Paper ID: 40584
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SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

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ADVANCED PROPULSION CONTROL SYSTEM(APCS) MODEL USING INTELLIGENT TECHNIQUES

Abstract

Launch vehicles are propelled by rocket engines with in-built Propulsion Control System(PCS) from lift off till satellite is injected to the specified orbit. As complexity of engine system increases, difficulty in controlling rocket-engine performance increases. Major components of PCS are flow regulators which gives propellants at required rate to engine, actuators for throttling flow area of flow regulators as per demand, control electronics, algorithms to compute error and correct system, sensors which sense process and gives feed back to control loop. Even though Conventional Propulsion Control System(CPCS) works satisfactorily, there are some limitations exists. 1) The conventional approach depends on mathematical model of system. For the complex cryogenic and space shuttle engines, modeling with better accuracy is difficult. 2) Even though sensor health checks are carried out in real time, sudden degradation of feedback sensors is not addressed. 3) In case of sensor failures, conventional systems are designed to work with pre-defined parameter value. This gives degraded performance of engine. 4) CPCSs are designed to work in parallel redundant configuration. However, it is not possible to reconfigure the system according to real time requirements. These limitations were noticed during rocket engine developmental testing. Some of the malfunctions of CPCSs are due to incorrect input due to various reasons like flow meter drift, wrong assembly of temperature sensors and flow control valve oscillations. These factors motivated to develop APCS. The APCS is conceived by using neuro-fuzzy techniques with following objectives: a)To find faulty feedback sensors and isolate them b)To reconfigure PCS in real time c)To compute propulsion parameters errors from a desired value and correct them for smooth function of engine. Following APCSs models are developed using neuro-fuzzy intelligent techniques: 1) In order to fine tune flow regulator to give desired propellant flow to engine and avoid flow-oscillations, Hybrid Self Tuning Fuzzy–PID model is developed. This model is based on Fuzzy Inference System and does online tuning of regulator-process PID-parameters. 2) ANFIS- Model for Temperature sensor Failure Detection is conceived to detect the failures of sensors by considering neuro-fuzzy techniques and ANFIS network. This model is able to identify faulty feedback temperature sensors of CPCS system and isolate them from decision making process. 3) GARIC Model for Flow meter failure Detection based on GARIC architecture is developed to handle the situation of sudden flow meter drift. This is a unique and novel model which combines GARIC architecture and ANFIS network.