Gecko

Design for IGA-type discretization workflows

Funded by the European Union

3rd Gecko Meeting

DC09 - Introduction

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Personal Information

Academic Background

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- University Erlangen Nuremberg, Mech.Engineering
- TUM, Mechanical Engineering (M.Sc.)

FAU Friedrich-Alexander-Universität Erlangen-Nürnberg

TUM

Research Experience at TUM (Laboratory for Product Development & Lightweight Design)

LPL

- Systematic methods for component design
- Design and implementation of lightweight TMD and electromagnetic dampers

PhD Student at KU Leuven (LMSD)

KU LEUVEN

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DC09 - Research field

Model Order Reduction of coupled vibro-acoustic systems

Objectives: DC9 will work towards efficient model order reduction schemes for one-way coupled and fully coupled vibro-acoustic analysis where the acoustic domain is described using a boundary discretisation. Where efficient model order reduction of unbounded and bounded vibro-acoustic systems is well-established using finite element and (in)finite elements for the structural and acoustic part of the problem, the combination of finite elements for the structural part and boundary elements for the acoustic part is not often considered, due to the different properties of the matrices involved. DC9 will investigate how to combine Krylov and/or modal-based strategies. In a next phase, the methodology will be extended towards isogeometric descriptions of the geometry incorporating IGA BEM. Finally, DC9 will extend the developed techniques to include fast assembly strategies for BEM systems such as the Fast Multipole and H-matrix approaches.

Expected Results:

- Efficient Model order reduction for coupled vibro-acoustic methods, using a boundary element description for the acoustic domain
- Extension of the methodology to IGA based MOR for vibro-acoustic systems
- Incorporate FMBEM and H-matrices within IGA-BEM MOR.

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Motivation of Research

Model Order Reduction of coupled vibro-acoustic systems

- For acoustic problems: $\Delta p(\vec{r}) + k^2 p(\vec{r}) = -j\rho_0 \omega q_a \delta(r, r_q)$

  Helmholtz equation (Hermann Ludwig Ferdinand von Helmholtz 1821-1894)

- Acoustic pressure: $p(\vec{r}) = \int_{\Omega_f} \left(\mu(r_f) \frac{\partial G(r, r_f)}{\partial n} - \sigma(r_f) G(r, r_f) \right) d\Omega_f(r_f)$

$\mu(r_f)$: *double layer potential*

$\sigma(r_f)$: *single layer potential*

Why MoR IGA-BEM?

- Only boundary needs to be discretized in BEM compared to FEM
- Fulfillment of Sommerfeld radiation condition at infinity for BEM
- Sensitive to geometric description of surface → Incorporation of IGA with BEM
- However: There is no free lunch! (theorem of conservation of difficulties)
- System matrices in BEM are **dense, non-affine and highly oscillatory!**
- Use MoR IGA-BEM to reduce computational cost

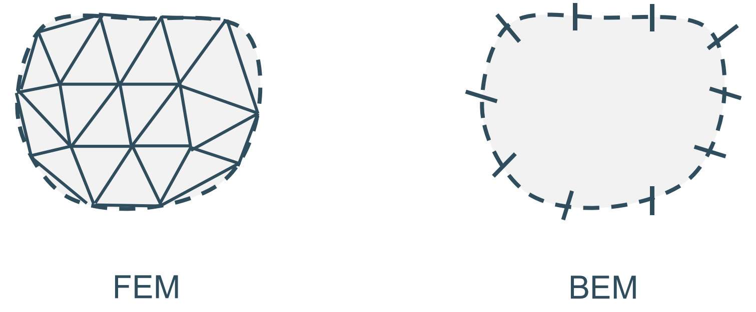

Figure 1: Overview of numerical methods

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Project Status

Current Progress

- Implementation of IGA-iBEM framework for multiple non-conforming patches

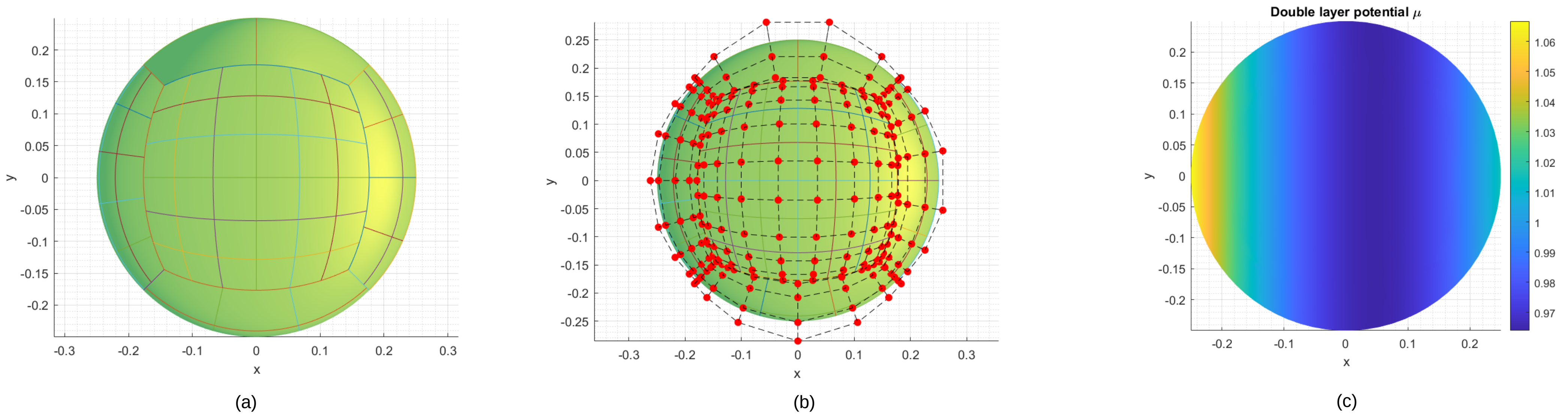

Figure 2.: (a) non-conforming multipatch geometry; (b) multipatch geometry with controlpoints; (c) double layer μ potential

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European Commission

Thank you!

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