SMART STRUCTURE DESIGN FOR MICRO-VIBRATION ENVIRONMENT CONTROL – THALES ALENIA SPACE EXPERIENCE

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ABSTRACT

One of the fundamental goals of the *Spacecraft for scientific investigation and astrophysics* are to guarantee a suitable Micro-vibration Environment for the main following objectives:

1 – *Earth observation*;
2 – *Space science*
3 – *Telecommunications* ➔ *pointing requirements mainly for geostationary satellite*;
4 – *Space infrastructures* ➔ *support experiments in material science, crystal growth and basic fluid physics for experiment at ISS on board or future manned space laboratories.*

Since the disturbance sources, like mechanism and thermal clank, induce higher vibration levels than the allowable ones it is common practice after the first ***Design Analysis Cycle*** to start a feasibility study on *potential Recovery Actions Passive or Active ones to retrieve the expected Non–Compliances.* Currently the preferred recovery actions are the passive ones for feasibility, more reliability and cost reasons mainly for mechanism while for the thermal clank only structural architecture (distance from disturber to receiver, structural joints) can reduce its disturbance effect.
The implementation of active isolation system can guarantee a better mechanical stability for both the steady state disturbers and the transitory ones with the advantage of mass and volume reduction vs. the passive one. Moreover, by both a technological study funded by ESA and also by the collaboration with Politecnico of Turin it was possible to develop and to tune the whole simulation methodology on the effects of active actuators with embedded "local" control laws and also to develop a self adaptability control system that can control different disturbances signature during the operative life of the spacecraft.
The outcomes of these propedeutic Studies on the simulation of SMART structure based on FE and MATLAB models open new scenario for its application on future Space Projects.
In fact on control aspects the outcomes are :

- powerful self-adaptability
- Weighting effect as expected based on multiple-channel active control theory.
- Significant Control effect on broadband up to 17 dB (i.e. ≈7 times more on Q factor - between 155Hz -215 Hz).
- stand- alone control

Moreover confirmation of the whole Design process based on :

- FEM and ANSYS simulation for the definition of the control architecture, the sensor and actuators type, the optimization of the control parameters.
- the control architecture optimisation based on numerical and experimental modal bases
- Maximisation of the control effect based on the measured TF and the real time filtering effects
- Goodness of the control law based on the fact that where the dynamic of the model is higher also the filtering effect control is significant.
- Optimisation of the numbers and locations of the actuators/sensors for the damping effect maximization .

Due to the maturity of the active control Design process is now under evaluation feasibility study to embark a complete active control system on:

- Optical payload for Data Relay System mission
- As technological demonstrator for large antenna micro-vibration control

The requested follow-on of these studies for space application is the miniaturisation of the requested electronics for the control.

The objective of this paper is to show this Design evolution and the further steps to develop in order to get the requested Technological Readiness Level for industrial application in Space projects.