Recent Developments in Quantum-CFD

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ABSTRACT

Quantum Computing[1] is an emerging compute technology that has the potential to revolutionize the field of Computational Fluid Dynamics as radically as the advent of modern microprocessors in the late 1960s. Quantum computing draws its unparalleled power from the exploitation of quantum mechanical effects like quantum superposition, quantum entanglement, and quantum parallelism. The clever utilization of these concepts in Quantum-CFD (QCFD) algorithms creates the potential for an exponential speed up over classical methods leading, in turn, to a drastic reduction of the computing time or a significant increase of the level of detail beyond what is thinkable with even exascale computer systems. Early work[2-6] shows promise, but it is also clear that much research work is still required to make practical applications of QCFD a reality.

The power of quantum computing namely comes at the cost of rethinking traditional CFD approaches and revising them to exploit quantum superposition, entanglement, and parallelism. In addition to that, the classical way of thinking in terms of pre-processing, calculation, and post-processing needs to be overcome as any potential advantage of quantum computing is scotched if a full read-out of the flow field is performed. In addition, the cost of (repeated) initialization of the quantum state in the quantum processor poses significant challenges. Last but not least, reproducible deterministic flow calculations will become a thing of the past as quantum computing is intrinsically probabilistic.

This minisymposium aims at bringing together early adopters of quantum computing and CFD experts to discuss recent developments in Quantum-CFD. We welcome contributions on QCFD algorithms with long-term perspective, complexity theoretical results, as well as practical implementations of algorithms on Noisy and Intermediate-Scale Quantum computers. To make this minisymposium accessible for non-quantum experts, we will open it with an introductory keynote presentation covering the basic concepts of quantum computing and reviewing the history of QCFD.

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