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CHOI-WILLIAMS DITRIBUTION ANALYSIS FOR FAULT DETECTION OF THE LIQUID PROPELLANT ROCKET ENGINE

Abstract

Research on fault detection technology for Liquid Propellant Rocket Engine can establish a solid theory and application basis for enhancing the reliability and safety of space vehicles thruster system as well as reducing the costs. Turbopump is the important component of Liquid Propellant Rocket Engine to transport propellant. Because of its execrable working circumstance, turbopump has a higher fault probability than other components. What's more, its faults develop very fast, and severely endanger rocket engine safety. On the other hand, supported by the real-time fault detection technology, the turbopump fault detection system can detect faults in time. However, in practice, because of noises and the mixing of signals due to different components, the signal analysis and the feature extraction are quite difficult. Based on the vibration signal features law, the Choi-Williams distribution analysis for turbopump fault detection was brought forward, and the linear correlation, stability and fault sensitivity of signals time domain and frequency domain features were studied. Then the corresponding tubopump vibration signal features were selected and extracted. The turbopump vibration characteristics, fault modes and mechanism were analyzed. Then the linear correlation, stability and fault sensitivity of turbopump vibration signal time domain and frequency domain features were researched, and signal features were selected and extracted. Validated by the rotor platform online data, Choi-Williams ditribution analysis can detect the turbopump fault effectively and real time. The results reveal that the Choi-Williams ditribution theory for fault detection and diagnosis of liquid rocket engine has good performance in reliability and stability as well as solving fuzzy and stochastic problems. Moreover, the methods given in this thesis can predict faults early than the traditional methods such as RS (Red Line System), EA (Envelop Algorithm) and neural networks algorithm in some conditions.