Title: Robust topology optimization under uncertainty – application to automotive brake systems

Location: LAMIH UMR CNRS 8201, University de Valenciennes, Le Mont Houy, 59313 Valenciennes Cedex 9, France.

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Keywords: Topology optimization; Uncertainty; Surrogate models; Metaheuristic; Evolutionary algorithms; Numerical methods

Project description: Optimization under uncertainty aims at accounting for the observed variability of some model parameters in order to tend to robust and reliable designs. The integration of multiple uncertain parameter, for example relative to a topology, a topography or boundary conditions, relies on the use or the coupling of different theories (probability, interval, fuzzy …) for a successful representation of the observed evolutions. In engineering, investigated problems lead to large time consuming mathematical problems associated to the objective and state functions. Generally, they are addressed by considering the finite element method. To solve this kind of problem, numerical strategies based on parallel calculations, surrogate models and metaheuristic algorithms (Evolutionary algorithms) are necessary. Moreover, a multi-objective formulation must be considered to guarantee the robustness of the optimal solutions.

Research in optimization is a fundamental field for all the engineering domains to answer the new environmental requirements. The optimization method, proposed in this project, will be applied to investigate brake squeal phenomenon. Indeed, the reduction of environmental acoustic pollution is a major concern for automotive manufacturers. These last years, several research works revealed the interest for uncertain stability analysis used to simulate squeal. Among the already studied parameters, the variability of the topography of contact surfaces seems to be the most sensitive parameter. To tend to a robust design, it is essential to integrate the spatial uncertainty during the design step of the brake components.

The objective of this multidisciplinary thesis project is to develop a topology optimization strategy under topographical uncertainty for dynamic stability problems.

References of supervisor staff:

Talbi E-G. Metaheuristics: from design to implementation, Wiley, 2009.

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Renault A., Massa F., Lallemand B., Tison T. Experimental investigations for uncertainty quantification in brake squeal analysis. Journal of Sound and Vibration, 367, pp. 37-55, 2016.

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Funding: 1768,55 €/month gross salary during 3 years – Best start: October 2018.

Applicant profile: Candidates are required to have a degree in applied mathematics, computer science or mechanical engineering. Prior knowledge in optimization, uncertainty modelling and experience in developing scientific codes (Matlab, R, …) will be appreciated.

Candidature: Please send a one PDF file composed of:

- A CV (including your background and contribution in the topics of interest)
- Two last year's Master or Engineering school transcripts and class ranking
- 2 recommendations letters

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