

## Master thesis

# Nonlinear Modal Analysis of a Piezoelectric Ultrasonic Drive

## Background

The generalization of modal analysis, the standard method for the analysis of linear dynamical systems, has been under research for decades. Since the turn of the millennium, great progress has been made in the basic mathematical principles for describing and treating nonlinear systems. In this context, methods like Dynamic Mode Decomposition (DMD, 2008) and further extensions based on it like EDMD are popular and successfully used in fluid mechanics. Nevertheless, methods like (E)DMD are very general tools to investigate dynamic systems based on simulated or measured time series.

In this thesis, the dynamic behavior of a piezoelectric ultrasonic drive, which is used for high precision movement and positioning tasks, will be investigated and characterized via (E)DMD. The system behavior is characterized by strong nonlinearities, which is why the analysis by (E)DMD promises new insights and a better understanding of the system. The analysis is based on measurement series, which are generated and recorded in suitable experiments.

The thesis is carried out and supervised in cooperation with Physik Instrumente (PI) GmbH & Co. KG in Karlsruhe. We will be happy to provide more details in a first meeting.

## Tasks

- Planning and execution of experiments with existing setups
- Analysis and evaluation of measurement series
- Interpretation and visualization of dynamic effects

## Profile

- Enrolled in mechanical engineering, mechatronics or electrical engineering
- Interest in programming and dynamics related topics
- Ability to work independently and in a team

## Contact

Dr.-Ing. Ulrich Römer  
Geb. 10.23, R205.2  
[ulrich.roemer@kit.edu](mailto:ulrich.roemer@kit.edu)