SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (1) (1)

Author: Mr. elayaperumal ezhilrajan
Indian Space Research Organization (ISRO), India, mu_ezhilrajan@yahoo.co.in

PROPULSION CONTROL SYSTEM MODEL FOR LIQUID ROCKET ENGINES USING INTELLIGENT TECHNIQUES

Abstract

The main objectives of the propulsion control system are (a) to safe guard the propulsion systems from failures (b) to get high performances from propulsion modules (c) to control the engine operations in the uprated or throttling conditions. For achieving a desired performance, minimum propulsion parameters which are to be monitored and controlled are thrust, specific impulse, propellant flow and mixture ratio(MR). Conventional propulsion control systems which works in a close loop mode, some time become insufficient because of of lack in information or sudden failure/degradation of critical feed back sensors during engine operations. The growth of intelligent techniques like fuzzy logic, neural networks and neuro-fuzzy in the control system modelling helps to solve these kind of problems. Fuzzy logic provides a very good inference mechanism and handle imprecise & inconsistent data. Other intelligent technique, neural networks which works on a basic structure called neurons, has advantages such as learning, adaptation, fault tolerance and parallelism. For a control system which is complex and non-linear in nature, neuro-fuzzy techniques which takes good characters of fuzzy logic and good techniques of neural network are highly useful. NASA developed a model for health monitoring and to identify sensor failures for a jet engine systems. Also for Space Shuttle Main Engine(SSME), neural network model was developed to simulate sensor failure and estimate the Mixture ratio(MR). These models either depends on a reliable system model or insufficient to find out sensor degradation in real time. To over come these problems, a neuro-fuzzy model was developed with following features: (a) The developed Neuro-fuzzy model does not require well established Engine Model. (b) Main architecture of the model is derived from the well proven Neuro-fuzzy architecture, "Generalized Approximate Reasoning based Intelligent Controller (GARIC)", which combines the advantage of both neural and fuzzy architecture. (c) Model has a capability to control multiple propulsion parameters for an example MR and thrust (d) A special intelligent algorithm using Reinforcement Learning Techniques is built in the model. This learns from environment and assumes that there is no supervisor to critically judge the control actions. (e) Model is very unique in detecting not only failure of the sensor but also degradation like drift in sensors. This model was developed using MATLAB tools. A typical degration of flow meter during engine operations was simulated. The results shows that flow meter degradation was captured and necessary control actions were taken up automatically.