Project Title:

PrognosAI – AI-Driven Predictive Maintenance System Using Time-Series Sensor Data

Submitted By:
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Dataset Source: NASA Turbofan CMAPSS – Time-Series Engine Sensor Data

Abstract

PrognosAI is an intelligent predictive maintenance solution that estimates the health lifespan of turbofan engines using deep learning on multi-sensor time-series data. The system leverages sequence modeling neural networks, alerts, and analytical dashboards to support maintenance teams in making data-driven and cost-effective decisions.

1. Introduction & Purpose

Maintenance management is a critical aspect of aviation engine reliability. Predictive maintenance, powered by artificial intelligence, helps anticipate component degradation before failures occur. PrognosAI integrates deep learning-based Remaining Useful Life (RUL) estimation using historical CMAPSS engine data for real-time maintenance decision support.

Core Goals:

- Build a neural-based RUL prediction model.
- Provide intelligent alert notifications and health scoring.
- Enable visual monitoring via a dashboard.

2. Dataset Summary

• Dataset Provider: NASA — CMAPSS simulation environment

• Features: 21 sensor outputs + 3 operational settings

• Units: Multiple turbofan engines (FD001 – FD004)

• Target Attribute: Remaining Useful Life (RUL) for each engine cycle

3. System Workflow

The solution follows a multi-stage life-cycle from data ingestion to model inference:

Step 1: Importing raw sensor logs from CMAPSS
Step 2: Cleaning, sequencing, normalization
Step 3: LSTM-based model training and tuning
Step 4: Predicting RUL + evaluating performance
Step 5: Dashboard visualization + alert logic

4. Milestone 1 – Data Engineering

Tasks Completed:

• Loaded raw CMAPSS dataset files
• Computed RUL for every operational cycle
• Applied Min-Max feature scaling
• Generated fixed-length sliding windows
Tools Used:

• pandas – dataframe handling

• numpy – numerical & sequential reshaping

• sklearn.preprocessing – MinMaxScaler

5. Milestone 2 – Model Construction

• Implemented stacked LSTM neural architecture

• Loss Function: MSE | Optimizer: Adam

• Integrated dropout to reduce overfitting

• Used cross-validation for stable learning

6. Milestone 3 – Performance & Alert Logic

Performance Outcomes:

• High accuracy with low RMSE and MAE
• Consistent prediction stability across validation folds
Alert Condition Rules:

• Critical: RUL ≤ 20%
• Moderate: 21–50%
• Healthy: > 50%

7. Milestone 4 – UI Dashboard & Deployment

• Built an interactive dashboard using Streamlit

• Supports input upload + instant inference

• Shows per-unit RUL values with alert color coding

• Allows downloading predicted results table

8. Results Summary

Key Metrics:

• R^2 Score: Above 0.95
• RMSE: Very Low
• MAE: Very Low
Strengths:

• High reliability in degradation pattern learning
• Supports proactive maintenance decision-making

9. Conclusion & Improvements

PrognosAI demonstrates reliable predictive capacity over engine lifespan monitoring, serving as a strong base model for real-time aviation maintenance intelligence.

Future Enhancements:

- IoT-stream based real-time inference
- Hybrid ensemble deep models
- Web-API + cloud deployment

10. Technologies & Tools

- Programming: Python 3.x
- AI Frameworks: TensorFlow, Keras
- Data: pandas, numpy, sklearn
- Visualization: plotly, matplotlib
- App Layer: Streamlit
- Model Handling: joblib