TECHNISCHE HOCHSCHULE DEGGENDORF

UQVI

ANALYSIS AND QUANTIFICATION OF MODEL-FORM UNCERTAINTY IN STRUCTURAL DYNAMIC SYSTEMS WITH AN EMPHASIS ON VIBRATION ISOLATION USING DIFFERENT MATHEMATICAL MODELS AND A REALIZED TEST RIG

Weitere Infos:

Abstract

Project title:

Model-Form Uncertainty in Passive and Active Vibration Isolation

Short title:

UQVI- Uncertainty Quantification in Vibration Isolation

Introduction:

Mathematical models are indispensable tools in understanding the behaviour of real-world systems and informing decision-making in the early stages of the design process. Due to inherent uncertainties in real-world systems and the simplifications made during model development, there will always be discrepancies between model predictions and actual observations. To ensure the credibility of mathematical models, it is crucial to understand and quantify these uncertainties.

Aim:

The research project focuses on analysing and quantifying model-form uncertainty in structural dynamic systems with an emphasis on vibration isolation using different mathematical models and a realized test rig.

Methodology:

A complex dynamic component of an automobile, such as a suspension strut, can be modelled in its simplest form using a mass-spring-damper system, a one-mass oscillator. However, simplicity comes with uncertainty about model adequacy. More advanced models will lead to more adequacy. To verify and validate different mathematical models predicting the dynamic behaviour of the mass-spring-damper system, an experimental test rig has been set up. The test rig is versatile enough to conduct experiments for various masses and stiffness values. In addition, effects from passive and active vibration isolation are studied. For passive vibration isolation, passive damping is provided by the inherent properties of the system, while active damping for active vibration isolation involves the use of controlled forces for vibration isolation. The test rig is a two-mass oscillator. One mass represents the oscillating mass of a one-mass oscillator system. The other mass is a frame that supports the oscillating mass. The latter is excited by an impact force on the frame. Currently, three mathematical models have been established: an analytical one-mass oscillator model, an analytical two-mass oscillator model, and a finite element model to predict the vibration of the oscillating mass in the test rig. The deterministic discrepancies between the simulated results and the experimental results have been obtained. Further research aims at non-deterministic analysis using Bayesian methods and refining the models to reduce model form uncertainty.

Result:

As part of this approach, we assess the uncertainty in different model-forms to determine whether a model is adequate for predicting the dynamic behaviour of structural systems. If the uncertainty in a simpler model is acceptable, there is no need to use more complex models with lower uncertainty. The scope and novelty of this work lie in creating a metric to quantify model-form uncertainty and determining whether a model is adequate for predicting the dynamic behaviour of structural dynamic systems.

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