

DETEKSI DINI ANOMALI DATA SENSOR UAV MENGGUNAKAN ISOLATION FOREST

Dustin Rozan Muhammadiy

21/477884/TK/52644

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INTISARI

Pembangunan industri berkelanjutan sesuai SDG 9 memerlukan sistem monitoring yang andal, termasuk pada Unmanned Aerial Vehicle (UAV). Saat ini, deteksi anomali data UAV di PT. Dirgantara Indonesia masih mengandalkan metode *supervised learning* yang membutuhkan pelabelan manual.

Penelitian ini bertujuan mengevaluasi kinerja algoritma *unsupervised learning* Isolation Forest dalam mendeteksi anomali pada data telemetri satu sekuen UAV MALE tanpa proses pelabelan. Evaluasi dilakukan secara numerik menggunakan metrik AUPRC dan *F1-Score* untuk memastikan ketahanan terhadap ketidakseimbangan data serta menghindari *accuracy paradox*.

Penelitian ini mengembangkan sistem deteksi anomali berbasis *Isolation Forest* untuk data telemetri UAV tak berlabel dengan pendekatan univariat. Berbasis metode evaluasi data *auxiliary*, hasil eksperimen pada data uji menunjukkan performa kuat dengan akurasi > 90%, AUPRC rata-rata 90%, serta presisi, recall, dan *F1-Score* yang seimbang di atas 75%. Implementasi pada data telemetri nyata berhasil memvalidasi model ini sebagai solusi efektif untuk pemantauan operasional UAV secara real-time tanpa kebutuhan pelabelan manual.

Kata kunci: Deteksi Anomali, UAV, *Unsupervised Learning*, *Isolation Forest*, Univariat

Pembimbing Utama : Prof. Ir. Nazrul Effendy, S.T, M.T., Ph.D., IPM.,
ASEAN Eng.

Pembimbing Pendamping : Ir. Jarot Sugiharto, M.T.





EARLY ANOMALY DETECTION UAV SENSOR DATA USING ISOLATION FOREST

Dustin Rozan Muhammadiy

21/477884/TK/52644

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ABSTRACT

Sustainable industrial development in line with SDG 9 requires reliable monitoring systems, including those for Unmanned Aerial Vehicles (UAVs). At present, anomaly detection in UAV data at PT. Dirgantara Indonesia still relies on supervised learning methods that require manual labeling.

This study aims to evaluate the performance of the unsupervised learning algorithm Isolation Forest in detecting anomalies within single-sequence telemetry data of MALE UAVs without labeling. The evaluation was carried out numerically using AUPRC and F1-Score metrics to ensure robustness against data imbalance and to avoid the accuracy paradox.

The research develops an anomaly detection system based on Isolation Forest for unlabeled UAV telemetry data using a univariate approach. Based on auxiliary data evaluation methods, the experimental results indicate strong performance with accuracy above 90%, an average AUPRC of 90%, and balanced precision, recall, and F1-Score exceeding 75%. Implementation on real telemetry data further validates this model as an effective solution for real-time UAV operational monitoring without the need for manual labeling.

Keywords: Anomaly Detection, UAV, Unsupervised Learning, Isolation Forest, Univariate

Supervisor : Prof. Ir. Nazrul Effendy, S.T., M.T., Ph.D., IPM., ASEAN Eng.

Co-supervisor : Ir. Jarot Sugiharto, M.T.

