JOOYOUNG HAHN

Faculty of Civil Engineering
Slovak University of Technology

Project number
2140/01/01

Project duration
2/2022 - 1/2025

BIOGRAPHY

Jooyoung Hahn finished his PhD degree in 2008 and continued to his career of numerical image processing and computer vision as a research fellow in Nanyang Technological University, Singapore, from 2008 to 2010 and as a senior postdoctoral research fellow in Karl Franzes University Graz, Austria from 2010 to 2012. He joined AVL List GmbH in 2012 and contributed new development of numerical algorithms to solve partial differential equations on polyhedral meshes in the level of industrial application until 2021. In 2022, he started the SASPRO 2 fellowship in Slovak University of Technology in Bratislava.

"For the last ten years to work in the development of CFD software for industrial problems, it is a pity to observe that many well-studied numerical theories and algorithms in mathematics have difficulties to be applied directly to application problems. Private companies usually do not have enough time to check all details of numerical correctness and develop new algorithms and restrictions or difficulties in the development of an algorithm are usually limited inside. Therefore, from an academic side, industrial problems are unclear to know what are meaningful methods to solve in a real-world situation.
From my humble working experience in the academic and industrial sides, I would like to reduce the gap between the two sides in terms of solving partial differential equations for industrial problems. For such a purpose, SASPOR 2 provides the best format to achieve the mentioned goal. For the upcoming three years, we would like to strengthen the channel of communication with industries in a mutual sense. We focus on the development of reasonable solutions for industrial problems, which also bring good accomplishment in the computational community in mathematics and engineering. "

PROJECT SUMMARY

Numerical Methods for Computational Evolving Manifolds

The proposed project aims to develop new highly original, efficient, and accurate numerical methods for computational evolving manifold (CEM) brought about complicated industrial applications. The methods will bring breakthroughs in many branches of basic and applied science and technology such as multiphase flow (or combustion engine simulation) in computational fluid dynamics, geometric optics, surface reconstruction in medical image processing, rechargeable electric battery, optimal triangulations of surfaces or general domains in computational geometry, 3D mesh generation of complex shapes, etc. Designing novel numerical methods for CEM will be achieved by new viewpoints of limitations of two standard numerical methods; Eulerian and Lagrangian approaches for CEM. More importantly, realizing the complexity of industrial problems and accepting the restriction caused by the practical examples in real business will bring more precise insight into developing new algorithms based on theoretical ideas from numerical analysis and differential geometry and overcoming the limitations of standard methods.
Deep mathematical foundations in the proposed project also support insightful resolutions of the challenging objectives directly realized in the software industry of computational fluid dynamics and medical image processing. The proposed project reasonably brings the interdisciplinary nature of NMCEM which will make a high-impact research endeavour of solving interesting questions of real-life science in a long-term vision, such as how to reduce fuel consumption and greenhouse gas emissions, how to smartly plan for surgery of removing kidney stones, how to improve the stability of rechargeable battery in an electric vehicle, or how to overcome the industrial level of difficulties in the three-dimensional mesh generation.

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PUBLICATIONS

1. X.-C. Tai, **J. Hahn,** and G. J. Chung, A fast algorithm for Euler's elastica model using augmented Lagrangian method, 2011, SIAM Journal on Imaging Sciences, v4, 313-344. [PDF]

2. **J. Hahn**, C. Wu, and X.-C. Tai, Augmented Lagrangian method for generalized TV-Stokes model, 2012, Journal of Scientific Computing, v50, 235-264. [PDF]

3. M. Hintermüller, C. Rautenberg, and **J. Hahn**, Functional-analytic and numerical issues in splitting methods for total variation-based image reconstruction, 2014, Inverse Problems, v30, 055014. [PDF]

4. **J. Hahn**, K. Mikula, P. Frolkovič, and B. Basara, Inflow-based gradient finite volume method for a propagation in a normal direction in a polyhedron mesh, 2017, Journal of Scientific Computing, v72, 442-465. [PDF]

5. **J. Hahn**, M. Medľa, K. Mikula, P. Frolkovič, and B. Basara, Iterative inflow-implicit outflow-explicit finite volume scheme for level-set equations on polyhedron meshes, 2019, Computers & Mathematics with Applications, v77, 1639-1654. [PDF]

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