ECL_LTDS_Sinou_01

PhD Proposal 2017

School: Ecole Centrale de Lyon	
Laboratory: Laboratoire de Tribologie et Dynamique des Systèmes LTDS UMR 5513	**Web site: http://ltds.ec-lyon.fr/spip/**
Team: Dynamique non-linéaire, Incertitudes et Systèmes avec Interfaces	**Head of the team: Prof. J-J. Sinou**
Supervisor: Prof. J-J. Sinou	**Email:** jean-jacques.sinou@ec-lyon.fr Phone: +33 (0)4 72 18 64 66 Personal Homepage: http://jean-jacques.sinou.fr
Collaboration with other partner during this PhD: **In France:**	**In China:**

Title: Structural Health Monitoring based on non-linear vibration measurements
Scientific field: mechanical systems and structural dynamics.
Key words: structural dynamics; nonlinear vibrations; structural health monitoring and damage detection, civil engineering.

Details for the subject:

Background, Context:

Damage is a main cause of structural failure and often occurs on structures. In the past decades, special attention was given to avoid the sudden failure of structural components by detection damage in structures in the early state.
More specifically, structural health monitoring based on the vibration of structures has been at the focus of attention of many researchers in order to obtain very efficient tools of great importance for the civil and mechanical engineering communities.
It is generally admitted that the four principal damage stages of structural health monitoring are the determination of the presence of damage in the structure, the determination of the damage location in the structure, the quantification of the severity of the damage, and the prognosis of the remaining service life of the damaged structure.
Moreover, the need to be able to detect in the early stage the presence of damage in complex mechanical structures has led to the increase of non-destructive techniques and new developments based on the emergence of non-linear methodology.


Damage assessment in civil engineering sector and bridge collapse in Minneapolis 2007

Research subject, work plan:

Even if the choice of the most appropriate method for the detection and identification of damages in structures is essential, only few efforts have been dedicated to discuss advantages and limitations of linear and/or non-linear approaches based on vibrational measurements in the presence of uncertainties.
So the present study proposes to investigate the use of non-linear vibrational signatures for an efficient and robust detection and localization of damage in mechanical structures. The following questions will be addressed:

- Are the classical effective tool of non-destructive testing based on a linear analysis sufficient for detecting and identifying the location and severity of damage in the presence of uncertainties?
- If linear methods are not appropriate, how the non-linear measurements can be used for an efficient and robust detection and identification of damage in the presence of uncertainties?
- What is the significance of the non-linear vibrational measurements for mechanical damaged structures for the prognosis of the remaining service life of the damaged structure?

Applications for damage detection in practical cases will be proposed on academic structures with possible applications in energy and civil engineering sectors, where damage assessment can be a crucial point.

Work plan:

1- Methods of damage detection using linear analysis
   a. direct use of modal parameters
   b. changes in Frequency Response function
   c. coupling responses measurements

2- Structural Health Monitoring based on non-linear analysis
   a. changes in frequencies and dynamic response due to the breathing mechanism
   b. appearances of nonlinear signatures (Higher-Order Frequency Response Functions)

c. transient signals and Wavelet Transform

3- Extension of linear and nonlinear approaches by including the presence of uncertainties (measurements, structures,…)
   a. uncertainty effects on the variability of the linear measurements
   b. uncertainty effects on the variability of the non-linear vibration

4- Applications for damage detection in practical cases
   a. modeling of crack and breathing behavior
   b. numerical simulation and experimental tests

Previsional Schedule:

	Year 1		Year 2		Year 3	
	Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
Methods of damage detection using linear analysis						
Structural Health Monitoring based on non-linear analysis						
Extension for linear/nonlinear approaches with uncertainties						
Applications in practical cases						

References:

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