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LIQUID-PROPELLANT ROCKET ENGINES FAULT DIAGNOSTIC BASED ON DYNAMIC CLOUD BP NETWORKS

Abstract

Fault diagnosis is very important to improve and enhance the reliability and safety of current expendable and next-generation reusable liquid-propellant rocket engines. However, fault diagnosis for liquid-propellant rocket engines often faces a lack of prior knowledge or insufficient sampling data, and thus becomes a decision-making problem with uncertain information sources. In this paper, a method based on dynamic cloud back-propagation (BP) networks is proposed. This uses cloud theory to synthetically combine randomness and fuzziness. In this work, a cloud model and BP neural network are synthetically combined in series. A cloud transformation is used to identify the network structure and extract the features of the cloud model. Simultaneously, a unit-delay step is introduced into the input layer to describe the dynamic behaviour during the engine working process. The proposed fault diagnosis method for liquid-propellant rocket engines is verified using actual data. The results confirm that the proposed method accurately recognizes all three relevant failure modes. Further, randomness associated with the measurement process and ambient noises are simulated by adding random noise to the test conditions. Simulation results demonstrate that the method correctly detects and classifies faults according to the principles of sustainability, indicating a high robustness towards noise. The proposed method has a single-step operating time of 1.24 10-4 s, satisfying the real-time requirements for fault diagnosis in liquid-propellant rocket engines. In addition, the data compression capability of the proposed method, which is due to the function of its fuzzy layer, means that fewer training data are required than in traditional neural networks. This effectively overcomes the issue of a lack of training samples