

RANCANG BANGUN SISTEM DETEKSI DINI KEBAKARAN BERBASIS ESP32-CAM DAN SENSOR ASAP MENGUNAKAN METODE *CONVOLUTIONAL NEURAL NETWORK* UNTUK KLASIFIKASI VISUAL API

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ABSTRAK

Sistem deteksi kebakaran konvensional seringkali memicu peringatan palsu (*false alarm*) karena hanya mengandalkan sensor asap atau suhu tanpa verifikasi visual, sehingga mengurangi kepercayaan dan efektivitas respon darurat. Penelitian ini merancang bangun sistem deteksi dini kebakaran berbasis *Internet of Things* (IoT) yang mengintegrasikan mikrokontroler ESP32-CAM dan sensor asap MQ-2 menggunakan metode *Convolutional Neural Network* (CNN) dengan algoritma YOLO untuk klasifikasi visual api secara *real time*. Sistem ini bekerja dengan mekanisme verifikasi ganda, di mana notifikasi peringatan dan bukti visual dikirimkan melalui Telegram, serta aktuator *sprinkler* diaktifkan secara otomatis hanya jika terdeteksi indikasi api dan asap secara bersamaan. Hasil pengujian menunjukkan bahwa sistem mampu mendeteksi keberadaan api dengan tingkat akurasi di atas 90% dan waktu respon rata-rata antara 2,1 hingga 4,8 detik, menjadikannya solusi adaptif dan andal untuk meningkatkan keamanan pada ruangan tertutup.

Kata Kunci : Deteksi Dini Kebakaran, ESP32-CAM, Sensor MQ-2, *Convolutional Neural Network* (CNN), *Internet of Things* (IoT).

DESIGN AND IMPLEMENTATION OF AN EARLY FIRE DETECTION SYSTEM BASED ON ESP32-CAM AND SMOKE SENSOR USING CONVOLUTIONAL NEURAL NETWORK FOR VISUAL FIRE CLASSIFICATION

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ABSTRACT

Conventional fire detection systems often trigger false alarms as they rely solely on smoke or temperature sensors without visual verification, thereby reducing trust and emergency response effectiveness. This study designs and builds an Internet of Things (IoT)-based early fire detection system integrating an ESP32-CAM microcontroller and an MQ-2 smoke sensor, utilizing the Convolutional Neural Network (CNN) method with the YOLO algorithm for real-time visual fire classification. The system operates with a dual verification mechanism where warning notifications and visual evidence are sent via Telegram, and sprinkler actuators are automatically activated only when both fire and smoke indications are detected simultaneously. Test results demonstrate that the system detects fire with an accuracy rate above 90% and an average response time between 2.1 to 4.8 seconds, making it an adaptive and reliable solution for enhancing safety in enclosed spaces.

Keywords : *Early Fire Detection, ESP32-CAM, MQ-2 Sensor, Convolutional Neural Network (CNN), Internet of Things (IoT).*