Context

ArianeGroup is increasingly interested in vibration simulation. Simulating the pyrotechnic shocks in SYLDA structure could size the detachment technology. Covering both the large and the medium frequencies is a real challenge that defeated classical numerical softwares, such as explicit finite elements methods. An alternative is proposed by the Variational Theory of Complex Rays (VTCR) [1].

The VTCR is a frequential method that uses waves as shape functions. Currently, it solves linear problems. The goal is to extend it to nonlinear problems, as present in pyrotechnic shocks. Nonlinearities are computationally expensive due to frequency-time inversions. The first key point is to reduce it by proposing a large frequency band resolution.

The problem: pyrotechnic shocks in SYLDA structure

It was shown that medium frequency (5 KHertz) can not be neglected.

The VTCR efficiency (TAPYROSS):

Resolution strategy: FEM

Resolution strategy (4) : VTCR

The VTCR is the adapted method for medium frequency

First step to nonlinear problems: large band resolution

Instead of resolving the problem by frequency, we are searching a low rank solution (Prepered Generalized Decomposition : PGD method)[2,3]:

\[ A_{ij} \approx A_{ij}^{TD} = \sum_{m} A_{ij}(\theta)\lambda_m(\omega) \]

Large band approximated solutions in a square acoustic cavity with different methods (adimensional parameters)

Different methods were developped for large band resolutions, some with good convergence properties

Project milestones

Validation and extension to large band resolution in shells

TAPYROSS is a vibration software simulator using VTCR to simulate vibrations in SYLDA. We will reduce computational time by implementing the large band resolution.

Resolution of non linear problems

The objective is to extend VTCR to non linear problems as visco-plasticity and damage. We expect to develop an algorithm based on many passages between frequency and time domain, hence obtaining a large band resolution.

Conclusions

The VTCR is a strong alternative for medium frequency resolution. However, computational costs increase when the solution over a large frequency band is needed. Therefore we developed algorithms based on Proper Generalized Decompositions.

The following works will extend the large band resolution to shells. This opens the way to non linear problems.

References


