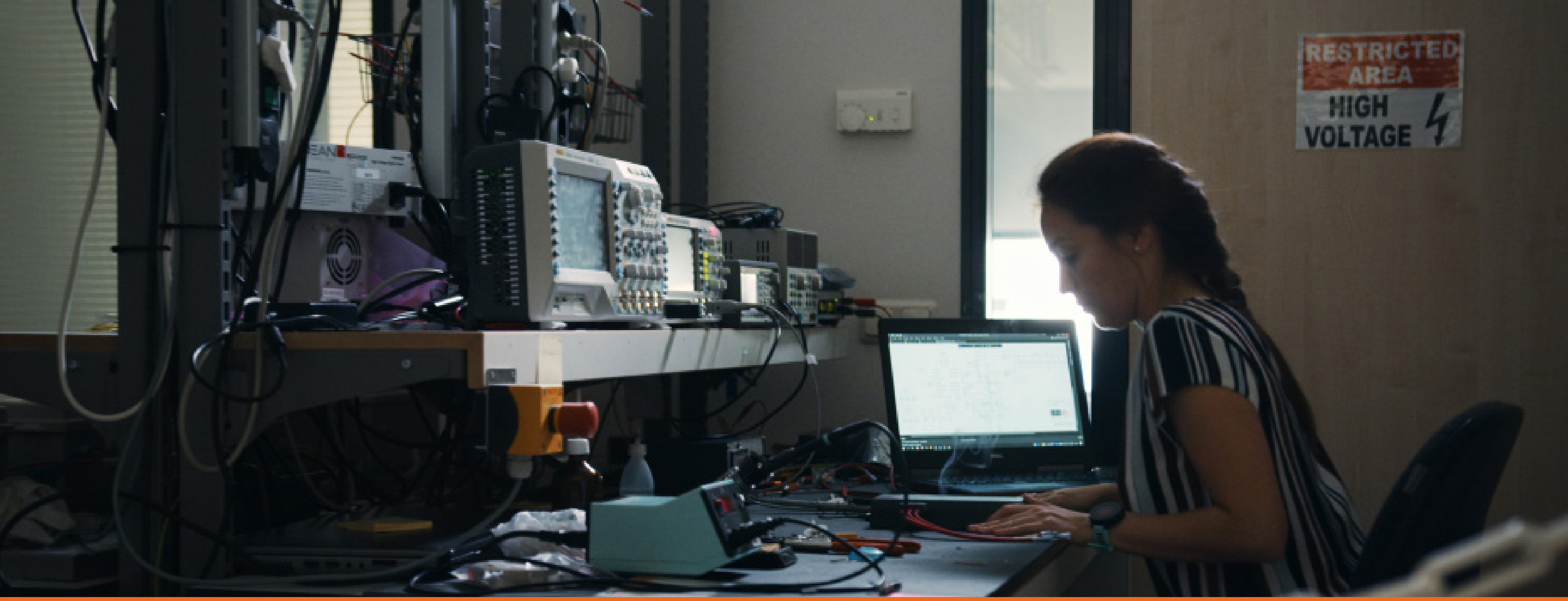

IDENTIFICATION OF THERMAL SYSTEMS

Assignment

The goal is to develop and test a frequency based identification method, such as LPM, for a thermal system and show the accuracy of this method.

Activities

- Make a (simple) model of the thermal system to be tested (i.e. lumped mass).
- Apply traditional step-response identification for first-order identification.
- Develop a frequency based identification (LPM / LRM).
- Test accuracy of this frequency based identification.
- Fit the parameters of model to the measured response.

Context

In the development of mechatronic products and systems, thermal effects often affect the performance or the precision. As the demands on performance are continuously increasing, the challenge to handle these effects is becoming more important.

High quality thermal systems models are essential to optimize overall system performance. Next to the modelling, verification and identification on system hardware or is required.

Internship overview

- Master Student
- Internship Assignment
- Mechatronics
- Location: Eindhoven

Technologies

- Thermal
- Modeling
- Lumped mass
- System identification
- Step-response
- LPM / LRM
- Multi-sine

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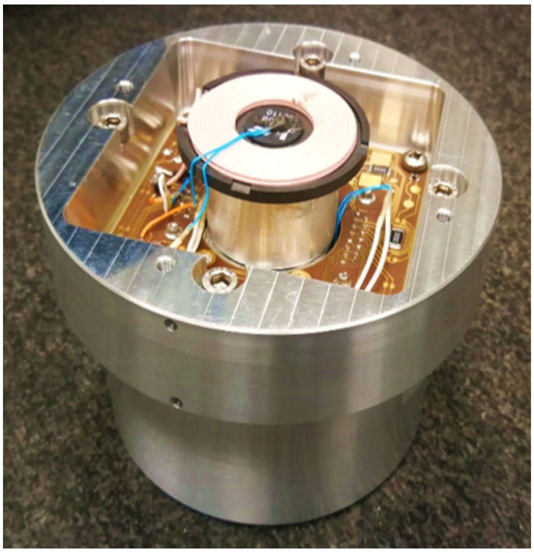
Traditionally thermal identification is done by performing step-response measurements and fitting time-constants. This method is time consuming and gives only limited insight into the system. State-of-the-art identification algorithms, such as local polynomial method (LPM), result in more information (frequency information), shorter experiments and better rejection of disturbances.



Thermal setup for identification, with multiple heaters and sensors

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Would you like to know more about this student assignment?

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2D TUNED MASS DAMPER

Assignment

Develop design rules for optimal Tuned Mass Damper (TMD) design and apply these for a specific demonstration setup. Identify the ideal frequency range for application of TMDs, suitable viscoelastic materials and practical concepts for fine-tuning the TMD frequencies.

In general, a TMD is tuned at one specific frequency. The challenge of this assignment is to design TMDs that can damp resonances in multiple directions (translation/rotation). The frequencies at which the TMD operates should be altered independently.

Activities

- Make an overview of existing TMD concepts
- Derive design guidelines for a TMD
- Extend design guidelines to TMDs suited for damping in multiple directions
- Design a '2D TMD' for a demonstration setup
- Model and optimize your design (FEM – lumped mass model)
- Determine how to experimentally validate your models
- Build and test your design

Internship overview

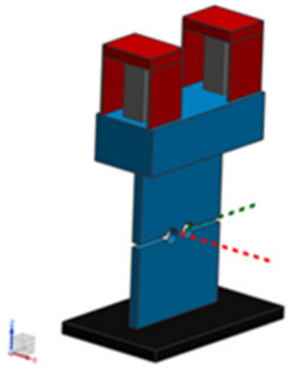
- Master Student
- Internship
- Mechanics / Mechatronics
- Location: Eindhoven

Technologies

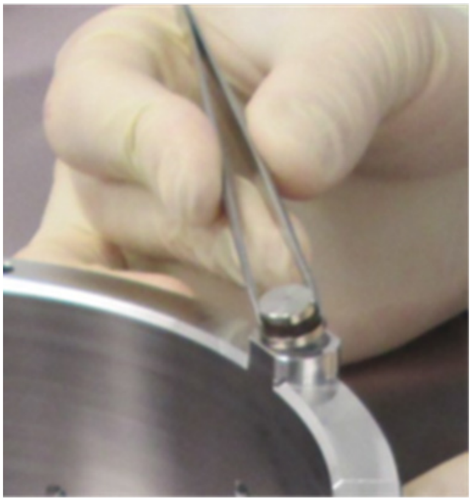
- NX Nastran
- Finite Element Analysis
- Material modelling
- System identification
- Lumped mass modelling

Context

Dynamical performance of high-tech mechatronic products and systems is often limited by undamped eigenfrequencies of the system. As performance requirements increase, the eigenfrequencies can no longer be designed high frequent enough to be insignificant to the performance. Then, such modes should be damped.
Adding damping to the structure itself is often not possible, among others due to mass, volume, or cleanliness constraints. A Tuned Mass Damper (TMD) is a highly mass effective damping solution that can be added to a system to greatly damp specific eigenmodes.



Schematic of an envisioned tuned mass damper demonstrator



Example of a tuned mass damper

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CONSTRAINED LAYER DAMPING AND ACOUSTIC BLACK HOLES

Assignment

Develop design guidelines for applying CLD and ABH techniques to high-tech system designs, explore the combination of these two techniques in theory and design, and apply and validate the acquired knowledge on a demonstrator setup.

Activities

- Summarize the theory on CLD and ABH techniques and explore the combination of them
- Design a CLD + ABH demonstrator that effectively exhibits these design methods
- Simulate and predict the behaviour of the demonstrator via lumped mass as well as via FEM methods
- Validate the demonstrator using experimental modal analysis
- Optimize the applicability of ABH's for frequencies in the range of 50-200 Hz
- Apply the developed knowledge and guidelines to a design of a complex real-world system

Internship overview

- Master Student
- Internship
- Mechanics / Mechatronics
- Location: Eindhoven

Technologies

- Design for Dynamics
- Acoustic Black Holes
- Damping
- Constrained Layer Damping
- Lumped Mass modelling
- Finite Element modelling
- Experimental modal analysis

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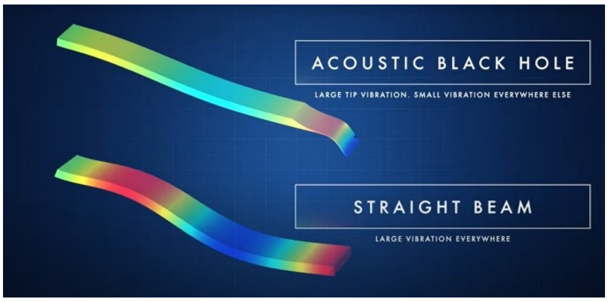
Context

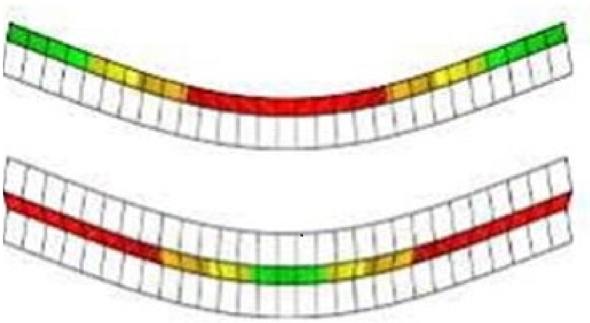
In the development of high-tech systems, the required performance is ever increasing. This has caused a growing attention to the dynamic behavior of systems, with specific detailed designs tailoring to it. Such designs occur increasingly both via mechanical design principles as well as via damping solutions.

An emerging trend is a design method called Acoustic Black Holes (ABH's) where most of the vibrational energy of certain modes can be trapped inside parts of the vibrating structure, thus decreasing the vibration of the rest of the structure. Currently, applications and theory exist for acoustic vibration modes, which are often of higher frequency than high-tech system structural modes. Research into applications within typical system modes helps for the applicability of this design method.

Another interesting opportunity is the combination of using a ABH to trap the vibration in a small section of the structure with damping this vibration. For plate modes a typical damping technique is Constrained Layer Damping (CLD), where a small amount of rubber enclosed by a constraining layer is applied to a surface. The volume and cost effectiveness of such a damping method could be greatly increased combining it with the ABH technique.



Effect of an Acoustic Black Hole



Shear in visco-elastic materials in Free Layer and Constrained Layer Damping

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