DESIGN AND CONSTRUCTION OF A SMART VEHICLE DETECTOR AS A DRIVING INFORMATION ASSISTANT SYSTEM USING ESP32-CAM BASED ON RASPBERRY PI 4B MICROCONTROLLER

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ABSTRACT

The application of Artificial Intelligence (AI) in modern vehicles is crucial for improving driving safety. This research implements the design and construction of a smart driving information assistant system using an offline integration of ESP32-CAM and a Raspberry Pi 4B microcontroller. The system utilizes the ESP32-CAM to capture road frames via WiFi, which are then processed by the TensorFlow Lite framework on the Raspberry Pi 4B to detect cars, motorcycles, and trucks. As a secondary support system, three HC-SR04 ultrasonic sensors are implemented to measure physical distance and trigger LED warning indicators (Safe: green LED at >4 meters; Warning: yellow LED at 2–4 meters; Danger: red LED at ≤1 meter). Field testing was conducted on Mastrip, Kalimantan, Jawa, and Riau streets during both day and night. The results demonstrated the highest detection performance during the day on Mastrip Street, achieving an average road accuracy of 47%. At night, an anomaly occurred where car detection accuracy rose to 65% on Kalimantan Street due to vehicle headlight contrast, whereas motorcycle detection dropped to 0% across almost all routes due to oncoming glare. The system faces detection failures under heavy traffic congestion or when objects are too close (1–5 meters). Ultimately, the ultrasonic sensor integration successfully serves as a crucial backup system when the camera experiences visual limitations.

Keywords: *ESP32-CAM, Raspberry Pi 4B, Object Detection, Ultrasonic Sensor, Driving Information Assistant*.