

ABSTRAK

IMPLEMENTASI METODE ISOLATION FOREST UNTUK MENDETEKSI PENYIMPANGAN SUHU DAN KELEMBAPAN PADA SISTEM MONITORING INKUBATOR TELUR BEBASIS INTERNET OF THINGS (2026:XII + 91 halaman + 26 gambar + 9 tabel + lampiran)

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Keberhasilan proses penetasan telur dipengaruhi oleh kestabilan suhu dan kelembapan di dalam inkubator. Penyimpangan pada kedua parameter tersebut dapat mengganggu perkembangan embrio dan menurunkan tingkat keberhasilan penetasan. Meskipun sistem monitoring berbasis Internet of Things (IoT) telah banyak dikembangkan, sebagian besar penelitian masih berfokus pada pemantauan kondisi lingkungan secara real-time tanpa memanfaatkan data historis untuk mendeteksi penyimpangan secara otomatis. Penelitian ini bertujuan merancang dan mengimplementasikan sistem monitoring suhu dan kelembapan inkubator telur berbasis IoT yang terintegrasi dengan metode Isolation Forest untuk mendeteksi anomali pada data sensor. Sistem dikembangkan menggunakan mikrokontroler ESP32 dan sensor DHT22 sebagai perangkat akuisisi data, kemudian data dikirim ke platform ThingSpeak melalui jaringan Wi-Fi untuk penyimpanan dan pemantauan secara real-time. Selanjutnya, data divisualisasikan melalui dashboard berbasis Streamlit dan dianalisis menggunakan metode Isolation Forest untuk mengidentifikasi kondisi normal maupun anomali. Model dibangun menggunakan algoritma unsupervised machine learning dengan nilai contamination sebesar 5%. Hasil penelitian menunjukkan bahwa sistem mampu melakukan monitoring suhu dan kelembapan secara real-time, menampilkan data pada dashboard, serta mendeteksi anomali secara otomatis berdasarkan pola data historis. Dari sebanyak 905 data pengamatan, model berhasil mengidentifikasi 860 data normal (95,03%) dan 45 data anomali (4,97%). Hasil tersebut menunjukkan bahwa metode Isolation Forest mampu mendukung proses analisis data sensor secara otomatis sehingga dapat membantu pengguna mengidentifikasi penyimpangan kondisi inkubator lebih dini dibandingkan sistem monitoring konvensional yang hanya menampilkan data pengukuran. Penelitian ini diharapkan dapat menjadi referensi dalam pengembangan sistem monitoring berbasis IoT yang dilengkapi kemampuan deteksi anomali pada berbagai aplikasi pemantauan lingkungan.

Kata Kunci: Internet of Things, Inkubator Telur, Isolation Forest, Deteksi Anomali, ESP32, DHT22, Streamlit.

ABSTRACT
**IMPLEMENTATION OF THE ISOLATION FOREST METHOD FOR
DETECTING TEMPERATURE AND HUMIDITY ANOMALIES IN AN IOT-
BASED EGG INCUBATOR MONITORING SYSTEM**
(2026:XII + 91 pages + 26 pictures + 9 tables + appendices)

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The success of the egg incubation process is highly dependent on maintaining stable temperature and humidity conditions inside the incubator. Deviations in these environmental parameters may interfere with embryo development and reduce hatchability. Although Internet of Things (IoT)-based monitoring systems have been widely developed, most existing studies primarily focus on real-time environmental monitoring without utilizing historical sensor data for automatic anomaly detection. This study aims to design and implement an IoT-based egg incubator monitoring system integrated with the Isolation Forest algorithm to detect anomalies in temperature and humidity data. The proposed system employs an ESP32 microcontroller and a DHT22 sensor for data acquisition. The collected data are transmitted via Wi-Fi to the ThingSpeak cloud platform for real-time storage and monitoring. Furthermore, the data are visualized through a Streamlit-based dashboard and analyzed using the Isolation Forest algorithm to distinguish between normal and anomalous conditions. The model was developed using an unsupervised machine learning approach with a contamination value of 5%. Experimental results demonstrate that the proposed system successfully performs real-time monitoring, presents environmental data through an interactive dashboard, and automatically detects anomalous conditions based on historical sensor patterns. From a total of 905 observations, the model identified 860 normal instances (95.03%) and 45 anomalous instances (4.97%). These findings indicate that the Isolation Forest algorithm effectively enhances sensor data analysis by automatically identifying abnormal environmental conditions, providing earlier detection than conventional monitoring systems that only display measurement values. Therefore, the proposed system can serve as a reference for the development of IoT-based environmental monitoring systems equipped with intelligent anomaly detection capabilities.

Keywords: Internet of Things, Egg Incubator, Isolation Forest, Anomaly Detection, ESP32, DHT22, Streamlit.