Curriculum Vitae

RNDr. Pavel Kůs, Ph.D.

Date of birth: Feb 24, 1982, Prague, Czech Republic
Email: kus@math.cas.cz

Research interests

Numerical analysis: numerical solution of partial differential equations, finite element method, mesh adaptivity, domain decomposition, eigenvalue solvers

High-performance computing: efficient implementation of large-scale parallel algorithms using MPI, node-level performance, GPU computing, task-based approaches

Scientific software development with focus on maintainability, re-usability and reproducible science

Applications: coupled problems in electrical engineering, computational fluid dynamics, materials science

Professional experience

2020–present Researcher, Institute of Mathematics, Academy of Sciences CR, Prague, Czech Rep.

2016–2019 HPC expert, Max Planck Computing and Data Facility, Muenchen, Germany

2015–2016 Post-doc, Institute of Mathematics, Academy of Sciences CR, Prague, Czech Rep.

2012–2015 Post-doc, Faculty of Electrical Engineering, University of West Bohemia, Pilsen, Czech Rep.

2009–2012 Software Developer, S-cape, Prague, Czech Rep.

2007–2013 Junior Researcher, Institute of Thermomechanics, Academy of Sciences CR, Prague, Czech Rep.

2007–2011 Junior Researcher, Institute of Mathematics, Academy of Sciences CR, Prague, Czech Rep.

2006–2007 Teaching assistant, University of Texas at El Paso, USA

Education

2006–2011 Doctoral study of computational mathematics, Faculty of Mathematics and Physics, Charles University, Prague, Czech Rep. Doctoral thesis: Automatic hp-adaptivity on meshes with arbitrary-level hanging nodes in 3d, supervised by doc. RNDr. Tomáš Vejchodský, Ph.D

2006–2007 Graduate studies of mathematics at University of Texas at El Paso

2001–2006 Faculty of Mathematics and Physics, Charles University, Prague, Czech Rep. Master thesis: Solution of convection-diffusion equations with adaptive methods of higher order in space and time, Supervised by prof. RNDr. Vít Dolejší, Ph.D

Research visits

2014–2015, 3x, total 4 months International Centre for Numerical Methods in Engineering (CIMNE), Universitat Polytecnica de Catalunya, Barcelona, Spain. Host Santiago Badia, Department of High Performance Scientific Computing

2007, 3 months Computer Science Research Institute (CSRI), Sandia National Laboratories, Albuquerque, New Mexico, USA. Host Pavel Bochev, Group of Compatible Discretizations

Selected external collaborations

2016–present Max Planck Institute for Polymer Research, Mainz, Germany. Group of Torsten Stuehn, improvements of domain decomposition strategies of molecular dynamics simulations.

2018–present National Institute for Research in Digital Science and Technology (INRIA), Strasbourg, France. Berenger Bramas, task-based HPC strategies.

2019–present Max Planck Institute for Physics, Muenchen, Germany. Stefan Stonjek, using machine learning techniques for track reconstruction of the ATLAS data.

Participation at conferences and publications

- Active participation at more than 30 scientific conferences in Europe, USA and Asia
- Co-author of 16 journal publications and 11 papers in conference proceedings
- Co-editor of PANM 18 and PANM 19 proceedings; regular reviewer for various journals
- Scopus: 189 citations, h-index 7; Google Scholar: 313 citations, h-index 8

Co-organization of conferences

ESCO 2014, PANM 14 (2008), FEMTEC 2006, PANM 18 (2016), PANM 19 (2018)

Teaching

2012–2015 Faculty of Electrical Engineering, University of West Bohemia, Pilsen: mathematical modeling in electrical engineering; applications of theoretical electro-magnetism

2006–2007 University of Texas at El Paso, USA: calculus and linear algebra courses

Supervisor for 1 master student (defended 2014), 1 Ph.D. student

Research grants

2020–2022 Adaptive methods for the numerical solution of partial differential equations: analysis, error estimates and iterative solvers (GAČR 20-01074S); team member

2019-2020 Advanced incompressible flow simulations for vortex identification (OPEN-17-40), computer time at IT4Innovations

2018–2020 Advanced flow-field analysis (GAČR 18-09628S); team member

2018–2019 High-resolution flow simulations for vortex identification, computer time at IT4Innovations

2016–2019 ELPA-AEO (Eigenwert-Löser für Petaflop-Anwendungen: Algorithmische Erweiterungen und Optimierungen), BMBF Project 01IH15001; post-doc position

2015–2016 Multilevel Domain Decomposition Solvers for Incompressible Flows, computer time at the National Supercomputing Center IT4Innovations; team member

2012–2015 EXLIZ (Excellence of human resources as basis for the competition ability), European Union project CZ.1.07/2.3.00/30.0013; post-doc position

2011–2015 New adaptive higher-order monolithic methods for numerical solution of evolutionary multiphysics problems in electrical engineering (GAČR P102/11/0498); team member

2007–2011 Methods of higher order of accuracy for solution of multi-physics coupled problems (IAA100760702); team member

Languages

Czech – native, English – fluent, German – intermediate, Spanish – elementary

Computer skills

- professional knowledge: C/C++, Linux
- advanced knowledge: Fortran, MPI, OpenMP, Matlab, Python, Cuda C, LaTeX
- working experience: Git, SVN, CMake, Make, matplotlib, ParaView, Keras

Computational software projects

ELPA (2016–present) Eigenvalue SoLvers for Petaflop-Applications, extremely scalable direct eigenvalue solver, developed by consorcium led by Max Planck Computing and Data Facility. Used in many electronic structure and material science codes. My role is to incorporate new mathematical and algorithmic ideas and optimize HPC-related software aspects of the code including the use of GPUs.

ESPResSo++ (2016–present) A parallel C++ code for molecular-dynamics simulations developed at Max Planck Institute for Polymer Research. Among other things I implemented variable cell sizes throughout the distributed grid to speed-up solution of problems with heterogeneous structure.

FEMPAR (2014) Extremely scalable domain-decomposition finite element library developed at CIMNE, Barcelona, Spain. I created prototype implementation of adaptive mesh refinement in the frame of domain decomposition.

Agros2D (2011–2015) A multi-platform application for the solution of physical problems based on the Hermes library, developed at the University of West Bohemia in Pilsen. I have implemented various physical fields (nonlinear magnetic harmonic, RF, flow, porous media flow, etc.) and field coupling. I have also implemented optimization algorithms and framework for shape and material multi-criteria optimization.

Transformer (2011–2012) Software for calculation of electromagnetic forces in the transformer window. Developed at Czech Technical University in Prague for a company ETD Transformers, Pilsen. I was responsible for the development of the FEM core of the application.

Intrepid (2007) Hierarchy of interoperable software tools developed in Sandia National Laboratories, Albuquerque, USA. I contributed to the implementation of the higher-order FEM functionality.

Hermes3D (2006–2013) An open-source multi-physics FEM solver developed formerly at University of Texas at El Paso, USA. My responsibility was to implement hexahedral meshes with arbitrary-level hanging nodes, higher-order basis functions and *hp*-adaptivity for elliptic and electromagnetic problems.

Journal publications

1. Kůs, P., Marek, A., Lederer, H., Caborgno, C., Kowalski, H. H., Scheurer, C., Koecher, S., Nemec, L.: *ELPA Eigensolver Library: Recent Optimizations for Modern Architectures*, Parallel Computing, 85, pp. 167-177, 2019.

2. Alvermann, A., Basermann, A., Bungartz, H.-J., Carbogno, C., Ernst, D., Fehske, H., Futamura, Y., Galgon, M., Hager, G., Huber, S., Huckle, T., Ida, A., Imakura, A., Kawai, M., Köcher, S., Kreutzer, M., Kus, P., Lang, B., Lederer, H., Manin, V., Marek, A., Nakajima, K., Nemec, L., Reuter, K., Rippl, M., Röhrig-Zöllner, M., Sakurai, T., Scheffler, M., Scheurer, C., Shahzad, F., Simoes Brambila, D., Thies, J., Wellein, G.: *Benefits from using mixed precision computations in the ELPA-AEO and ESSEX-II eigensolver projects* , Japan Journal of Industrial and Applied Mathematics, 36 (2), pp. 699-717, 2019.

3. Bramas, B., Kůs, P.: *Computing the sparse matrix vector product using block-based kernels without zero padding on processors with AVX-512 instructions*, PeerJ Computer Science 2018(4),e151, 2018

4. Kůs, P., Šístek, J.: *Coupling parallel adaptive mesh refinement with a nonoverlapping domain decomposition solver*, Advances in Engineering Software 110, pp. 34–54, 2017

5. Hierro, A., Badia, S., Kůs, P.: *Shock capturing techniques for hp-adaptive finite elements*, Computer Methods in Applied Mechanics and Engineering 309, pp. 532–553, 2016

6. Kůs, P., Šolín, P., Andrš, D.: *Arbitrary-level hanging nodes for adaptive hp-FEM approximations in 3D*, Journal of Computational and Applied Mathematics, 270, pp. 121–133, 2014

7. Di Barba, P., Doležel, I., Karban, P., Kůs, P., Mach, F., Mognaschi, M. E. , Savini, A.: *Multiphysics field analysis and multiobjective design optimization: A benchmark problem*, Inverse Problems in Science and Engineering, 22 (7), pp. 1214–1225, 2014

8. Mach, F., Štarman, V., Karban, P., Doležel, I., Kůs, P.: *Finite-element 2-D model of induction heating of rotating billets in system of permanent magnets and its experimental verification*, IEEE Transactions on Industrial Electronics, 61 (5), 6584800, pp. 2584–2591, 2014

9. Šolín, P., Korous, L., Kůs, P.: *Hermes2D, a C++ library for rapid development of adaptive hp-FEM and hp-DG solvers*, Journal of Computational and Applied Mathematics, 270, pp. 152–165, 2014

10. Karban, P., Mach, F., Kůs, P., Pánek, D., Doležel, I.: *Numerical solution of coupled problems using code Agros2D*, Computing, 95 (SUPPL.1), pp. S381–S408, 2013

11. Kotlan, V., Karban, P., Ulrych, B., Doležel, I., Kůs, P.: *Hard-coupled modeling of induction shrink fit of gas-turbine active wheel*, Studies in Computational Intelligence, 483, pp. 325–339, 2013

12. Mach, F., Kůs, P., Karban, P., Doležel, I.: *Optimization of the system for induction heating of nonmagnetic cylindrical billets in rotating magnetic field produced by permanent magnets*, Computing, 95 (SUPPL.1), pp. S537–S552, 2013

13. Mach, F., Kůs, P., Karban, P., Doležel, I.: *Higher-order modeling of electrostatic separator of plastic particles*, Przeglad Elektrotechniczny, 88 (12 B), pp. 74–76, 2012

14. Dubcová, L., Šolín, P., Červený, J., Kůs, P.: *Space and time adaptive two-mesh hp-FEM for transient microwave heating problems*, Electromagnetics, 30(1), pp. 23–40, 2010

15. Kůs, P., Šolín, P., Doležel, I.: *Solution of 3D singular electrostatics problems using adaptive hp-FEM*, COMPEL: The International Journal for Computation and Mathematics in Electrical and Electronic Engineering, 27(4), pp. 939–945, 2008

16. Dolejší, V., Kůs, P.: *Adaptive backward difference formula-Discontinuous Galerkin finite element method for the solution of conservation laws*, International Journal for Numerical Methods in Engineering, 73(12), pp. 1739–1766, 2008

Publications in conference proceedings

1. Kůs, P., Lederer, H., Marek, A.: *GPU Optimization of Large-Scale Eigenvalue Solver*, Numerical Mathematics and Advanced Applications: ENUMATH 2017, Lecture Notes in Computational Science and Engineering 126, pp. 123-131, 2019

2. Kůs, P.: *Convergence and stability of higher-order finite element solution of reaction-diffusion equation with Turing instability*, Proceedings of Applications of Mathematics 2015, pp. 140–147, 2015

3. Mach, F., Kuthanová, J., Mizerová, K., Karban, P., Kůs, P., Doležel, I., Polanský, R.: *Model-based determination of nonlinear material parameters of metals with low melting points*, Industrial Electronics Society, IECON Proceedings (Industrial Electronics Conference) 7048975, pp. 3240–3245, 2014

4. Mach, F., Kůs, P., Karban, P., Doležel, I.: *Separation of plastic particles in electrostatic field produced by electrodes of optimized shape*, Komunikacie 15 (2 A), pp. 40–45, 2013

5. Kotlan, V., Kůs, P., Doležel, I.: *Thermoelastic friction clutch and its operation characteristics*, ICEMS 2012 - Proceedings: 15th International Conference on Electrical Machines and Systems, 2012

6. Kůs, P., Mach, F., Karban, P., Doležel, I.: *Genetic algorithms for multicriteria shape optimization of induction furnace*, AIP Conference Proceedings 1479 (1), pp. 2344–2347, 2012

7. Mach, F., Kůs, P., Karban, P., Doležel, I.: *Optimized arrangement of device for electrostatic separation of plastic particles*, Proceedings of 9th International Conference, ELEKTRO 2012, pp. 431–434, 2012

8. Kůs, P., Kotlan, V., Karban, P., Doležel, I.: *Nonlinear coupled problems solved by hp-FEM*, AIP Conference Proceedings 1389, pp. 1948–1951, 2011

9. Kůs, P.: *Integration in higher-order finite element method in 3D*, Proc. PANM 2010, Dolní Maxov, pp. 131–136, 2010

10. Kůs, P., Šolín, P., Doležel, I.: *On Adaptive hp-FEM with Arbitrary-Level Hanging Nodes in 3D*, Proc. ENUMATH 2007, Graz, Austria, 2007 (CD-ROM)

11. Kůs, P., Dolejší, V.: *Solution of time-dependent convection-diffusion equations with the aid of higher order adaptive methods with respect to space and time*, Proc. PANM 2006, Prague, 2006