MONITORING AND DIAGNOSIS OF SYSTEMS AND EQUIPMENT OF NUCLEAR AND INDUSTRIAL PLANTS I

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Methodology for remote monitoring of leaks in tubes using piezoelectric sensors array and higher order spectral analysis - This work is focused in the remote on-line detection and localization of leaks in tubes. Leakages in pressurized tubes generate stress waves that propagate along the walls of these tubes. These waves can be detected by accelerometers or by acoustic emission sensors. In order to determine the localization of the leakage one must measure the arrival time interval in the case of transient signals or the phase shift between two stress waves? signals when they are stationary as well as their correspondent velocities. For this, we intend to develop a methodology for the detection and localization of these leaks in pressurized tubes using computational tools for the acquisition and processing of signals coming from the propagation of vibratory waves generated by leaks in these tubes. The mathematical methods to be used are a combination of Higher-Order Spectral Analysis (HOSA) with Beam-forming techniques. Among many HOSA derived methods we plan to apply, particularly the Direction of Arrival Estimation (DOA) and Time-Delay Estimation (TDE). Until the moment we have as result, the mathematical model of the tube, which we are confronting with the real values measured through the mapping of this tube by a group of sensor of the accelerometer type. As well as the characterization of the speeds of the waves propagating on the surface of the tube.

Monitoring and automated diagnosis of defective bearings using advanced signal processing - Faults detection and classification of defective bearings have been a constant concern in the rotating machinery industry, mostly in those which execute safety functions. This research project deals with the development of an automated bearings monitoring and the diagnosis system using wavelet zero crossings and paraconsistent fuzzy logic for the detection and classification of defects using vibration analysis techniques for using in a nuclear power plant and other industrial applications. A vibration laboratory with two rotating machine defects simulator and a modern data acquisition system is in operational condition for the generation and analysis of data banks. A software was develop in Matlab programming language for analysis of the data banks. The next step is the analysis of this data bank and the adjustment of the inference functions for the paraconsistent fuzzy logic diagnosis engine.

Plant condition monitoring and fault detection - This approach is based on the concept of analytical redundancy as opposed to physical redundancy (hardware or parallel), that uses measurements from redundant sensors for fault diagnostics purposes. Analytical redundancy makes use of the prediction of signals generated by the mathematical model of the system being considered. These predictions are compared with the actual measurements from system sensors using data driven modeling. The methodologies used to obtain analytical redundancy are GMDH (Group Method of Data Handling) and Neural Network. A heat exchanger model was developed in the Matlab platform. The GMDH methodology implemented is working properly since the magnitude of the regularity criterion is controlled by the magnitude of the machine rounding error, indicating that the method is not introducing additional errors and, most of all, the error propagation is stable. The main results are: data normalization is fundamental to obtain better precision, the larger the number of data points, the lesser the error, the error decreases with the decreasing of noise level. The next step is to develop an Ipen nuclear research reactor model and apply the GMDH methodology to predict the reactor variables. This work is a part of a Monitoring and Diagnosis System for Fault Detection using GMDH data-driven model to be applied to the IEA-R1 Ipen reactor.

Wavelet transforms and fuzzy logic in the diagnosis of faults in steam generator tubes by eddy current testing - Ageing and subsequent loss of integrity of nuclear power plant steam generators are the foremost causes of expensive equipment replacement and reduction of availability and reliability. This project developed a novel methodology to improve the analysis of Eddy Current testing signals in steam generator tubes by using Wavelet transforms to pre-process the signal removing noise and non target informations as well as stablishing standard defects signatures. In order to improve the correct diagnosis ratio, automation in the analysis is implemented using a fuzzy logic inference method where inference functions based on the phase angle, amplitude and wavelet transform parameters are used. A experimental Eddy Current bench was set up around a Zetec machine and a data acquisition system to test several different tubes with most of possible faults simulated. The methodology was successfully tested against the data generated.