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Abstract

HYBRID INTELLIGENT TECHNOLOGY BASED FAULT DIAGNOSIS SYSTEM FOR SQUIRREL CAGE INDUCTION MOTOR

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This study proposes a novel method – constructing a hierarchical Fuzzy-Inference Net, kernel technology forming the Fuzzy-Expert System for diagnosis and detection of internal faults in three phase induction motor. The fault diagnostic problem has been widely discussed in the literature and Artificial Intelligent (AI) technologies have been increasingly gaining significance in the said field. However, literature review shows that the AI based fault diagnostic models in motor fault diagnosis so far partially depend on the conventional methods. For example, Fuzzy Logic, Artificial Neural Networks etc. are used as the decision making tool of the signal analysis methods such as Motor Current Signature Analysis (MCSA) and Wavelet Packet analysis etc. and thereby face some of the same difficulties faced by these conventional methods. In the present study AI based fault diagnostic and detection system, which is independent of the conventional methods is proposed.

Some of the key challenges in constructing the proposed hierarchical Fuzzy-Inference Net are: solving the uncertainties involved in the fault diagnosis; defining & assigning the probability parameters, such as Prior Probability, Likelihood of Sufficiency (LS)

and Likelihood of Necessity (LN) to each node of the Inference Net; quickly reach the valid hypothesis/conclusion using limited symptoms; approximately locate the fault in the absence of some important evidences etc. Research reveals that Fuzzy Logic theory integrated with Bayesian theory, Expert System theory helps in solving these difficulties. Based on Bayesian theorem, the Propagation of Probabilities is used to address the uncertainties involved in motor fault diagnosis. The membership grades obtained from the defined membership function (using Fuzzy Logic) of input fault symptoms are used to define and assign the probability parameters.

As it is desirable to solve the fault diagnostic problem by using a single AI technology, great efforts have been taken in the present study to diagnose and detect the fault using pure Expert System. The main difficulty faced in such system is that the probability parameters (uncertainty values) assigned to each node of the Inference Net are static, which makes it difficult for the diagnostic system to properly detect the severity/ location of fault. The need of dynamic uncertainty values to diagnose and detect the fault with greater accuracy led to the integration of Fuzzy Logic technology in the present study.

Some of the other uncertain issues which may lead to misdiagnosis, such as asymmetry of the motor, slight static asymmetrical input voltages and motor misalignment etc. are also solved in the present study. The uncertainty issues occurring in each stage of the Inference Net is solved by using Propagation of Probabilities based on Bayesian theorem. Moreover the designed diagnostic system will not only diagnose the type of fault but also detect the exact location of fault, and

consequently give proper instruction for the user to locate and repair the faulted part. The validity and effectiveness of this approach is witnessed clearly from the results obtained.

As a key technology, the proposed hierarchical Inference Net might also be applied to other fault diagnosis applications, such as fault diagnosis of buildings, industrial equipments, even the prognosis of human's diseases etc.

Key words: Fault Diagnosis, Internal Faults, Uncertainty, Membership Function, Fuzzy Sets, Hierarchical Fuzzy-Inference Net, Propagation of Probabilities, Prior/Posterior Probabilities, Likelihood of Sufficiency (LS), Likelihood of Necessity (LN)