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Title

Demonstration plan of fault diagnosis in propulsion system during HTV-X experiment mission for future technologies

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Abstract

The conventional redundant architecture of liquid propulsion system for spacecraft guidance, navigation, and control (GN&C) is based on cold backup concept. A resilient redundant architecture, that is less wasteful than the conventional because of that all redundant branches are used in nominal system operation and manage degraded performance caused by a failure, was proposed and applied to the HTV-X [1, 2].

However, fault detection and diagnosis of this architecture in short time are difficult based on attitude information due to its recovery nature. To realize fault diagnosis on fluidic components such as propellant valves and filters, focusing on the dynamic pressure response in the piping system under thruster pulse operation can be a solution [3]. This research, motivated by the above difficulty with fault detection and diagnosis, puts forth a new concept to identify branches with a fault by focusing on the spacecraft attitude information and the dynamic behavior of fluid inside the propulsion system. A pressure surge due to a water hammer is caused by a sudden change in the fluid flow velocity in the piping system after the open or close operation of a fast-acting valve. The surge pressure propagation through the system piping can provide useful information for monitoring the state and identifying the location of fault component. The amplitude and frequency of the surge pressure are determined by the fluid flow rate and length of the pipes.

Moreover, this study proposed a model-based approach as an efficient solution to obtain a prior dataset under fault conditions. In this study, the verification and validation of a model based on the in-situ measured data on orbit was planned and proposed to demonstrate feasibility of reproducing the frequency response by the model, important to failure diagnosis. This study presents a demonstration plan and its background of this concept of fault diagnosis on HTV-X utilized as experiment platform for exploitation of future space technologies.

References

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