DIGITAL TWIN OF A ROTATING SHAFT FOR PREDICTIVE MAINTENANCE

Using MATLAB Simulink & Simscape

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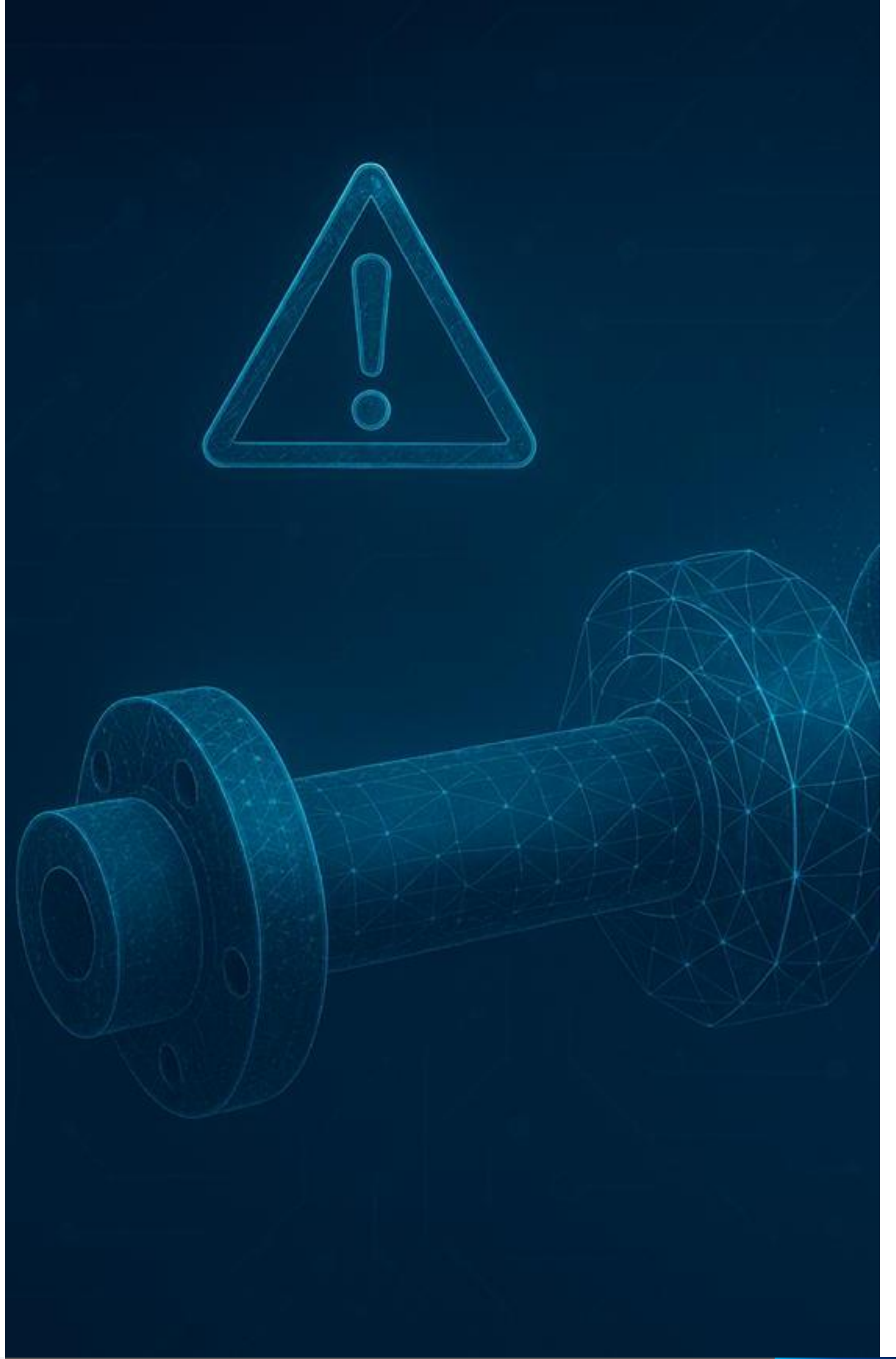
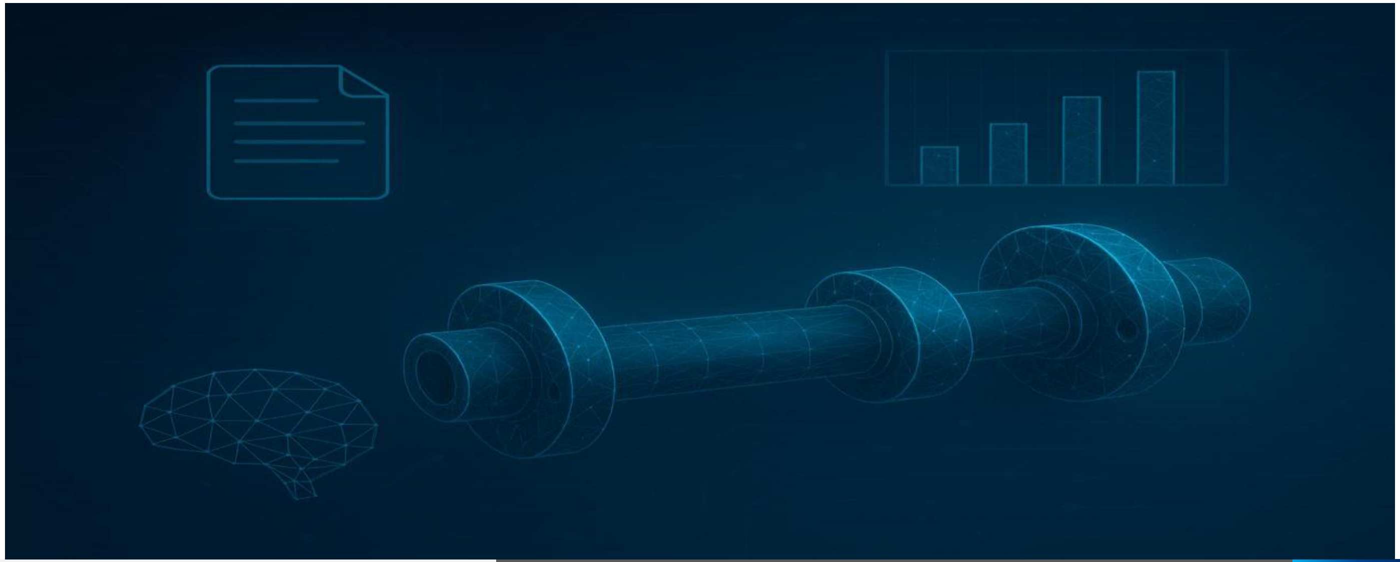
Project Motivation

- Rotating shafts are critical components in industrial machinery.
- Failures due to imbalance or misalignment cause downtime and cost.
- Predictive maintenance using digital twins helps prevent failures.
- MATLAB Simulink enables accurate physics-based modelling and testing.



Objectives

- Build a MATLAB-based Digital Twin of a rotating shaft system.
- Simulate real-world behavior under normal and faulty conditions.
- Collect and analyze vibration data for fault prediction.
- Deliver an MVP showcasing initial simulation and analytics.



Technology Stack

- MATLAB Simulink – Dynamic modelling and simulation
- Simscape Multibody – Mechanical system representation
- Signal Processing Toolbox – Vibration and frequency analysis
- Machine Learning Toolbox – Predictive fault detection
- MATLAB App Designer – Visualization dashboard
- GitHub – Version control and documentation

MVP (Minimum Viable Product)

- Simplified rotating shaft simulation using Simulink.
- Includes sensors for vibration and torque.
- Demonstrates healthy vs faulty operation (imbalance).
- FFT or RMS analysis for fault detection.
- Visual results showing differences in behaviour.

System Architecture

- Physical Model – Shaft and motor using Simulink + Simscape
- Data Layer – Signal acquisition from virtual sensors.
- Analytics Layer – Fault detection and condition monitoring.
- Visualization Layer – Dashboard for monitoring results

Methodology

- Literature review and requirement specification.
- Build base shaft model in MATLAB Simulink.
- Introduce imbalance/fault simulation.
- Perform FFT and signal-based analysis.
- build visualization dashboard.
- Validate and test predictive results.

Timeline & Milestones

- October 16 – Proposal + Tech Stack + MVP
- November 6 – Core Code + Baseline Simulation + Test Plan
- November 27 – Feature Progress + Unit/CI Status + Issues Board
- December 18 – Demo Video + Run Instructions + Packaging Status
- January 15 – Final Presentation + Report

Expected Outcomes

- A functional digital twin model in MATLAB.
- Simulation results for fault detection and prediction.
- Dashboard visualization for predictive maintenance.
- Scalable framework for future machinery applications.

Next Steps

Implement MVP in MATLAB Simulink.

Collect test data and refine predictive analytics.

Prepare November progress report with core code results.

Thank you

references

•Grieves, M. (2014). *Digital Twin: Manufacturing Excellence through Virtual Factory Replication.*
• White Paper, Florida Institute of Technology.

•Tao, F., Zhang, H., Liu, A., & Nee, A. Y. C. (2018). *Digital Twin in Industry: State-of-the-Art.*
•*IEEE Transactions on Industrial Informatics*, 15(4), 2405–2415.
•Kritzinger, W., Karner, M., Traar, G., Henjes, J., & Sihn, W. (2018).
•*Digital Twin in Manufacturing: A Categorization and Literature Review. Procedia CIRP*, 57, 34–39.

- https://www.mathworks.com/discovery/digital-twin.html
- https://www.mathworks.com/campaigns/offers/digital-twins-for-predictive-maintenance.html
- https://www.mathworks.com/company/technical-articles/predictive-maintenance-using-a-digital-twin.html
- https://github.com/mathworks/MATLAB-Simulink-Challenge-Project-Hub/discussions/46