Joints Workshop Technical Talk

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Important Topics in our Area

- **Nonlinear or Linearized Joint Modeling**

**Industrial Problems**
- Local Joint Models
- Nonlinear FE Joint Models (Zero Thickness Elements)
- Linearized FE Joint Models (Thin Layer Elements)

**Research Problems**
- Surface roughness description Herz-Mindlin Theory for single asperities
  - Greenwood Williamsen Tripp
  - Stochastic roughness models
  - Fractal surface description
  - Multi particle dynamics
- Nonlinear normal and tangential contact equations
- Harmonic balance description
- Modeling of Epistemic and Aleatoric uncertainties

**Identification of Joint Model Parameters from isolated joints**
- Resonator measurements, Pressfit joints
- Optoelectronic measurements
Important Topics in our Area

Industrial Contact Problems
- SRTM 10 bay space frame with passive and semi-active joints
- Bolted housing of airbag control unit
- Damping description in design phase of
  - motors with attached gearbox (cars, trucks, yachts, ships)
  - bolted joints of cylinder head, oilpan, gearbox
  - influence of different seal systems
- Uncertainty description of assembled structures with joints
- Joints in tooling industry, Pressfit joints in turbogenerators
- Disc brake contact problems
- Bolted joint damping layers (exhaust systems)

Control problems for structures with semi-active joints
- Control concepts
  - Ljapunov controller, maximizing dissipation
  - Clipped LQG SISO-, MIMO-controller
Which Problems to Take in

SRTM 10 bay space frame with passive and semi-active joints
Optimal actuator and sensor placement concepts

- Scientific interest in collaboration with colleagues, such as the brake dynamics group organized by Harald Abendroth
- Funding offers by
  - FVV (Forschungsvereinigung Verbrennungsmotoren)
  - DFG (German Research Society)
  - Research groups
  - Transfer for Industrial problems
  - State funding (BW)
End User of Results / Funding

Who will be the end user of the results?

- Industry
  - Automotive suppliers
  - Car industry
  - Machine tools industry, Turbomachinery design
  - Optical industry
  - Biomedical industry (stent design, lithotripter design, peristaltic transport)
- Inventors
- Small business

How we get funding?

- Contact with Industry by local and international conferences
- DFG, FVV, VDMA
- Individual contacts
- Courses organized by IAM at HDT, VDI etc.
Friction-induced vibrations in brake systems

- Development of “silent” friction brakes is a major challenge in automotive industry
- Brake squeal is largely understood (qualitatively + quantitatively)
- BUT: prediction capabilities of simulation tools are poor
- State of the art tool: complex eigenvalue analysis
  
  Overprediction of instabilities

- Damping and nonlinearities mainly determine stability of the brake system
  
  Joints have to be taken into consideration

Bernhard Stingl, Merten Tiedemann, Norbert P. Hoffmann
Mechanics and Ocean Engineering
MT1  Komplexe Eigenwertanalyse eines linearen FE-Modells (MDGKN-System)
Merten Tiedemann, 8/1/2012

MT2  Wichtige Fügestellen:
- Scheibe-Belag
- Belag-Sattel
- Sattel-Halter
Merten Tiedemann, 8/1/2012
Challenges in the field of brake squeal simulation

- Characterization and description of nonlinear joint dynamics
- Implementation of joint models in commercial FE software
- Model order reduction
- Nonlinear stability analysis / limit cycle calculation


Friction as a Dynamical System?

Engineering

- material constant
- \( F_f = \mu N \)

Physics

- dynamical system
- \( \dot{F} = f(x, \dot{x}, F) \)

Transfer state of the art knowledge to engineering?

- Is Coulomb friction sufficient?
- Can we apply extended friction models?
Where to apply?

Failure of joints

- extended interface with stress field
- failure $\triangleq$ transition to sliding
- derivation of design rules
- monitoring systems, e.g. overload detection

Friction induced vibrations

- multiscale systems: structure and interface dynamics
- scales may interact $\rightarrow$ separation of scales fails

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**Extended Friction Models**

**Roughness based**

- repeated shearing, failure and reattachment of asperities

**Bristle Model**

- rough interface: elastic bristles

Experimental Model Setup

- periodic interface
- shaft-hub-connection, clutch, screw-underhead contact, …
- strain field measurement
- disturbed stress field by tilting