DIGITAL TWIN OF A ROTATING SHAFT FOR PREDICTIVE MAINTENANCE

Using MATLAB Simulink & Simscape

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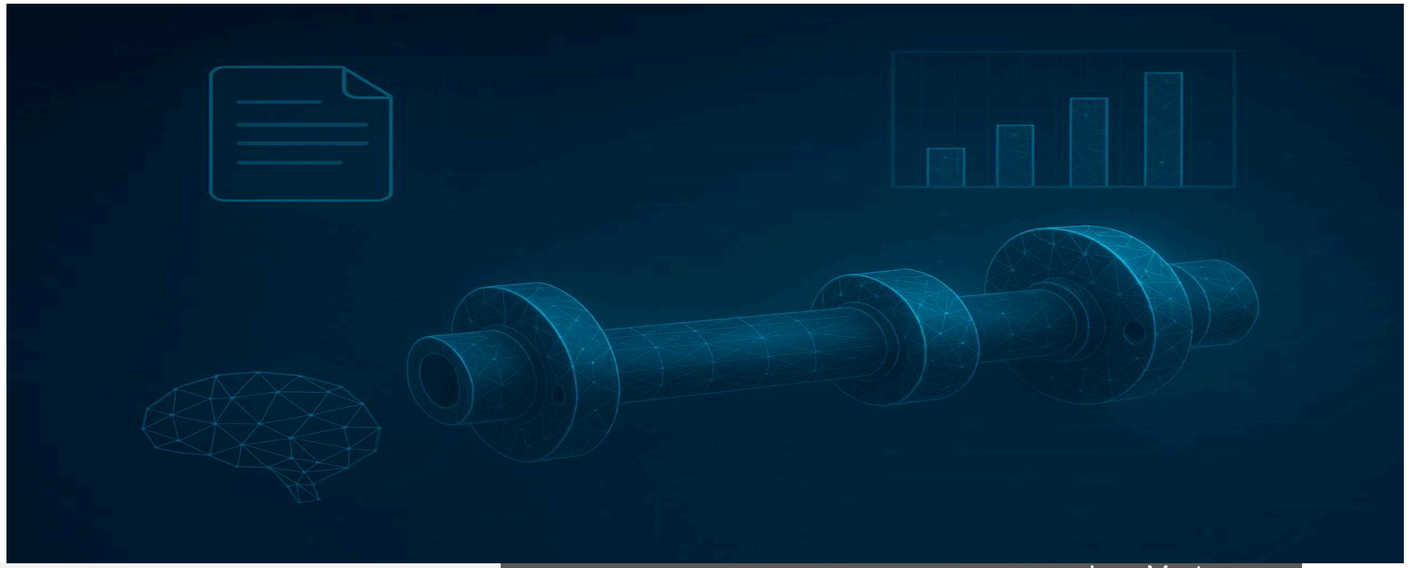
Project Motivation

- 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.

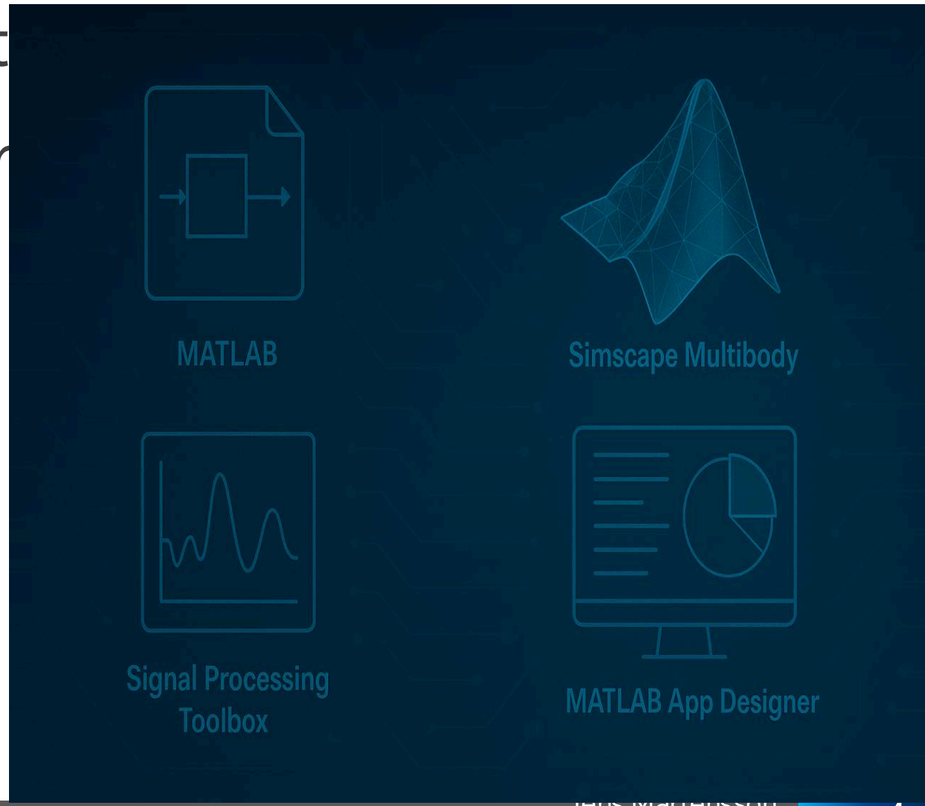
Objectives

- 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 det
- MATLAB App Designer – Visualization dashboar
- 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.

references

•*Raja Singh, R.et al., "Building a Digital Twin Powered Intelligent Predictive Maintenance System for Industrial AC Machines," Machines, 2023 (MDPI).*
•*-Han, T. et al., "Overview of Predictive Maintenance Based on Digital Twin Technology," Mechanical Systems and Signal Processing, 2022.*

•*These studies highlight digital twin applications in rotating machinery but lack simulation-focused approaches for shaft namics using MATLAB/Simulink, which this oroject aims to address*

Thank you