ABSTRACT

The modern day concept in Machinery Maintenance Management is Condition-based and predictive in nature, to avoid accidental and unscheduled downtime of machinery. Periodic data collection and its processing is therefore mandatory to diagnose incipient defects and assess health of the machinery. Early detection of defects not only helps in planning the maintenance strategy but also prevents machinery from detrimental failures.

This research has evolved a robust signal processing technique that can efficiently handle the predominantly non-linear and non-stationary signals from running machinery for detection of developing faults. The focus areas have been bearings and gearboxes that are present in almost all machines as the load bearing and transmitting members and their vibration signatures can divulge vital information about health of the machine.

Fourier Transform (FT) till date has been considered to be the most suited application for handling vibration signals. However, it is inefficient for non-stationary and nonlinear signals. An algorithm has been proposed to convert the vibration signal into nearly mono-component Intrinsic Mode Functions (IMFs), which are basic form of the signal with single frequency. IMFs are generated using a unique signal filtration method called modified Empirical Mode Decomposition. Use of Hilbert Transform with such IMFs gives the analytic signal from where the instantaneous frequency and phase can be calculated. A novel use of this technique, implemented on motor current signatures from an automotive gearbox, has successfully detected Gear-Mesh Frequencies where FT based Motor Current Signature Analysis has not been much accurate. Implementation of the proposed technique on vibration signatures from rolling element bearings too has yielded results with great accuracy. The robustness and efficacy of the technique has further been demonstrated for detection of crack in rotors and characteristic frequencies in Marine Gas Turbine Engines. In an unconventional usage, acoustic data from submarine-based SONAR has been analysed for target identification successfully. The proposed methodology can thus be efficiently extended to a variety of applications involving non-stationary and nonlinear signals.