Importance based Streamline Generation Method on the Large CFD Dataset

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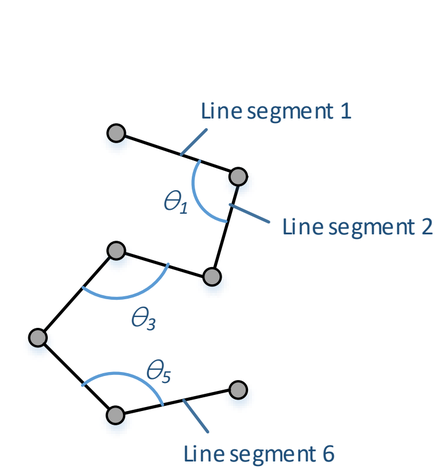
Introduction

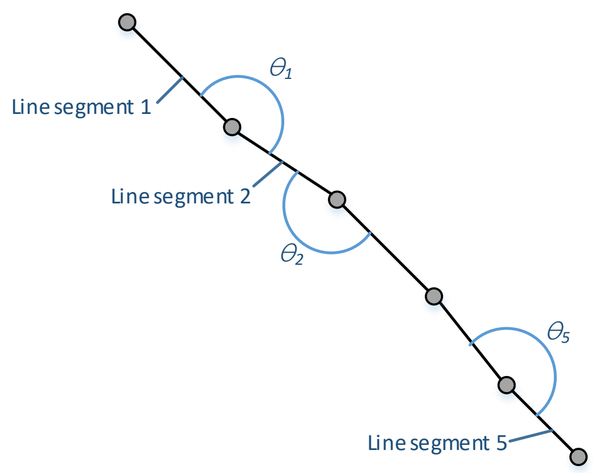
- Streamline is one of the most frequently used visualization methods to show flow in the fluid dataset
- It is a challenging problem to find streamlines which show the most prominent flows among plenty of possible streamlines
- Too many streamlines may produce visual clutters which occlude other visual objects
- We propose an effective seed location method to create streamlines which show important features while reducing visual clutter

Spirality

- Many domain scientists want to visualize vortex area of flow field which usually forms swirling streamlines
- We calculate spirality of each streamline by summing every included angle between consecutive two line segments
- Spirality of (a) is much higher than (b)



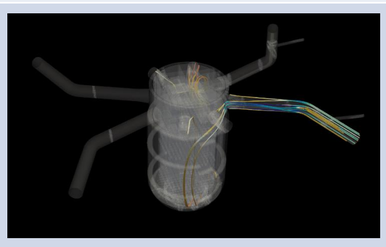
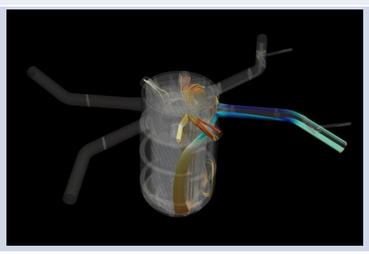
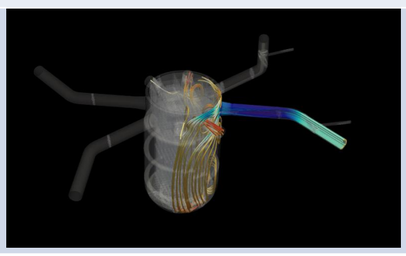
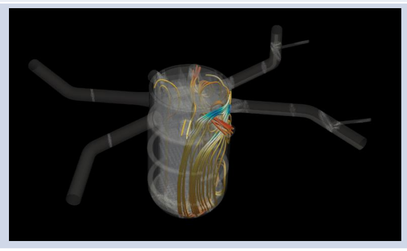
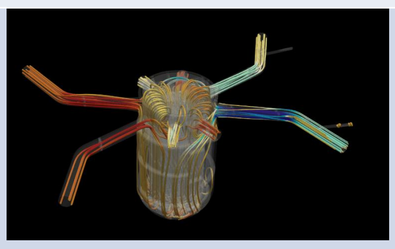
(a)



(b)

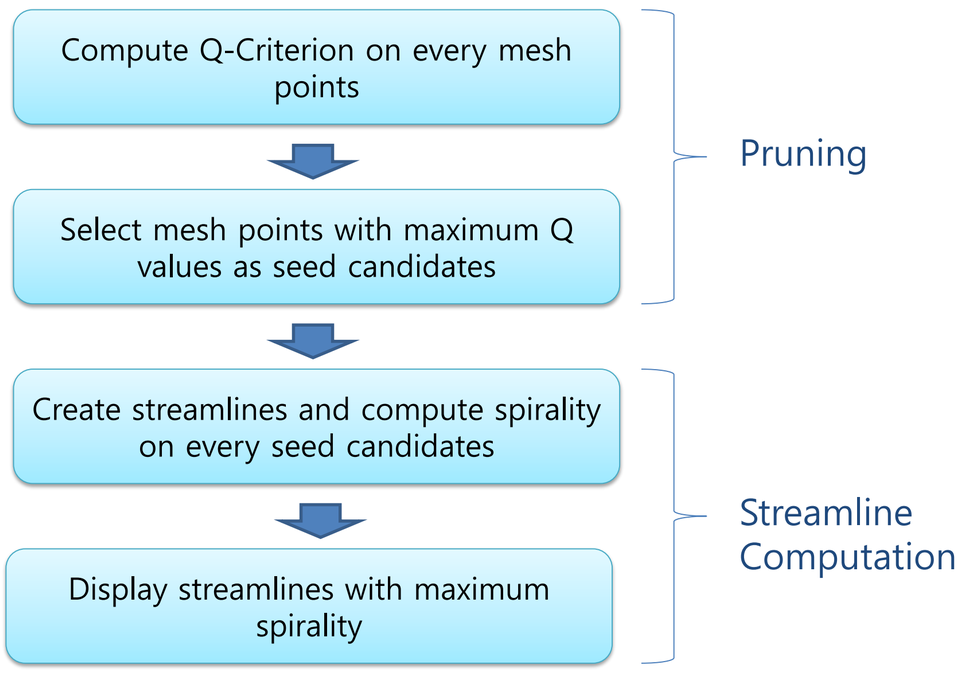
Importance Function

- We have considered several vortex criterion methods as an importance function because many domain scientists regard vortex (or wake) as an essential feature
- The traditional criteria create worse streamlines than proposed criterion

Vorticity	Helicity	Q-criterion	λ_2-criterion	Spirality
$\omega = \nabla \times V$	$h = (\nabla \times V) \cdot V$	$\frac{1}{2}\left(\lVert\Omega\rVert^2 - \lVert S\rVert^2\right) > 0$	$\lambda_2(S^2 + \Omega^2) < 0$	$\sum_{i=1}^{N-1} \cos\theta_i$
7.29	7.34	7.27	7.44	1298.59
				

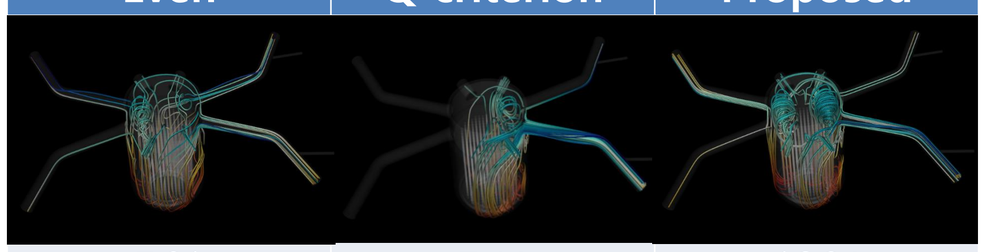
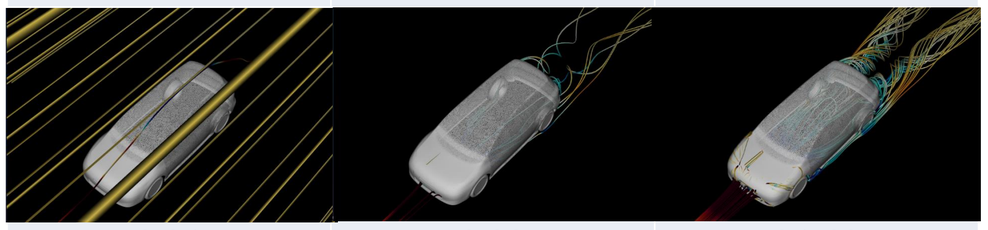
Pruning

- Spirality makes the best streamlines which shows prominent flows but needs too much computing time compared to other criteria because it needs create all streamlines
- We prune seed points with low Q-criterion value in the flow fields because they have less possibility to create highly swirling streamlines



Results

- We've got streamlines showing prominent flows with much less computation time

Even	Q-criterion	Proposed
		
7.01	7.44	16.84
		
8.21	8.83	21.62
		
6.16	7.40	12.55

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