ABSTRAK

Penelitian ini dilatarbelakangi oleh tingginya potensi gangguan mekanis pada mesin industri yang sering tidak terdeteksi secara dini sehingga dapat menyebabkan kegagalan mesin yang berdampak pada terhentinya proses produksi. Metode pemeliharaan konvensional berbasis waktu dinilai kurang efektif karena tidak merepresentasikan kondisi aktual mesin secara real-time.

Penelitian ini bertujuan untuk merancang dan mengimplementasikan sistem monitoring getaran dan suhu mesin industri berbasis *Internet of Things* (IoT) menggunakan mikrokontroler ESP32 sebagai upaya deteksi dini gangguan mekanis mesin guna mendukung penerapan pemeliharaan berbasis kondisi (*condition-based maintenance*). Keterbaruan penelitian ini terletak pada integrasi sistem monitoring multi-sensor yang secara langsung mengacu pada standar industri ISO 10816-3, dengan pemrosesan parameter getaran berbasis nilai *Root Mean Square* (RMS) dan *Fast Fourier Transform* (FFT), tanpa menggunakan algoritma prediktif atau pembelajaran mesin yang kompleks.

Metode penelitian dilakukan melalui perancangan dan implementasi sistem monitoring menggunakan dua sensor getaran ADXL345 dan dua sensor suhu MAX6675 yang terintegrasi dalam satu node ESP32. Data getaran diolah dalam bentuk RMS dan FFT untuk mengidentifikasi karakteristik frekuensi dominan mesin, kemudian dikirimkan secara *real-time* ke platform IoT *ThingsBoard* melalui protokol *Message Queuing Telemetry Transport* (MQTT).

Hasil pengujian menunjukkan bahwa sistem mampu melakukan akuisisi, pemrosesan, dan pengiriman data secara stabil. Nilai RMS getaran berada pada rentang 2,15–2,17 mm/s dengan variasi sekitar 19-25%, sedangkan suhu operasi mesin tercatat sekitar 67 °C dengan variasi sekitar 3,3% selama periode pengujian. Analisis FFT menunjukkan adanya frekuensi dominan yang sesuai dengan karakteristik operasi mesin. Berdasarkan klasifikasi ISO 10816-3, kondisi mesin berada pada kategori aman. Indikator visual berupa LED berfungsi dengan baik sebagai penanda kondisi sistem secara lokal.

Sebagai kontribusi utama, penelitian ini menghasilkan sistem monitoring kondisi mesin yang mudah diimplementasikan, dengan tingkat ketersediaan sistem (*availability*) mencapai 100% selama pengujian, sistem ini terbukti andal dan siap diimplementasikan pada lingkungan industri nyata sebagai solusi monitoring kondisi mesin berbasis IoT.

Kata kunci: Monitoring Getaran, *Internet of Things (IoT)*, Akuisisi Data.

ABSTRACT

This research is motivated by the high potential for mechanical failures in industrial machines, which are often not detected early, leading to machine failures and consequently halting production. Conventional time-based maintenance methods are considered ineffective because they do not represent the actual condition of the machine in real time.

This research aims to design and implement an Internet of Things (IoT)-based industrial machine vibration and temperature monitoring system using an ESP32 microcontroller for early detection of mechanical failures and support the implementation of condition-based maintenance. The novelty of this research lies in the integration of a multi-sensor monitoring system that directly refers to the ISO 10816-3 industry standard, with vibration parameter processing based on Root Mean Square (RMS) and Fast Fourier Transform (FFT) values, without the use of complex predictive algorithms or machine learning.

The research method involves designing and implementing a monitoring system using two ADXL345 vibration sensors and two MAX6675 temperature sensors integrated into a single ESP32 node. Vibration data was processed in RMS and FFT formats to identify the dominant frequency characteristics of the machine, then transmitted in real time to the ThingsBoard IoT platform via the Message Queuing Telemetry Transport (MQTT) protocol.

Test results demonstrated that the system was capable of stable data acquisition, processing, and transmission. The RMS vibration value was in the range of 2.15–2.17 mm/s with a variation of approximately 19–25%, while the machine's operating temperature was recorded at approximately 67°C with a variation of approximately 3.3% during the test period. FFT analysis indicated the presence of a dominant frequency consistent with the machine's operating characteristics. Based on the ISO 10816-3 classification, the machine was considered safe. Visual indicators, such as LEDs, functioned effectively to indicate the system's local condition.

As a key contribution, this research resulted in a machine condition monitoring system that is easy to implement, with a system availability rate reaching 100% during testing. This system has proven reliable and ready for implementation in real industrial environments as an IoT-based machine condition monitoring solution.

Keywords: Vibration Monitoring, Internet of Things (IoT), Data Acquisition.