Paper ID: 78001
oral

IAF SPACE PROPULSION SYMPOSIUM (C4)
Liquid Propulsion (2) (2)

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

SOFT FLOW METER FOR MISSION-ONBOARD TO MEASRUE FLOW PARAMETER FOR LIQUID ROCKET ENGINES

Abstract

World wise launch vehicle scenario is to cater the need of carrying heavy satellite payloads. This necessitates development of High Thrust Liquid Engines which is propelled by huge amount of propellants. This demands heavy size flow meters and complicated assembly to mount in propulsion modules of launch vehicle. Flow meter is normally employed in rocket engines for onboard flow measurements to estimate Mixture Ratio (MR) and Propellant Outage or left out after mission. Huge mass flow meters in turn increase mass of launch vehicle and reduce payload capability. In order to enhance the payload capacity, the best choice is that flow meters are to be avoided and MR shall be controlled by an alternative way. Modern trends in technology development envisage the usage of Artificial Intelligence and Machine learning techniques because it is well proven that complex non-linear problems can be solved by these methods. There is a novel idea which uses Artificial Intelligence techniques like Neural Networks, without the existence of flow meter and by using techniques of Data Science; a soft-onboard flow meter is developed. The mere objective of this model is that for High Thrust Engines, design and development of Soft Flow Intelligence Model (SFIM), using other Engine measurements and predicts propellant flow with prescribed accuracy during mission in real time. To develop model, Adaptive Neural Networks(ANN) which is feed forward networks is envisaged. ANN carries out computations in forward pass. For these computations Linear Regression algorithms are adapted. To carry out errors and distribute errors as backward pass to each node, Back Propagation Algorithm with Gradient Decent approach is employed. Finally to generate complete model Fuzzy Inference System (FIS) concept is adapted. Many parameters are measured during mission and for arriving suitable input parameters; Bayes probability Model has been developed because Bayes theorem describes the probability of an event based on previous knowledge. Input parameters, arrived from Bayes model are Turbo-pump-speed, Engine-Chamber-Pressure, Pump-delivery-pressure and Pump- inlet-pressure. To develop and train this model, prior ground engine hot test Database is used with filtering and cleaning. A simulation environment is created and simulations runs are carried out by varying input and output conditions. This SFIM is used to predict flow as pre-hot-test predictions before engine hot tests. It is found, prediction matches with the actual test results of accuracy of one percentage error during engine steady state operations and two percentage errors during engine transient operation.