ICRTME – 2025

INTERNATIONAL CONFERENCE OF RECENT TRENDS IN MECHANICAL ENGINEERING

ICRTME25-201

Statistical Performance Validation of an Embedded PSoC-Based Ball Bearing Fault Detection System

Rajesh R[1], Pugazhenthi R[2], Durgalakshmi S[3]

[1]*Research Scholar, Department of Mechanical Engineering, VISTAS, Chennai*

[2]*Professor, Department of Mechanical Engineering, VISTAS, Chennai*

[3] *Associate Professor, Department of Civil Engineering, VISTAS, Chennai*

Corresponding author E-mail: rajeshr.kmct@gmail.com[1], pugal4@gmail.com[2*], dlakshmi.se@vistas.ac.in[3]

ABSTRACT

Bearings are critical components in rotating machinery, and their failure can lead to catastrophic system breakdowns and costly downtime. Early detection of localized defects such as those in the inner race, outer race, and rolling elements are therefore indispensable for predictive maintenance. This paper presents the design and statistical validation of a novel, embedded workbench for ball bearing fault diagnosis. The system employs an impulse excitation technique, where a solenoid induces a controlled vibrational trigger, and an accelerometer captures the response. The core implementation leverages a Programmable System on Chip (PSoC) for embedded data acquisition and a LabVIEW-based Virtual Instrumentation workbench for signal processing and analysis. The fault diagnosis is performed by examining the computed power spectrum of the vibration signals. Distinct fault signatures are identified: new bearings exhibit sharp amplitude peaks, outer race defects show a distinct peak rise, inner race defects generate sideband peaks, and ball defects result in a fully distorted spectrum. To rigorously validate the reliability of this approach, a statistical analysis was conducted on four new bearing models (6203-N, 6201-N, 6300-N, 6000-N). The results demonstrate with 95% confidence that the developed smart workbench produces consistent and statistically significant outcomes. The system's performance confirms its accuracy and repeatability, establishing it as a promising and validated tool for the static testing and fault diagnosis of rolling element bearings.

Key word: PSoC, LabVIEW, Ball bearing, Statistical analysis, Fault deduction

978-81-992034-1-9

DEPARTMENT OF MECHANICAL ENGINEERING
VISTAS, CHENNAI, INDIA