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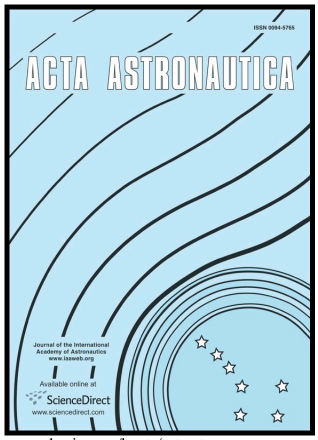

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Application of Fault Factor Method to Fault Detection and Diagnosis for Space Shuttle Main Engine

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Abstract

This paper deals with an application of the multiple linear regression algorithm to fault detection and diagnosis for the space shuttle main engine (SSME) during a steady state. In order to develop the algorithm, the energy balance equations, which balances the relation among pressure, mass flow rate and power at various locations within the SSME, are obtained. Then using the measurement data of some important parameters of the engine, fault factors which reflects the deviation of each equation from the normal state are estimated. The probable location of each fault and the levels of severity can be obtained from the estimated fault factors. This process is numerically demonstrated for the SSME at 104% Rated Propulsion Level (RPL) by using the simulated measurement data from the mathematical models of the engine. The result of the current study is particularly important considering that the recently developed reusable Liquid Rocket Engines (LREs) have staged-combustion cycles similarly to the SSME.

Keywords: Space Shuttle Main Engine, Fault Detection, Fault Diagnosis, Fault Factor, Linear Regression, Confidence Interval

1. Introduction

Safe flight of a spacecraft is strongly dependent upon normal operation of all the systems consisting of multiple stage rockets and the other launching facilities including the launching pad. Among those components, the first stage of the rocket system, mainly a large-scale liquid rocket engine (LRE), is the most likely to cause critical failures which may determine whether a flight mission is successful or not. This is because the LREs used as a first stage rocket operate under very high energy-density conditions, and are generally composed of many