Pengembangan Sistem Monitoring Kondisi Traktor Berbasis Multisensor Dan Edge Peocessing Untuk
Deteksi Anomali Getaran
Fajrian Anggit Hidayatulloh, Ir. Andri Prima Nugroho, S.T.P., M.Sc., Ph.D, IPU., ASEAN Eng., APEC Eng. ; Dr. Ir. Ra
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

PENGEMBANGAN SISTEM MONITORING KONDISI TRAKTOR BERBASIS MULTISENSOR DAN *EDGE PROCESSING* UNTUK DETEKSI ANOMALI GETARAN

INTISARI

Oleh:

Fajrian Anggit Hidayatulloh
22/495006/TP/13448

Mekanisasi pertanian yang meningkat memerlukan sistem pemantauan kondisi alat yang lebih adaptif dan cerdas. Sistem pencatatan jam operasional (*hour meter*) konvensional maupun berbasis IoT yang ada saat ini hanya berfungsi sebagai data logger pasif tanpa kemampuan menganalisis kondisi aktual peralatan, sehingga deteksi dini kerusakan sulit dilakukan dan rekomendasi perawatan hanya mengandalkan akumulasi waktu operasi. Penelitian ini bertujuan merancang dan membangun monitoring *system* terintegrasi berbasis ESP32 yang mampu memantau jam kerja, lokasi geografis (GPS NEO-6M), dan getaran mekanis (MPU6050) traktor pertanian secara simultan, serta melakukan deteksi anomali di tingkat perangkat (*edge processing*). Kebaruan sistem terletak pada arsitektur pemrosesan di *edge* yang mengekstraksi fitur getaran (RMS, nilai puncak, frekuensi dominan) dan mengklasifikasikan kondisi operasi sebagai "normal" atau "anomali" secara mandiri. Ketika anomali terdeteksi, sistem secara otomatis membubuhi data dengan *timestamp* jam operasional dan koordinat GPS. Penelitian dibatasi pada perancangan perangkat keras, pengembangan algoritma *edge processing*, dan pengujian kemampuan sistem menghasilkan data olahan. Luaran utama berupa data terstruktur (ringkasan jam kerja, koordinat, parameter getaran, status anomali) yang disimpan dalam media lokal sebagai dasar rekomendasi perawatan prediktif (*predictive maintenance*). Hasil yang diharapkan adalah prototipe sistem pemantauan traktor cerdas yang mampu bekerja pada sumber daya komputasi terbatas, menghasilkan data berkualitas, serta membuktikan konsep deteksi anomali berbasis *edge processing*. Sistem ini menjadi fondasi manajemen alat mesin pertanian yang efisien, responsif, dan berbasis data.

Kata Kunci: *edge processing*, deteksi anomali, traktor pertanian, sensor getaran, GPS, *predictive maintenance*, ESP32.

Pengembangan Sistem Monitoring Kondisi Traktor Berbasis Multisensor Dan Edge Peocessing Untuk
Deteksi Anomali Getaran
Fajrian Anggit Hidayatulloh, Ir. Andri Prima Nugroho, S.T.P., M.Sc., Ph.D, IPU., ASEAN Eng., APEC Eng. ; Dr. Ir. Ra
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DEVELOPMENT OF A MULTISENSOR AND *EDGE PROCESSING*-BASED TRACTOR CONDITION MONITORING SYSTEM FOR VIBRATION ANOMALY DETECTION

ABSTRACT

By:

Fajrian Anggit Hidayatulloh

22/495006/TP/13448

The increasing mechanization of agriculture demands more adaptive and intelligent equipment monitoring systems. Conventional *hour meter* recording systems, including existing IoT-based solutions, function merely as passive data loggers without the capability to analyze actual equipment conditions. Consequently, early detection of potential failures is difficult to achieve, and *maintenance* recommendations rely solely on accumulated operating hours without considering critical machine health indicators such as vibration levels. This research aims to design and develop an integrated monitoring *system* based on ESP32 microcontroller that simultaneously monitors operating hours, geographic location (GPS NEO-6M), and mechanical vibration (MPU6050) of agricultural tractors, while performing anomaly detection at the device level (*edge processing*). The novelty of this system lies in its *edge processing* architecture, which autonomously extracts vibration features Root Mean Square (RMS), peak values, and dominant frequencies and classifies operational conditions as either "normal" or "anomaly." When an anomaly is detected, the system automatically appends the data with operating hour timestamp and GPS coordinates. This research is limited to hardware design, *edge processing* algorithm development, and testing the system's capability to generate processed data. The primary output is structured data summaries of daily operating hours, coordinates, vibration parameters, and anomaly status stored locally as a foundation for *predictive maintenance* recommendations. The expected outcome is a functional prototype of an intelligent tractor monitoring system capable of operating on resource-constrained devices, producing high-quality data, and proving that *edge*-based anomaly detection is feasible in agricultural applications. This system serves as a foundation for more efficient, responsive, and data-driven agricultural fleet management.

Keywords: *edge processing*, anomaly detection, agricultural tractor, vibration sensor, GPS, *predictive maintenance*, ESP32