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Due to the significance of rolling element bearings as one of the most largely used industrial machinery component, development of fault-diagnosis scheme to prevent its failure during the industrial operation is necessary. One of the significant modes of failure of rolling bearing is contact fatigue, which initiates subsurface and surface fatigue spalling, and thus reduces the remaining useful life of the rolling bearing. Such type of spalling is mainly known as localized faults. One of the conventional methods of monitoring the localized faults is the vibration analysis. But some drawbacks are always pertaining to the vibration analysis in terms of inaccuracy of results. In recent years, major research being found in developing automated fault diagnosis systems for performing condition monitoring. Mathematical modelling of bearing for fault diagnosis proved to be efficient tool in understanding dynamics of faulty bearing upon rotor-bearing systems. Application of machine learning techniques such as Artificial neural network (ANN), Support vector machine (SVM) in conjunction with advanced signal processing techniques like wavelet transform (WT), enabled expert diagnosis of rolling bearing. This technique provided the basis for prognosis of rolling bearing.

Apart from diagnosis the bearing with one sensor, which may be redundant in diagnosing all possible faults, techniques like sensor-fusion helped in classifying all the available faults of bearing.

In this thesis, a systematic approach is followed with an objective of developing a reliable fault diagnosis scheme of rolling element bearing with multiple localized defects in it. The scheme is developed with the help of work present in various chapters of thesis. These chapters include a general introduction about the rolling element bearing defects and its condition monitoring. Then a detailed literature review about various techniques of fault diagnosis of rolling element bearings and literature gap for pursuing the research in this area was carried out. Then mathematical modelling of rolling element bearing for fault severity analysis was developed along with incorporation of advanced signal processing techniques in the form of fault signal analysis.

Then statistical approach being performed for establishing the relation between fault severity with rotor speed. Response surface Methodology (RSM) technique is presented to discuss the relation between fault severity and rotor speed.

After successful development of statistical approach fault diagnosis was carried out using artificial neural network. It mainly focuses upon automated system of fault diagnosis.

Then sensor fusion of two different monitoring techniques (Vibro-Acoustic) was carried out. It gives the detail insights about fault predicting capability of each technique in terms of fault classification.

After developing various techniques of fault diagnosis of rolling element bearing pertaining to objectives of thesis, work was concluded in the form of proposed fault diagnosis scheme and future scope of research work is defined in this area.

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$\psi_{\tilde{n}}$: - Dual Functions.

$a_n$: - Expansion Co-efficient.

$C_d$: - Depth of local fault on surface of inner and outer races.

$C_{di}$: - Maximum depth the inner race will reach.

$C_{do}$: - Maximum depth outer race will reach.

$C_{dr}$: - Slot upon rolling element-moving upwards.

$C_r$: - Internal radial clearance.

$D_b$: - Rolling element diameter.

$D_p$: - Bearing Pitch diameter.

$c_i$, $c_o$ ,$c_r$:- Damping of inner raceway, outer raceway and unit resonator.

$f_{bpfi}$: - Ball pass frequency inner raceway.

$f_{bpfo}$: - Ball pass frequency outer raceway.

$f_{bsf}$: - Ball spin frequency.

$f_m$: - Modulation frequency (Hz).

$f_s$: - Shaft rotating frequency.

$k_i$, $k_o$ , $k_r$:- Stiffness of inner raceway, outer raceway and unit resonator.

$m_i$: - Mass of Inner raceway and Shaft.

$m_o$: - Mass of the Outer raceway and bearing support structure.

$m_{r1}$, $m_{r2}$:- Mass of the unit resonator.

$n_b$: - Number of balls.

$r_i$: - Inner race radius.

$x_i$ , $y_i$:- Inner raceway Displacement.

$x_o$ , $y_o$:- Outer raceway Displacement.

$x_r$ , $y_r$:- Measured Vibration response.

$\beta_j$: - Fault switch function.

$\delta_j$: - Contact deformation.

$\varphi_n$: - Synthesis Function.

$\tilde{\varphi_n}$: - Analytic Function.

$\omega_c$: - Nominal cage speed.

$\omega_s$: - Rotating angular speed.

$\omega_{spin}$: - Ball spin frequency.

$\phi_d$: - Defined angular position.

$\phi_{d0}$: - Initial starting location of spall.

$\phi_j$: - Angular position of jth rolling element.

$\phi_{slip}$: - Maximum Phase deviation (rad).

$\Delta\phi_d$: - Angular Distance.

$\Delta f$: - Maximum frequency deviation (Hz).

BDIR: - Ball defect and inner race defect.

BDOR: - Ball defect and outer race defect.

CD: - Combined defect.

CWT: - Continuous wavelet transform.

$f_x$., $f_y$ :- Non-linear contact force.

IR: - Inner race

OR: - Outer race.

$s$: - Continuous variable.

WT: - Wavelet transform.

$\Delta\phi di$: - Angular width of the fault sensed by inner race.

$\Delta\phi do$: - Angular width of the fault sensed by outer race.

$Ft$: - Applied radial load.

$K$: - Time-Varying non-linear contact stiffness.

$a$ : - Scale parameter.

$b$ : - Position parameter.

$n$: - Load deflection parameter.

$r$: - radius of curvature of raceways.

$x$: - Half the spall width.

$\alpha$: - Contact angle.

$\rho$: - Curvature.

$\psi$: - Mother wavelet.

$\psi$: - Space function.