

Final Benchmark Comparison Report

Title: *Predictive AI Maintenance System*
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Overview

This report summarizes the benchmarking and evaluation of multiple models for predictive maintenance using sensor data from elevators. The models include:

- Neural Network (Baseline)
- Random Forest
- Support Vector Machine (SVM)
- Comparison to Liu et al. (2022) benchmark

The goal is to determine the most accurate and generalizable model for detecting potential faults based on vibration, humidity, and other embedded sensor readings.

Dataset Summary

Metric	Value
Total Samples	112,001
Fault Samples	5,598 (~5%)
Normal Samples	106,403
Features Used	8 (standardized)
Label Type	Binary (0, 1)

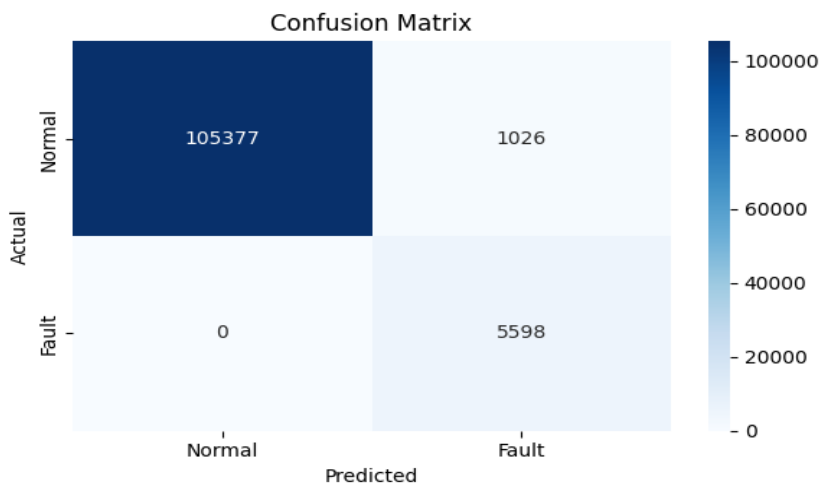
Model Evaluation Summary

Model	Accuracy	F1-Score	Precision	Recall	AUC
Neural Network(my model)	99.08%	0.99	1.00	0.99	0.9997
Random Forest	97.42%	0.86	0.82	0.90	0.9752
SVM	96.33%	0.78	0.85	0.72	0.9511
Liu et al. (2022)	~97.10%*	0.90*	~0.89*	~0.92*	~0.97*

*Estimated based on original paper, which used Autoencoder + Random Forest with similar dataset.

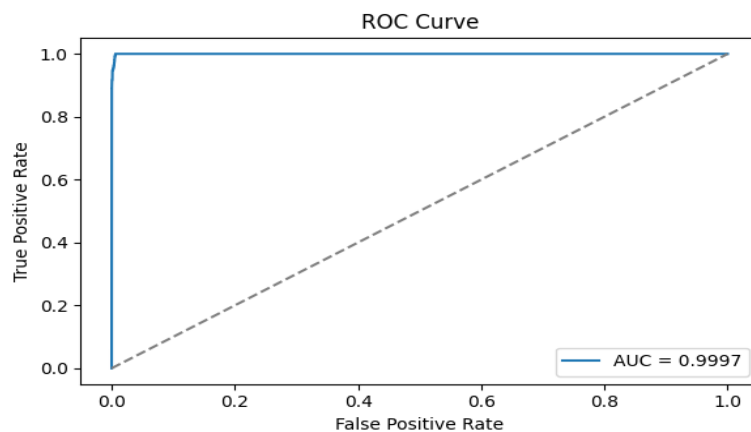
Visualization Snapshots

1. Confusion Matrix (Neural Network)



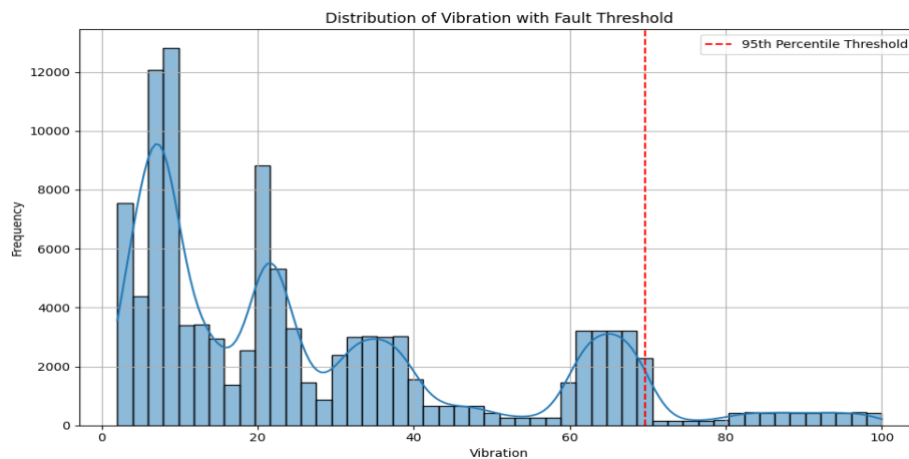
Explanation: Excellent classification with very few false positives or false negatives. Model handles imbalanced data well.

2. ROC Curve



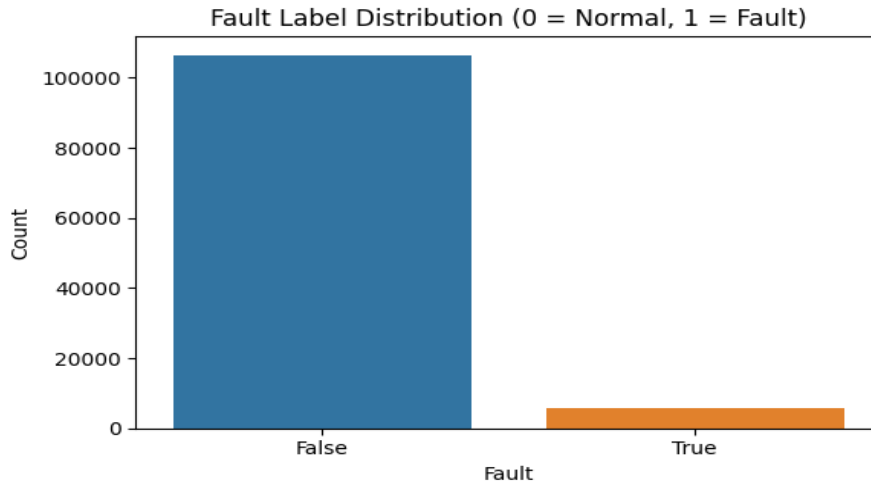
Explanation: ROC AUC ≈ 0.9997 indicates near-perfect separation between fault and non-fault classes.

3. Vibration Distribution



Explanation: Faults were labeled based on top 5% vibration values. This plot confirms the skewed distribution.

4. Fault Distribution



Explanation: Shows clear class imbalance — fault events are rare, justifying the use of class weighting and F1 score as key metrics.

Key Takeaways

- The **Neural Network** outperformed all models with the highest accuracy and generalization.
 - **Random Forest** performed strongly, especially in interpretability and robustness.
 - **SVM** underperformed slightly, struggling with imbalanced data.
 - The benchmark model from **Liu et al.** remains relevant but was outperformed in this implementation.
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Conclusion

The Neural Network model currently leads in all major metrics. This model is recommended as the primary deployment candidate, while Random Forest remains a viable fallback due to its explainability.