Leveraging High-Performance Computing for Global Scale Underwater Acoustics Simulations

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Computer simulations have emerged as a powerful tool for comprehending complex phenomena in various fields of science and engineering. Ocean acoustics, owing to the variability and intricate nature of the ocean landscape, is one such field that stands to benefit significantly from the utilization of computer simulations. Solving the wave equation, both time-dependent and time-independent, is the most straightforward method for understanding wave propagation [1]. However, this approach can be computationally demanding, especially in three-dimensional (3D) cases, resulting in the development of several modeling techniques, including deep neural networks (DNNs) [2]. Although these models are highly effective, they lack the flexibility to operate under marginal or extreme conditions. On the other hand, solving the wave equation, so to speak an "ab-initio" approach, remains the most reliable means of understanding wave propagation. Against this backdrop, high-performance computing (HPC) has the potential to revolutionize wave equation solvers [3]. In this presentation, we discuss our endeavours and achievements concerning parabolic equation (PE) and a Ying-Yang Grid finite-difference time-domain (FDTD) solvers. For instance, our 2D-PE method achieved a 110-fold speedup to a one-core CPU using four Nvidia V100 GPUs, while our FDTD solver achieved a 400-fold speedup. These achievements represent significant progress towards developing efficient and reliable underwater acoustic simulation tools that can operate at a global scale.

Keywords: parabolic equation; Ying-Yang Grid finite-difference time-domain; GPU; High-performance computing; global-scale underwater acoustics.

References

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