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SAFT: shotgun advancing front technique for massively parallel mesh generation on graphics processing unit

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Statement of the Problem: Large-scale numerical simulations need efficient parallel mesh generation schemes. Several parallel advancing front algorithms were proposed in the past decades, most of which utilize computer clusters and involve hundreds of CPU cores. The limited number of threads makes it difficult to realize massively parallel mesh generation. More importantly, previous works require domain decomposition, making it difficult to develop a fully automated workflow.

Methodology & Theoretical Orientation: We present a shotgun algorithm for parallel advancing front mesh generation. Our algorithm is front-based, therefore does not require domain decomposition. With the help of CUDA C++, we've successfully implemented the algorithm on GPU, which has thousands of CUDA cores. Different from traditional volume-based parallelization, each CUDA thread handles one face at a time.

Findings: The algorithm is implemented using CUDA C++ (code available online). Tested on a personal laptop, we have been able to generate 72.7M triangular elements in 7 minutes (≈176k elements per second).

Biography

Qingyi Zhou was born in Beijing, China, in 1997. He received the B.S. degree in electronic engineering from Peking University, Beijing, China, in 2019. He then joined the University of Wisconsin-Madison in 2020. Currently he serves as a research assistant in Prof. Zongfu Yu's lab, and is working toward the Ph.D. degree in electrical and computer engineering. His research interests include electromagnetic simulation, inverse design of novel photonic devices, as well as optical fiber communication. Recently he has been working towards developing robust FDTD algorithm for handling multi-physics problems.