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A NOVEL TECHNIQUE FOR HEALTH ASSESSMENT OF LIQUID PROPULSION SYSTEM USING NEURAL NETWORKS

Abstract

Propulsion system is one of the most crucial part of any launch vehicle as the mission success heavily depends on its performance. It is a complex multi-disciplinary system wherein the individual sub-systems play crucial role in the overall system performance. Models of Propulsion system has been developed over a period of time using classical methods. These techniques use analytical means to generate empirical models that assume ideal behavior and do not consider all the non-linearities associated with the system. This problem can be overcome by adopting Machine Learning techniques using Artificial Neural Networks (ANN) that can absorb non-linearities present in the real world and can possibly adapt to changing conditions. Valuable collection of data available from previous launch vehicle missions can be utilized to deduce mathematical representation of Propulsion System elements using ANN. Effective implementation can impart prognostic intelligence to monitoring systems such that anomalies are alerted well in advance or sufficiently before it leads to catastrophic failures. This is a crucial tool for developing autonomous health management systems for continuous monitoring, anomaly detection, failure prediction and systems that are capable of taking safety measures in advance.

This paper is particularly focused on modelling earth-storable liquid propulsion system in launch vehicles using data centric approaches such as Machine Learning. Artificial neural networks are used to deduce mathematical representation between system parameters which eliminates the need to have complete domain level knowledge. It is evident from the results that there is practically good match between the model output and system response. The approach and algorithm followed in this project are elaborately presented in this paper. The generated models are evaluated using flight data to assess its accuracy. Some of the potential areas in launch vehicle health management are discussed wherein the derived model can be effectively employed to replace/augment existing techniques. One of the significant application lies in automated data analysis for quick assessment of data and faster detection of anomalies. Initial transients in ground lit engines can be autonomously assessed to make conclusive decisions on launch GO/NO GO criteria. For clustered engines, abnormalities in any one of the engine during flight can be timely detected and appropriate corrective actions can be taken by employing similar intelligence in on-board systems. As a future scope, similar approach can be applied to cryogenic and semi-cryogenic propulsion systems also.