a critical microsleep phase; meanwhile, when the cabin temperature exceeds 40°C, the system activates the buzzer and LEDs, and sends a notification through the Telegram Bot.

Experimental results demonstrate that the YOLOv11n model is highly robust under various lighting conditions, achieving 97.3% precision, 96.4% recall, and 98.6% mAP@0.5. The edge computing implementation delivers real-time performance without frame dropping, maintaining a dynamic frame rate between 22.8 FPS and 72.4 FPS. This integration successfully yields a precise, tactical, and highly reliable driving safety assistant system.

Keywords: *Microsleep*, YOLOv11, *Edge Computing*, *Internet of Things*, MLX90614 Sensor, Driving Safety