Paper ID: 34186
oral

SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

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

# NEURO-FUZZY MODEL TO EVALUATE FEED-BACK SENSORS OF MIXTURE-RATIO CONTROL SYSTEM (MRCS) AND CONTROL THE PERFORMANCE OF ROCKET-ENGINE

**Abstract**

As complexity of engine system increases, difficulty in controlling rocket-engine performance increases, especially controlling propulsion parameters like mixture-ratio and thrust. For close loop engine control system like Mixture-Ratio Control System (MRCS), health and performance of feedback parameters are critical to deliver expected performance. But, because of reasons like actuator failures, sensor failures, flow meter drift etc. MRCS system may not do its job correctly. Various failure modes of feedback parameters are taken-care in available MRCS models. However, cases like sudden degradation of sensors are not addressed which can leads to performance deviation of launch vehicles. Critical parameters of cryogenic MRCS are Liquid Oxygen (LOX) flow and Liquid Hydrogen (LH2) flow. Flow meter consists of three coils which are used as feedback to MRCS. Probability of drift in flow meter exists and this leads failure of all three coil measurement. Hence Intelligent model-GMFD using Neuro-Fuzzy techniques and Generalized Approximate Reasoning based Intelligent Control (GARIC) network is developed which detects these kinds of failures and provides accurate input to MRCS so that propulsion parameters of rocket-engine is controlled and finally performance as-well.This model-GMFD is simulated for various test conditions with different test cases including flow-meter drift case, happened in actual rocket-engine test. During that engine test, LOX-flow to engine read lower side than expected value due to drift in flow-meter. In reality process is healthy, all input parameters to control system show correct data. This indicates, in actual process LOX flow is high and LH2 flow is low. As a result, actual mixture-ratio is higher whereas control system mixture-ratio is within specified value. This is dangerous situation in launch vehicle. In this paper, three critical test-cases data are presented with performance of GMFD model. Test-case-01 is normal test case wherein data-set matches with normal performance of engine, in test-case-02 data-set with 15% drifts in flow meter is considered and for test-case-03, actual drift data from engine-test is selected. From GMFD model validation, it is concluded that:1.Model can study engine flow data, check for validity and finds failures. 2.For valid flow data, model fine tune data. 3.For flow meter drift problem which gives incorrect data to MRCS, model identify invalid data and estimates correct data. 4.With corrected data, MRCS able to continue in close loop mode operations as compared to operating in open loop when error in data occur, gives good performance of engine.