Seminar in Spring Semester 2010

Boundary Element Methods

Supervisors	: Prof. R. Hiptmair
	: Dr. L. Kielhorn
Venue	: HG G 26.3
Time	: Mon 13-15
Language	: English
First session	: Mon, Oct 8, 2012
Prep meeting	: Mon, Sep 17, 2012, 13:15, HG G 26.3
Contact	: R. Hiptmair, hiptmair@sam.math.ethz.ch
Prerequisites	: Knowledge about numerical methods for PDEs as conveyed in the course *Numerical methods for elliptic partial differential equations*
Audience	: MSc Students of Mathematics, RW/CSE

Description:

Boundary value problems for linear differential operators with constant coefficients can often be recast as boundary integral equations for unknown traces of the solution. Boundary element methods seek to approximate these traces by means of piecewise polynomial trial functions. To obtain discrete equations one may employ the Galerkin approach, collocation, or numerical quadrature (Nyström method).

Presentations:

The seminar will comprise up to 20 student presentations of a duration of about 30 minutes. They should be partly based on PDF slides prepared using the BEAMER LATEXpackage (or LATEXbased tools under MacOS). The presentations should be done using a laptop computer (which can be provided). Speakers are advised to elaborate technical manipulations and proofs on the blackboard. MATLAB demonstration of simple numerical experiments is expected whenever appropriate. The lecture slides in PDF format should be made available immediately after the presentation.

Quizz:

Participants of the seminar will be asked questions about the previous presentations at the beginning of each session.

Available topics:

1. Sobolev spaces [SS10, Sect. 2.3], [Ste08, Sect. 2.2, 2.3, 2.4],

2. Trace spaces for 2nd-order elliptic BVPs [McL00, pp. 96-105], [Ste08, Sect. 2.5], [SS10, Sect. 2.4.1 & Sect. 2.6].

3. Fundamental solutions [Ste08, Sect. 5.1, Sect. 5.4]

4. Newton potential [Ste08, Sect. 6.1], [SS10, Sect. 3.1.1]

5. Potentials and jump relations [SS10, Sect. 3.3.1], [McL00, pp. 202-]

6. Boundary integral operators [SS10, Sect. 3.1.2]

7. Double layer boundary integral operators: explicit representations [SS10, Sect. 3.3.3], [Ste08, Sect. 6.3, 6.4]

8. The hypersingular operator [Ste08, Sect. 6.5]

9. Ellipticity [Ste08, Sect. 6.6.1, 6.6.2]

10. Contraction estimates [Ste08, Sect. 6.6.4], [SS10, Sect. 3.8]

11. Indirect boundary integral equations [SS10, Sect. 3.4.1] [SS10, Sect. 3.5.1]

12. Direct boundary integral equations [SS10, Sect. 3.4.2], [Ste08, Sect. 7.3], [SS10, Sect. 3.5.1/3.5.2]

13. Calderón projector [SS10, Sect. 3.6]

14. Combined field integral equations [SS10, Sect. 3.9.4]

15. Single trace formulation for transmission problems [CHJH12]

16. Coupling of BIE and volume variational formulation [Cos87, Ste11]

17. Galerkin discretization [Ste08, Ch. 8]

18. Boundary elements [Ste08, Ch. 10]

19. Regularizing coordinate transformations ("Duffy trick") [SS10, Sect. 5.2], [Hac95, Sect. 9.4.1]

20. Numerical quadrature [SS10, Sect. 5.3]

Speakers and dates for presentations:

Date	Speakers	Topics #
8.10.2012	R. Hiptmair	1,2
22.10.2012	N. Schenk	3, 4
29.10.2012	I. Getzner	5, 6
5.11.2012	L. Grosheintz	7, 8
12.11.2012	R. Hiptmair	9, 10
19.11.2012	M. Molina	11, 12
3.12.2012	J. Zech	13, 15
10.12.2012	R. Hiptmair	16, 17
17.12.2012	J. Ridder	18, 19

References

[CHJH12] X. Claeys, R. Hiptmair, and C. Jerez-Hanckes. Multi-trace boundary integral equations. Report 2012-20, SAM, ETH Zürich, Zürich, Switzerland, 2012.

[Cos87] M. Costabel. Symmetric methods for the coupling of finite elements and boundary elements. In C.A. Brebbia, W.L. Wendland, and G. Kuhn, editors, *Boundary Elements IX*, pages 411–420. Springer-Verlag, Berlin, 1987.

[Hac95] W. Hackbusch. *Integral equations. Theory and numerical treatment.*, volume 120 of *International Series of Numerical Mathematics*. Birkhäuser, Basel, 1995.

[McL00] W. McLean. *Strongly Elliptic Systems and Boundary Integral Equations*. Cambridge University Press, Cambridge, UK, 2000.

[SS10] S. Sauter and C. Schwab. *Boundary Element Methods*, volume 39 of *Springer Series in Computational Mathematics*. Springer, Heidelberg, 2010.

[Ste08] Olaf Steinbach. *Numerical approximation methods for elliptic boundary value problems*. Springer, New York, 2008. Finite and boundary elements, Translated from the 2003 German original.

[Ste11] O. Steinbach. A note on the stable one-equation coupling of finite and boundary elements. *SIAM J. Numer. Anal.*, 49(4):1521–1531, 2011.