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Automatic Quad Mesh Generation Using Level-Set for CFD Simulation

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Quad meshing is a very well-studied domain for many years. Although the problem can generally be considered solved, many approaches do not provide adequate inputs for Computational Fluid Dynamics (CFD) and, in our case, hypersonic flow simulations. Such simulations require very strong monitoring of cell size and direction. To our knowledge, engineers do this manually with the help of interactive software. In this work we propose an automatic algorithm to generate full quadrilateral block structured mesh for the purpose of hypersonic flow simulation. Therefore, we propose the following method:
1. We first discretize the boundary of the hypersonic vehicle.
2. Then we build several distance fields (level-set) in order to drive the advancing front creation of block layers [?].
3. We extract a gradient field from one of the previously computed distance field an combine it with a constant vector field that represents the flow direction to produce the vector field that captures both wall orthogonality and the flow direction.
4. The scalar field and the vector field drive the creation of a quadrilateral block structure where we create each node block in an advancing-front manner.
5. We eventually generate cells by distinguish the first block layer where we control size transition and wall orthogonality [?] and the remaining blocks where we discretize blocks using a transfinite interpolation scheme in each block. Using this approach we can handle some simulation input like the angle of attack and the boundary layer definition. We will present here 2D results of computation on a hypersonic vehicle using the meshes generated by our method.
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