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Shashank Jaiswal
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Education

Purdue University, West Lafayette
PhD in Aeronautics and Astronautics,
Focus: Design of numerical schemes for PDEs, CGPA : 3.89/4.0 ..... May'18 - May'21

MS in Physics and Astronomy,
Major: Quantum Information Science, CGPA: 3.80/4.0 ..... Aug'19 - May'21

MS in Aeronautics and Astronautics,
Major: Aerodynamics, CGPA : 3.88/4.0 ..... Aug'16 - May'18

Indian Institute of Technology (IIT), Hyderabad
B.Tech in Mechanical Engineering (Honors),
Focus: Computational Fluid Dynamics, CGPA : 8.28/10.0 ..... Aug'12 - May'16

Work Experience

Altair Engineering, Troy, MI ..... 17 May'21 - Present
Sr. Software Developer - High Performance Computing
Development of multi-threaded asynchronous event-driven systems for job-scheduling and resource allocation.

Mentor Graphics (Siemens), Wilsonville, OR ..... 6 May'19 - 6 Sep'19
R&D Calibre Design-to-silicon Intern with *Dr. Fedor Pikus (Chief engineering scientist)*
Research in development of quantum algorithms for Electronic Design Automation (EDA) [1,2]. A part of the work focused on design, analysis, and evaluation of quantum approximate optimization based algorithms for addressing non-planar graph problems in EDA space.

Research interests

High performance computing, Quantum computing, Augmented Reality, Computational Fluid Dynamics, Finite elements, Numerical methods for PDEs, Numerical relativity.

Patents

[1] F. G. Pikus and **S. Jaiswal**, Limited basis quantum particle definitions in applications of quantum computing to electronic design automation processes, (2020), US Patent 10,846,448.

[2] F. Pikus and **S. Jaiswal**, Adaptive penalty term determinations in applications of quantum computing to electronic design automation processes. (2020), US Patent App. 16/688,028

Monographs

[3] S. Jaiswal, *Isogeometric schemes in rarefied gas dynamics context,* Computer Methods in Applied Mechanics and Engineering **383**, 113926 (2021).

[4] S. Jaiswal, *Non-linear Boltzmann equation on unstructured-hybrid non-conforming multi-domains,* Journal of Computational Physics (2021), Accepted

Skills

Programming: C++, Python, Tcl, MPI, CUDA, Linux
Scientific computing: Discretization for PDEs, Quantum algorithms, Parallel/distributed algorithms
Specific Tools: Tensorflow, PyTorch, Unity, Qiskit, OpenFOAM, ZeroMQ

- Experience with programming in Python, C++ (8+ years).
- Experience with PDE based machine-learning models (optimal transport viewpoint).
- Experience with development of quantum algorithms and quantum software stacks.
- Experience with parallel computing: MPI, CUDA, OpenMP, JAX.
- Experience with development of numerical schemes for solving partial differential equations (PDE).
- Experience with finite element, isogeometric schemes, multi-physics design, simulation, and analysis.
- Experience with writing performance portable codes, profiling (LLVM sanitizers, valgrind, udb, gdb).
- Proficient working in a Linux/UNIX environment; git/subversion/p4, build/test systems, testing/release processes.

Research Experience

Development of high-performance deterministic full Boltzmann solvers ..... Jan'17 - Present
Research Assistant with *Prof. Alina Alexeenko, and Prof. Jingwei Hu, Purdue University*

Created a numerical scheme, termed discontinuous Galerkin fast spectral (DGFS), for solving full-Boltzmann equation with general collision-kernels on massively parallel CPU/GPU architectures. More specifically:

a) Developed an $O(N^4 \log N)$ algorithm (fastest known) for solving multi-species Boltzmann collision operator [5]

b) Developed an efficient, robust, and highly-accurate deterministic method for general 1D/2D/3D flows[6]

c) Implemented and demonstrated a parallel efficiency of 0.96-0.99 on 36 GPUs for flows involving ∼5 billion unknowns[7]

d) Applied these theoretical mathematical ideas for solving actual engineering flow problems involving 10^{12} unknowns[8]

For both single/multi species non-equilibrium rarefied flows, this is the first deterministic Boltzmann solver for ***general*** repulsive interactions, including, the well known Variable Soft Sphere model—necessary for simulating flows involving diffusive transport (Project Lead, Sole Developer, Only student involved).

Distinctions

- Awarded **ACM SIGHPC Travel Grant for PASC'19** (1/4 awardees internationally, 1/2 awardees outside EU), 2019.
- At 22, I co-wrote the first **National Science Foundation (NSF CDS&E #1854829)** proposal for ∼ $0.35 million based on my Masters research work, 2018. Purdue University, West Lafayette.
- Awarded **Undergraduate Research Excellence** (among ∼ 1% of the batch), 2016. Indian Institute of Technology, Hyderabad.
- **All India Rank 1335** among ∼ 1.3 million examinees (top ∼ 0.1%), in All India Engineering Entrance Examination (AIEEE), 2012.

Open source codes (as principle developer)

dgfs1D: Discontinuous Galerkin fast spectral (https://github.com/jaisw7/dgfs1D_gpu) ..... Released: Jan'19

A multi-CPU/multi-GPU research code for solving single/multi-species 1D-3V full Boltzmann equation. This code achieved a parallel efficiency of 99% on 36 GPUs[7].

frfs: Flux-reconstructed fast spectral (https://github.com/jaisw7/frfs) ..... Released: Dec'19

A multi-CPU/multi-GPU research code for solving single/multi-species full 3D-3V Boltzmann equation.

Publications

[5] **S. Jaiswal**, A. A. Alexeenko, and J. Hu, *A discontinuous Galerkin fast spectral method for the multi-species Boltzmann equation.* Computer Methods in Applied Mechanics and Engineering **352**, 56 (2019).

[6] **S. Jaiswal**, A. A. Alexeenko, and J. Hu, *A discontinuous Galerkin fast spectral method for the full Boltzmann equation with general collision kernels.* Journal of Computational Physics **378**, 178 (2019).

[7] **S. Jaiswal**, J. Hu, J. K. Brillon, and A. A. Alexeenko, *A discontinuous Galerkin fast spectral method for multi-species full Boltzmann on streaming multi-processors,* in *Proceedings of the Platform for Advanced Scientific Computing Conference*, PASC '19 (ACM, 2019) pp. 4:1–4:9.

[8] **S. Jaiswal**, A. Pikus, A. Strongrich, I. B. Sebastião, J. Hu, and A. A. Alexeenko, *Quantification of thermally-driven flows in microsystems using Boltzmann equation in deterministic and stochastic contexts.* Physics of Fluids **31**, 082002 (2019), [Invited].

[9] **S. Jaiswal**, J. Hu, and A. A. Alexeenko, *Fast deterministic solution of the full boltzmann equation on graphics processing units,* AIP Conference Proceedings **2132**, 060001 (2019).

[10] **S. Jaiswal**, I. B. Sebastião, A. Strongrich, and A. A. Alexeenko, *FEMTA micropropulsion system characterization by DSMC,* AIP Conference Proceedings **2132**, 070006 (2019).

[11] **S. Jaiswal**, I. B. Sebastião, and A. A. Alexeenko, *DSMC-SPARTA implementation of M-1 scattering model,* AIP Conference Proceedings **2132**, 070023 (2019).

[12] A. Pikus, I. B. Sebastião, **S. Jaiswal**, M. Gallis, and A. A. Alexeenko, *DSMC-SPARTA implementation of majorant collision frequency scheme,* AIP Conference Proceedings **2132**, 070026 (2019).

[13] **S. Jaiswal**, R. Reddy, R. Banerjee, S. Sato, D. Komagata, M. Ando, and J. Okada, *An efficient GPU parallelization for arbitrary collocated polyhedral finite volume grids and its application to incompressible fluid flows.* in *23rd IEEE High Performance Computing Workshop* (IEEE, 2016).

[14] S. Holay, R. Reddy, **S. Jaiswal**, and R. Banerjee, *High fidelity simulations of binary collisions of liquid drops.* in *18th Annual Conference on Liquid Atomization and Spray Systems* (ILASS, 2016).

[15] **S. Jaiswal** and N. Dongari, *Implementation of Knudsen layer effects in open source CFD solver for effective modeling of microscale gas flows.* in *Proceedings of 1st International ISHMT-ASTFE and 23rd National Heat and Mass Transfer conference* (ISHMT-ASTFE, Kerala, India, 2015)