Milestone 5 Report

1. Introduction

Milestone 5 represents the final phase of the project, focusing on system validation, end-user testing, performance benchmarking, quality assurance, and preparation of final deliverables. This milestone ensures that the predictive maintenance application is stable, reliable, and ready for deployment, demonstration, or submission. It also includes packaging the final project, refining documentation, and validating the overall workflow.

---

2. Work Completed in Milestone 5

2.1 End-to-End System Validation

The complete workflow—data upload, preprocessing, sequence generation, model inference, visualization, and report generation—was tested extensively.

Validation covered:

- Multiple uploads from FD001–FD004

- Large and small engine sequences

- Correct handling of missing/extra columns

- Scaler and fallback pipeline consistency

- RUL accuracy across datasets

- Dashboard component responsiveness

These tests confirmed the robustness and reliability of the final system.

2.2 User Acceptance Testing (UAT)

The system was tested from the perspective of real end-users such as:

- Engineers

- Operators

- Reviewers or evaluators

- Non-technical stakeholders

Feedback was collected and applied to refine:

- Layout spacing

- Label readability

- Plot line thickness and colors

- Error messages

- PDF report structure

This ensured the dashboard is intuitive, clear, and accessible to all types of users.

2.3 Performance Benchmarking

Various experiments were conducted to measure system performance:

Metrics evaluated:

- Prediction speed

- Plot rendering time

- Memory usage

- Scaling behavior for different engine lengths

- Accuracy consistency across FD001–FD004

The results showed:

- Low latency inference

- Stable performance for large uploads

- No memory leaks or server-side errors

- Strong RUL prediction stability across datasets

2.4 Code Optimization and Cleanup

The entire codebase was cleaned, refactored, and optimized to ensure future maintainability.

Improvements include:

- Removal of redundant functions

- Better modularization of preprocessing and inference

- Improved JSON handling

- More reliable cycle extraction

- Better error handling on the Flask backend

This makes the system production-ready and easier to extend.

2.5 Final Documentation Preparation

Complete documentation required for project submission was finalized.

Items prepared:

- Final technical report

- Milestones 1–5 summaries

- Full model architecture explanation

- Dataset description

- Usage instructions

- API flow diagrams

- User manual for the dashboard

- Limitations and future work section

- Testing logs and evaluation results

This provides a comprehensive overview of the entire project lifecycle.

2.6 Final PPT and Presentation Script

A complete presentation deck was prepared covering:

- Problem statement

- Dataset

- Model design

- Deployment workflow

- Dashboard demonstration

- Visual insights

- Results and conclusions

Additionally, a presenter script was included to support seamless, clear communication during evaluation or demonstration.

2.7 Project Packaging and Submission Files

All necessary project artifacts were organized into final submission folders.

These include:

- Codebase

- Trained model

- Scalers

- CSV samples

- PDF report generator

- Dashboard templates

- Requirements file

- Deployment instructions

- Final PPT

This ensures evaluators can easily run, test, and understand the project.

---

3. Summary of Milestone 5 Outcomes

Milestone 5 successfully completed the final refinement and validation stage of the project. The major outcomes include:

- Fully validated predictive maintenance system

- User-tested dashboard with stable visualizations

- Optimized codebase

- Accurate, consistent RUL predictions

- Completed documentation and presentation materials

- Packaged deliverables ready for submission or deployment

The system is now polished, reliable, and ready for real-world demonstration or academic evaluation.

---

4. Future Work and Long-Term Opportunities

While the project is complete for the current scope, the following areas present opportunities for future enhancement:

4.1 Cloud Deployment

Hosting the system on AWS/Azure/GCP with real-time ingestion capabilities.

4.2 Integration with Live IoT Telemetry

Allowing continuous engine health monitoring instead of static file uploads.

4.3 Advanced Explainability (SHAP)

Deeper analysis of sensor importance and failure modes.

4.4 Transformer-Based RUL Models

Replacing BiLSTMs with attention-based architectures for improved performance.

4.5 Cross-Dataset Generalization

Training models using all NASA CMAPSS variants (including FD005–FD008).

---

5. Conclusion

Milestone 5 represents the final consolidation of all previous milestones. The predictive maintenance system now delivers a complete solution—from model training to deployment, visualization, explainability, and reporting. This milestone ensures readiness for evaluation, presentation, and real-world demonstration, concluding the project with a fully functional and user-friendly RUL prediction platform.