

Robust inversion of non-linear dynamic systems

Weight reduction is becoming increasingly important in products that undergo cyclic loading, such as cars, aeroplanes, wind turbines, etc. The novelty of these dramatic design changes will cause material fatigue to become one of the key design drivers in the development of cars, aeroplanes, wind turbines and require tools to accurately predict the life time of a construction. The life time can be estimated with numerical simulation with virtual prototypes or experimentally in laboratory tests with physical prototypes on durability test rigs. The numerical simulation makes use of mathematical (finite element, multi-body) models to predict the cyclic stresses in a construction due to external excitations.

A critical numerical problem in all these life time prediction tests is the inversion of dynamical models. In physical testing, the inversion allows to predict the drives of the hydraulic actuators of a test rig such that measured signals (accelerations, displacements) on the prototype closely match the real-life outdoor test track measurements. The industrial standard for computing the hydraulic drives is via the inversion of Frequency Response Function (FRF) models. The main drawback of this approach that will become a severe bottleneck in the foreseen future increased demand for fatigue prediction, is that it is time consuming. For example the approximation of the non-linear dynamics of a practical test case with a suspension containing highly non-linear shock absorbers by a linear FRF model easily resulted in three weeks of iteration time to compute the hydraulic drives.

The contribution of the project is the development of identification methods and inversion methods for non-linear and/or large scale dynamical systems and the use of the identification and inversion results in tuning robust controllers, as well as towards applications of the developed methods and techniques in the light weight structures and the wind energy.