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ON CPU AND GPU PARALLELIZATION OF VM2D CODE FOR 2D FLOWS SIMULATION USING VORTEX METHOD

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VM2D [1] is an open-source software being developed by the authors for two-dimensional incompressible flows simulations around airfoils using vortex methods. Their range of applicability is limited by low subsonic Mach numbers, when compressibility influence can be neglected. Vortex methods can be very efficient in comparison with mesh methods due to the fact that vortex methods are purely Lagrangian meshfree methods. The primary computed variable is vorticity which is usually concentrated in compact domain around and behind the airfoil and its evolution can be simulated by using efficient meshfree methods, i.e., Viscous Vortex Domain method [2]. Vorticity generation on the airfoil surface line provides the boundary condition satisfaction (boundary integral equation [3]).

The main operations of the VM2D algorithm are pointed out, and the estimations of their computational complexity are given. The ratio between the computational complexities of the operations can vary significantly for different problems. Two model problems with different parameters are considered in order to analyze the ratio between computational complexities of the operations. Parallel algorithms are implemented for all time- consuming operations to perform the simulations on CPU and GPU. Test problems show that VM2D is efficiently parallelized; the accelerations achieved on GPUs are comparable to acceleration on hundreds and even thousands of CPU cores.

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