

2015 4th OpenFOAM Korea
Users' Community Conference
(10-11 Sept. Hotel ICC)



선박 및 추진기의 SnappyHexMesh를 이용한 자동격자 생성 및 계산

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박 선 호

❖ Ansys Fluent, Star-CCM+, CFX를 이용한 선박의 저항 및 자항성

능, 추진기 캐비테이션 계산

▣ 2000년: Fluent + Gridgen

■ Double body

■ Free-surface

▣ 2010년: Star-CCM+

■ Free-surface with motion

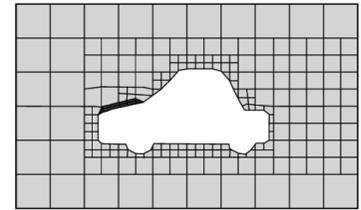
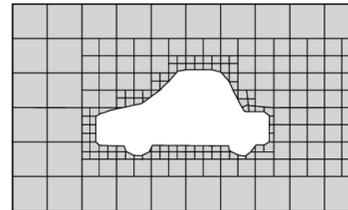
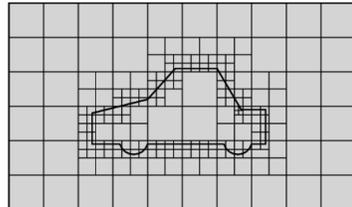
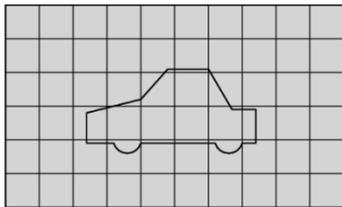
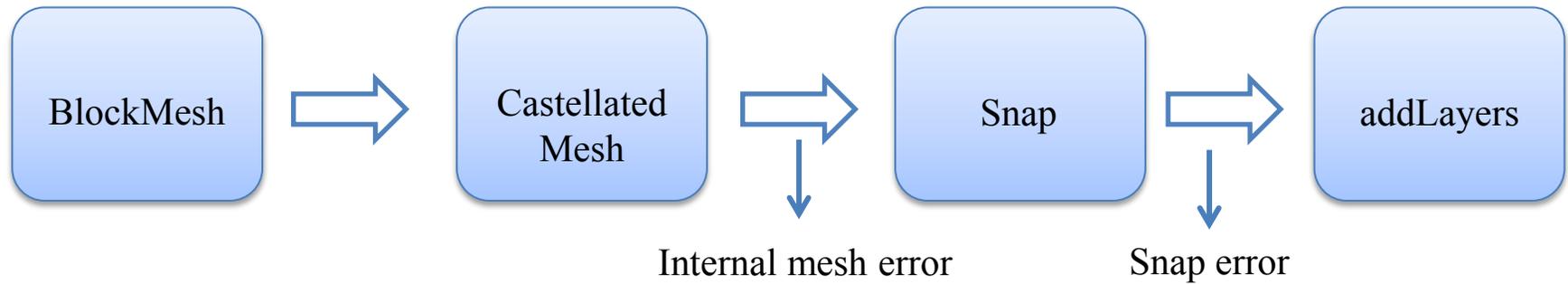
▣ 2020년: ??

- ❖ OpenFOAM을 이용한 선박 저항 및 추진기 계산
 - ▣ OpenFOAM에서 제공하는 격자 생성 및 solver의 검증
 - ▣ 상용코드와 정확도 비교
 - ▣ 사용코드와 사용자 편의 비교
 - ▣ 상용코드와 전처리 및 계산 시간 비교

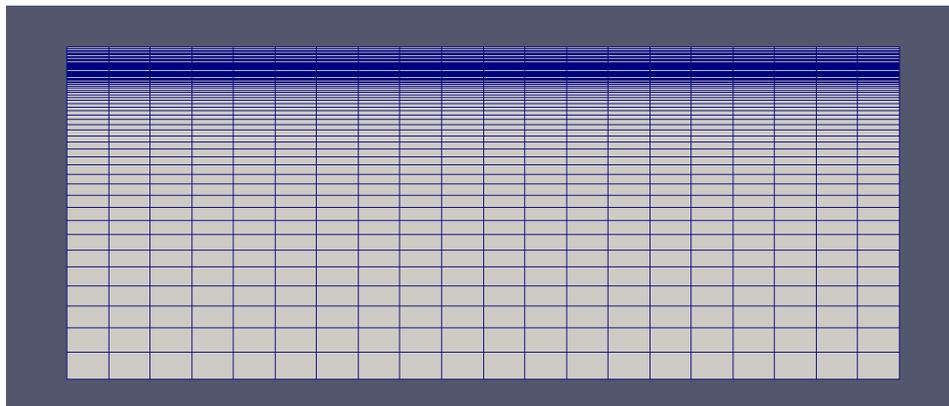
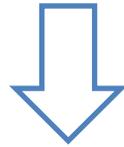
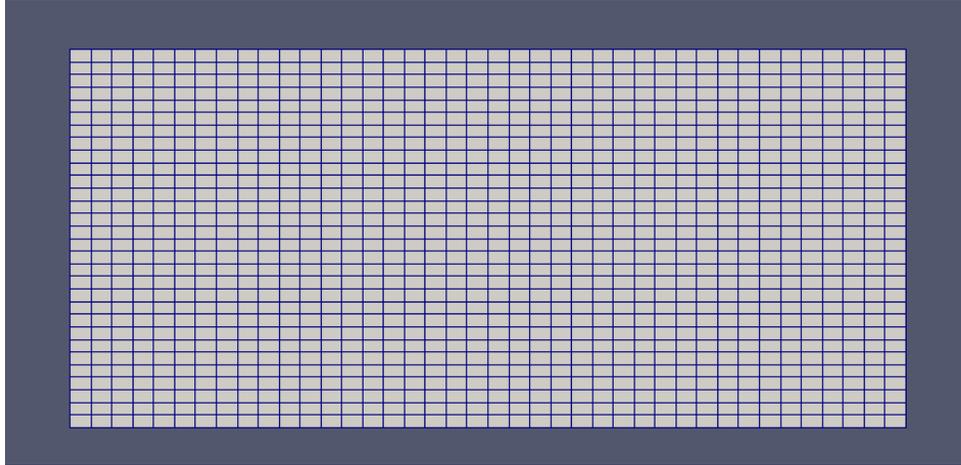
격자생성

❖ 격자생성: snappyHexMesh 사용

▣ stl파일 필요



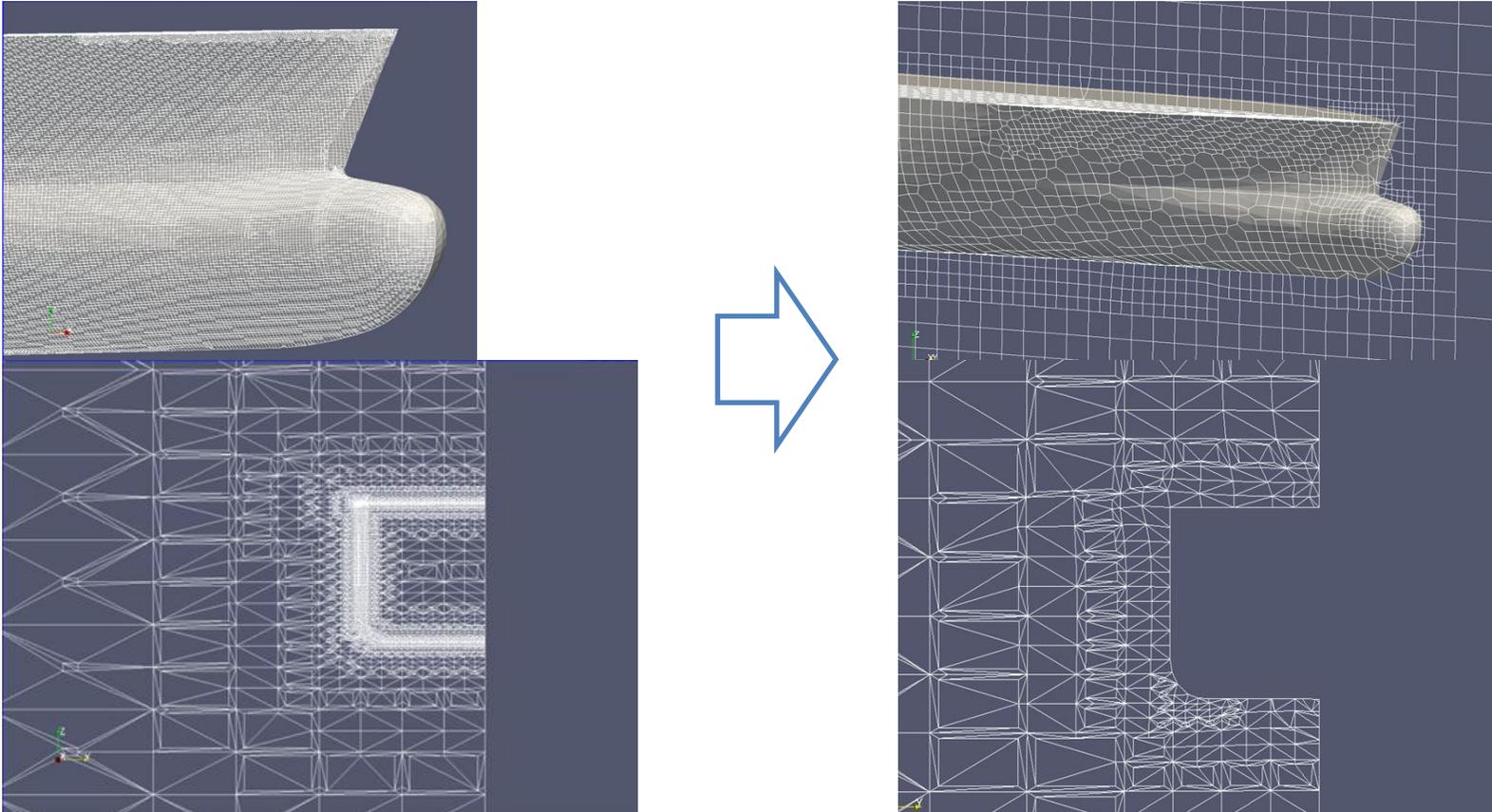
BlockMesh



BlockMesh를 이용하여 자유 수면 부근에 격자를 조밀하게 생성

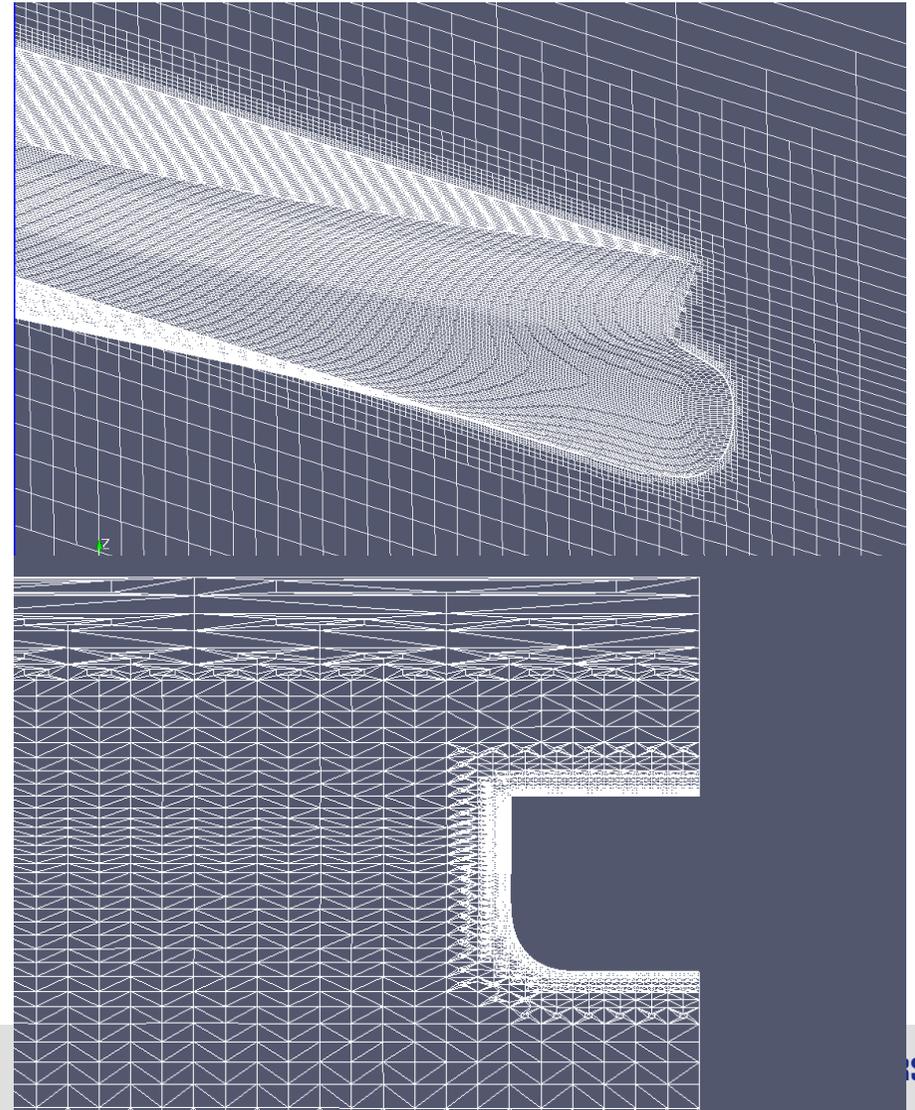
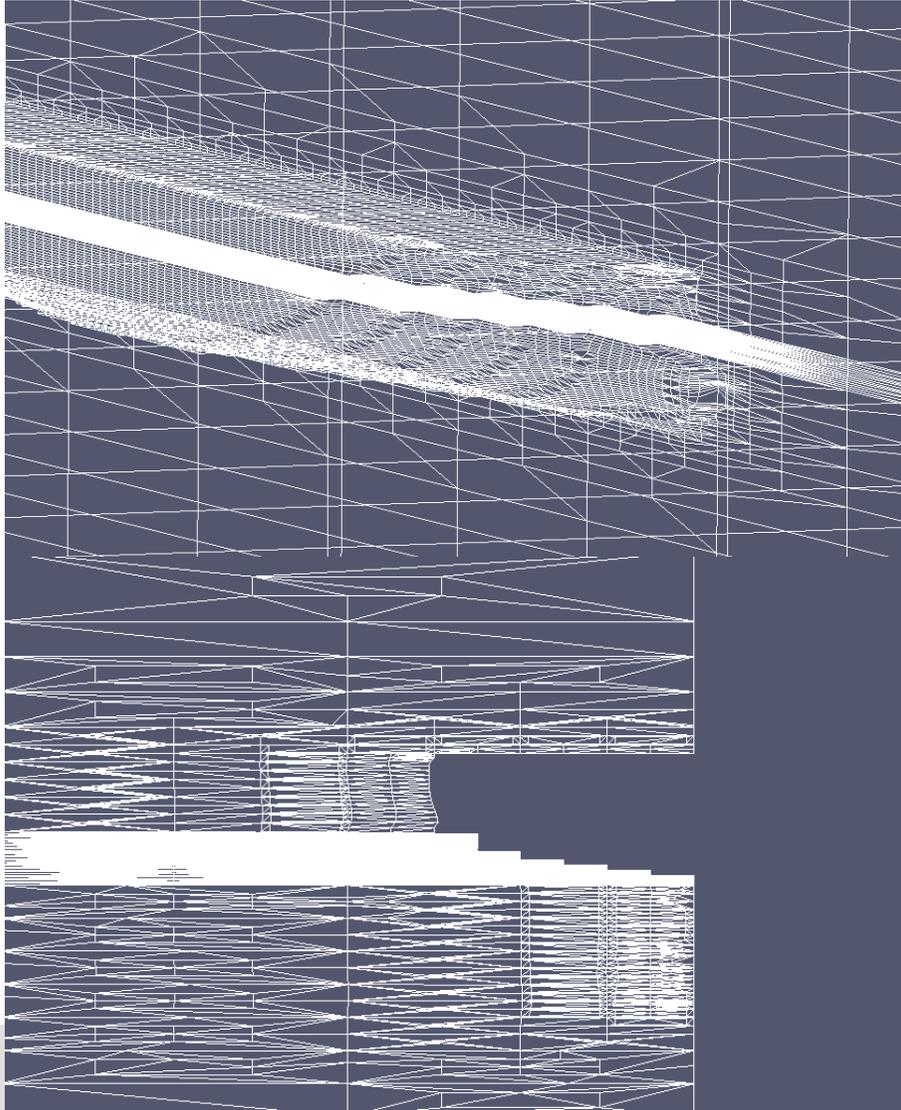
Internal Mesh Error

- ❖ Surface file(stl)이 close되어 있지 않은 경우 발생
- ❖ Close 되어 있지 않은 경우 refinementSurfaces level을 조절하여 방지



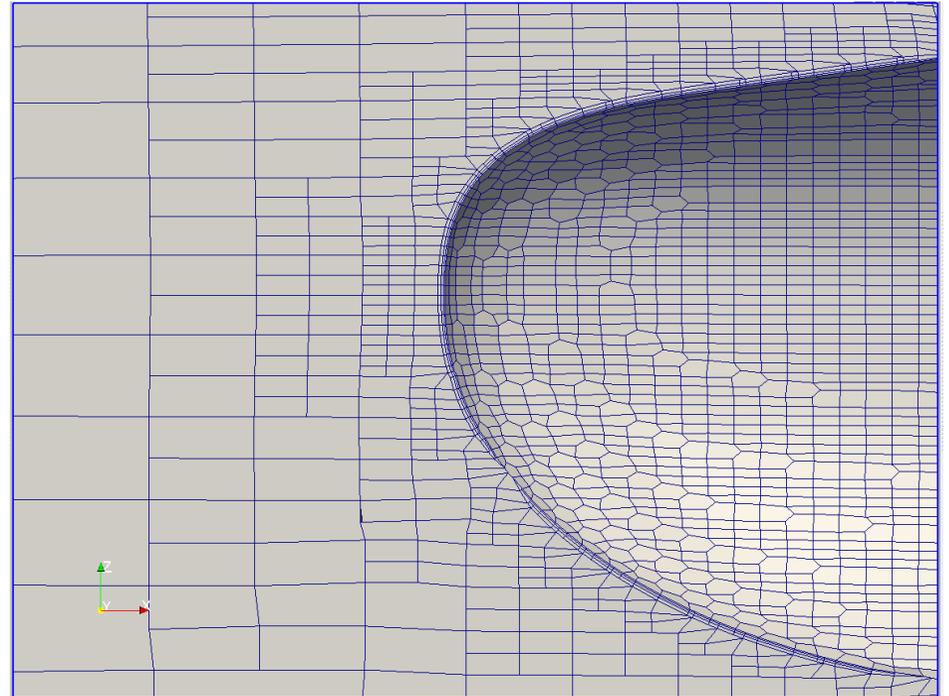
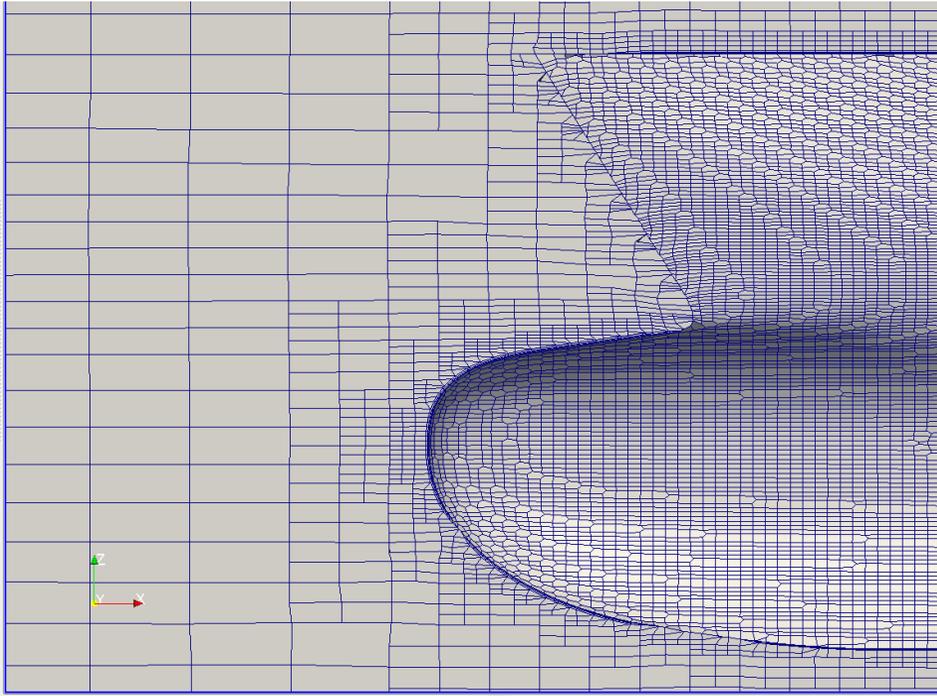
Snap Error

❖ Refine volume zone을 설정 (toposetDict)을 통해 해결



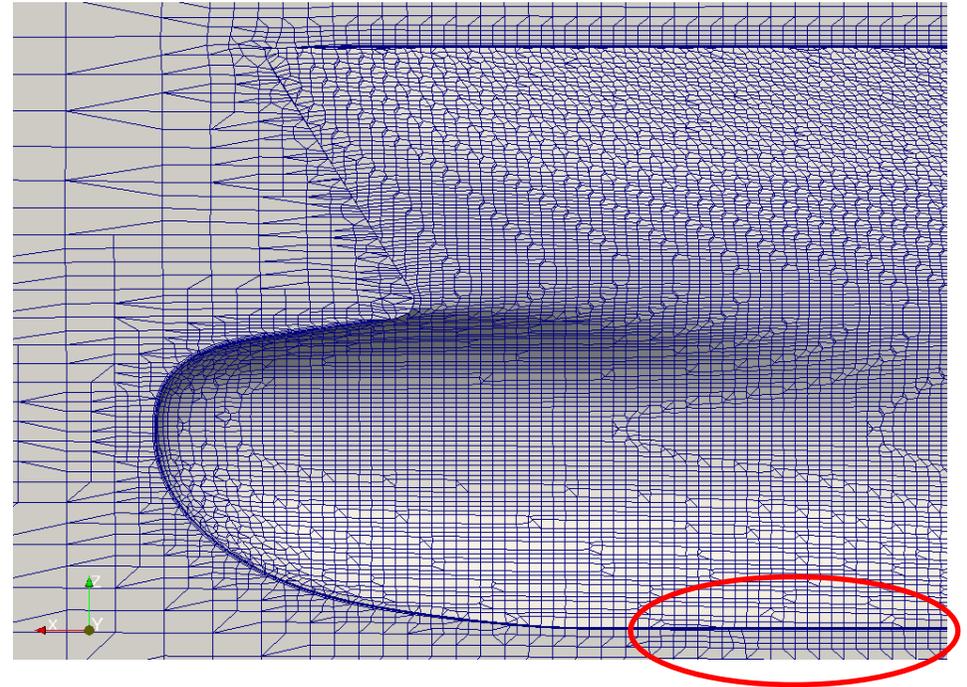
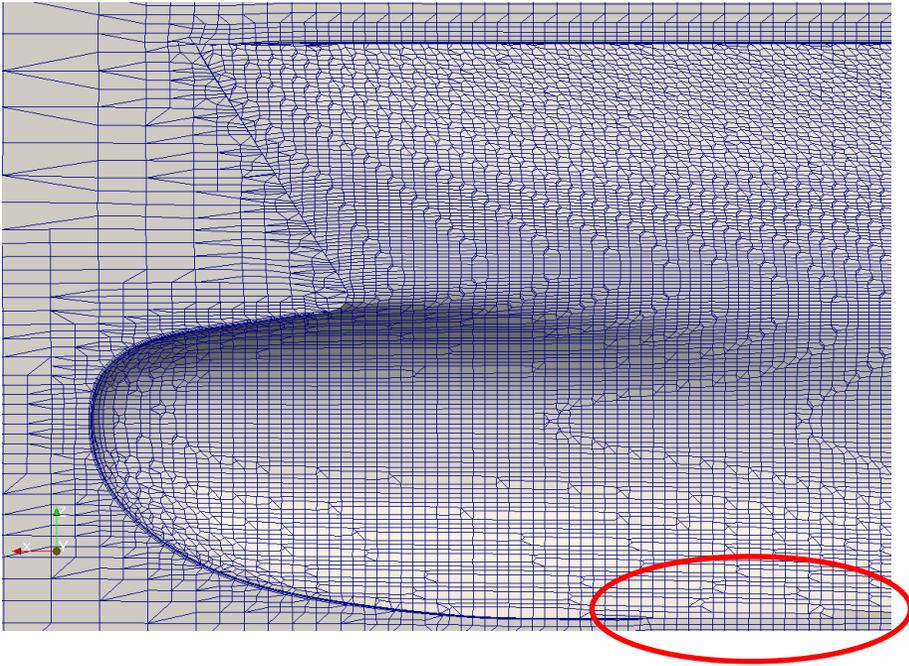
addLayers

❖ 벽면에 평행한 격자 생성



MeshQuality

- ❖ maxNonOrtho을 크게 설정하여 해결
- ❖ minTetQuality를 작게 가져감



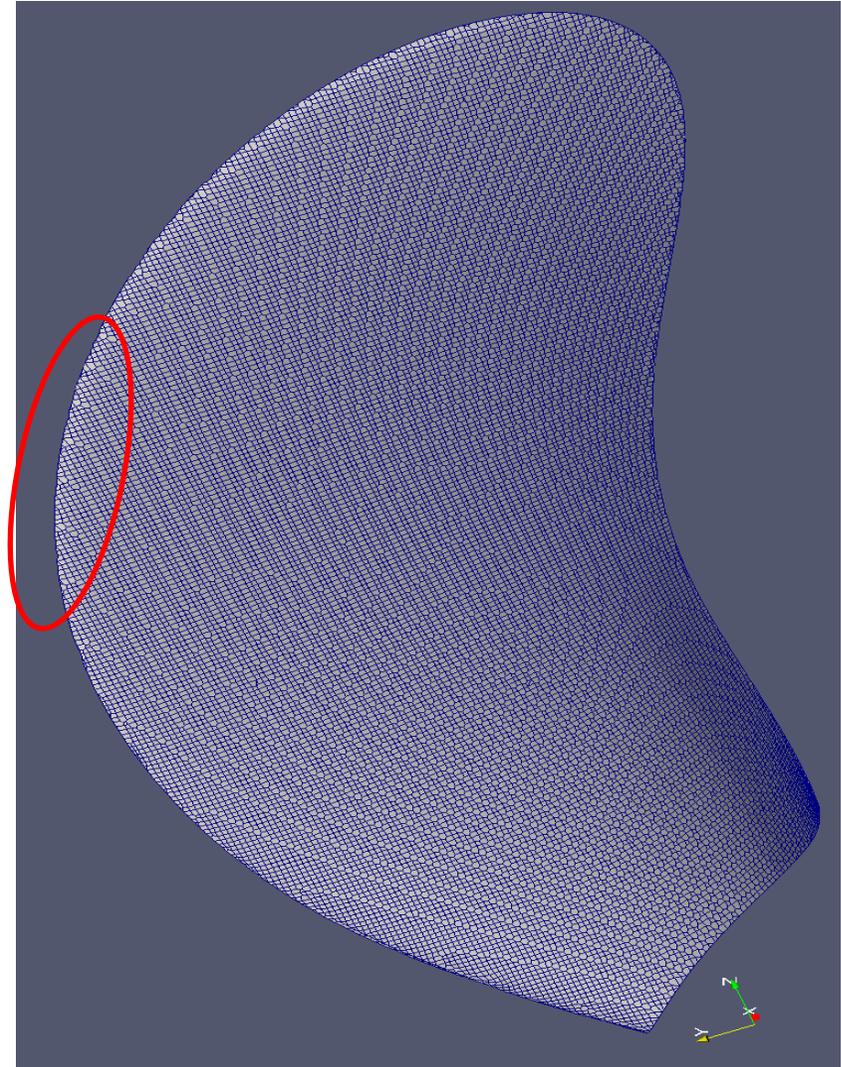
Comparison of Total Resistance

- ❖ 전저항 차이
- ❖ 계산시간 차이

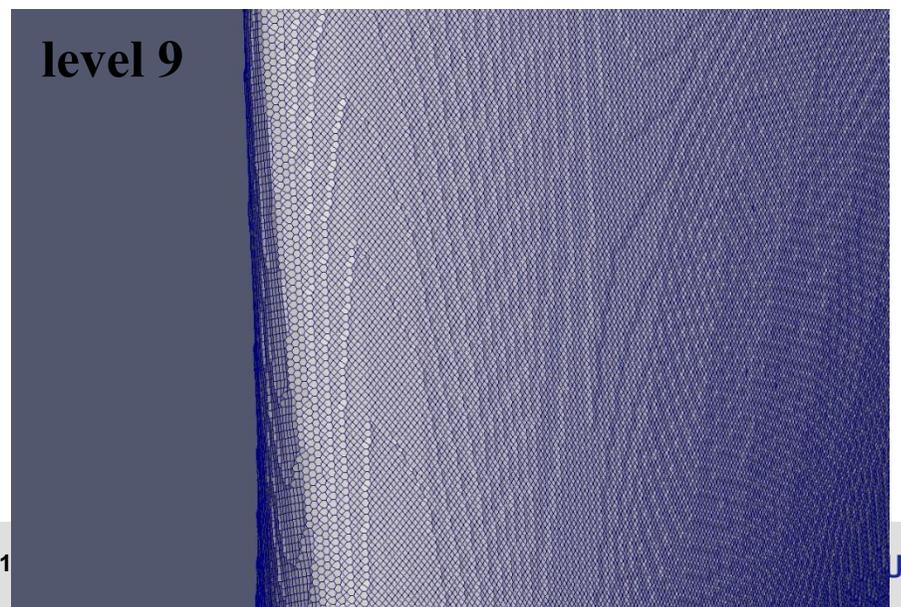
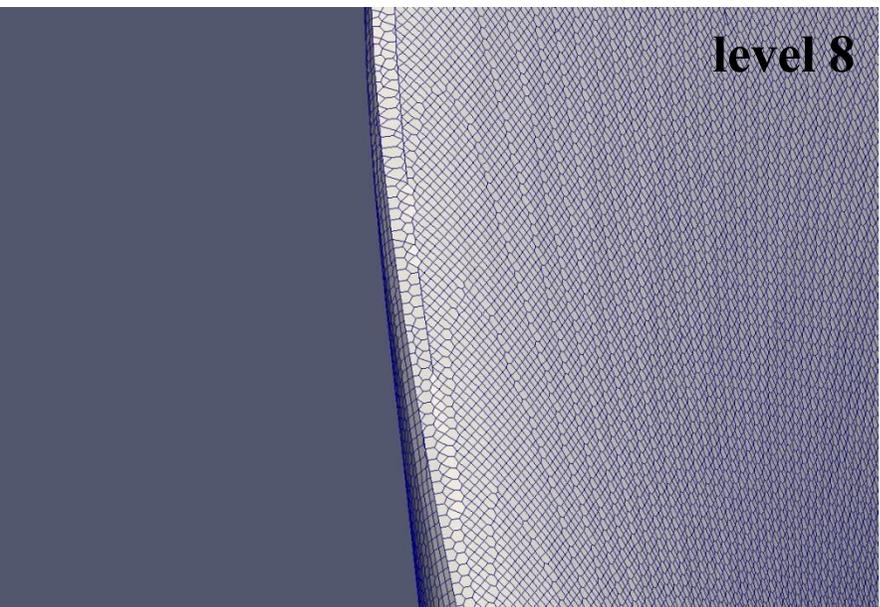
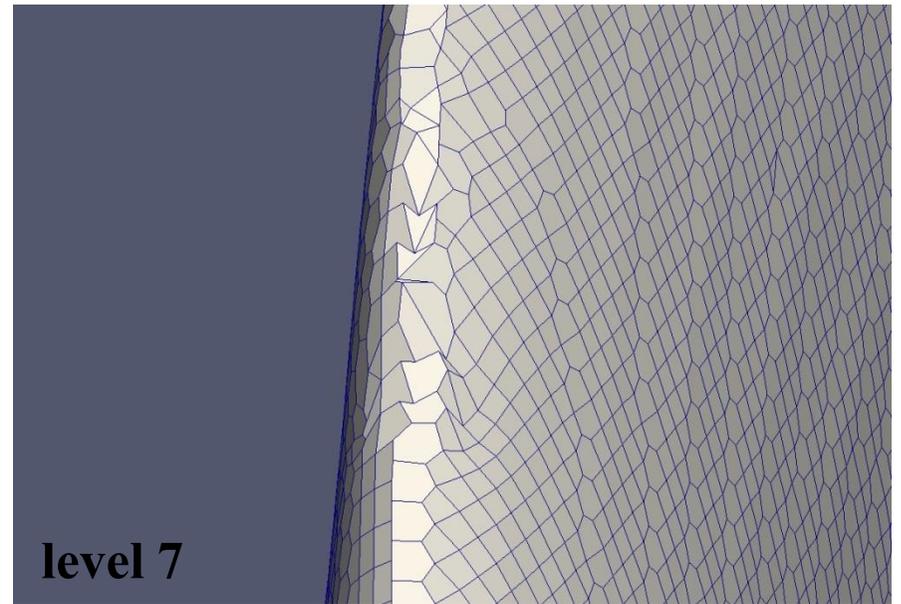
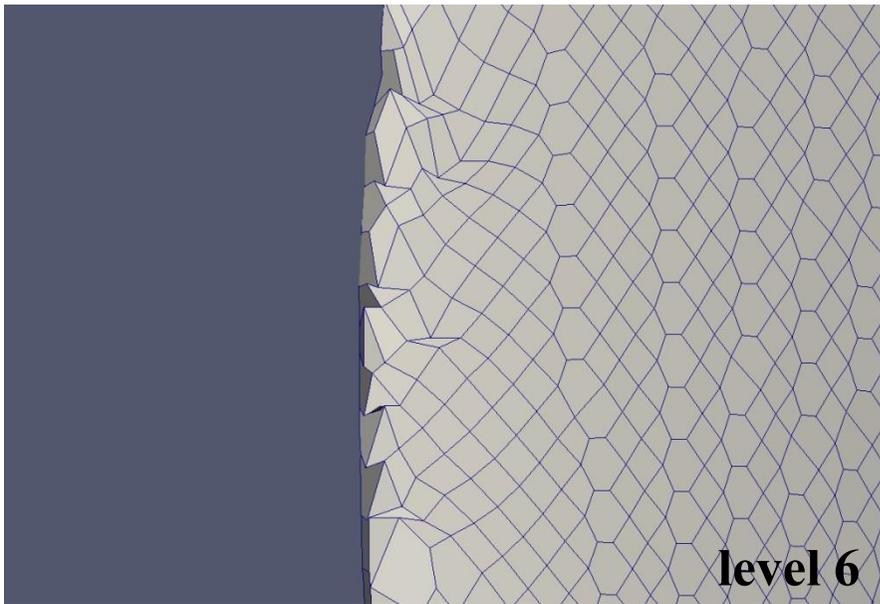
	$C_T(\times 10^{-3})$	$C_T/C_T(\text{EFD})$
EFD	3.557	100
OpenFOAM	3.696	103

추진기 격자

- ❖ Leading edge에 격자가 표면을 따라가지 못하는 문제 발생
- ❖ 두께가 얇기 때문에 격자를 조밀하게 생성 (refinementSurfaces)하여 해결

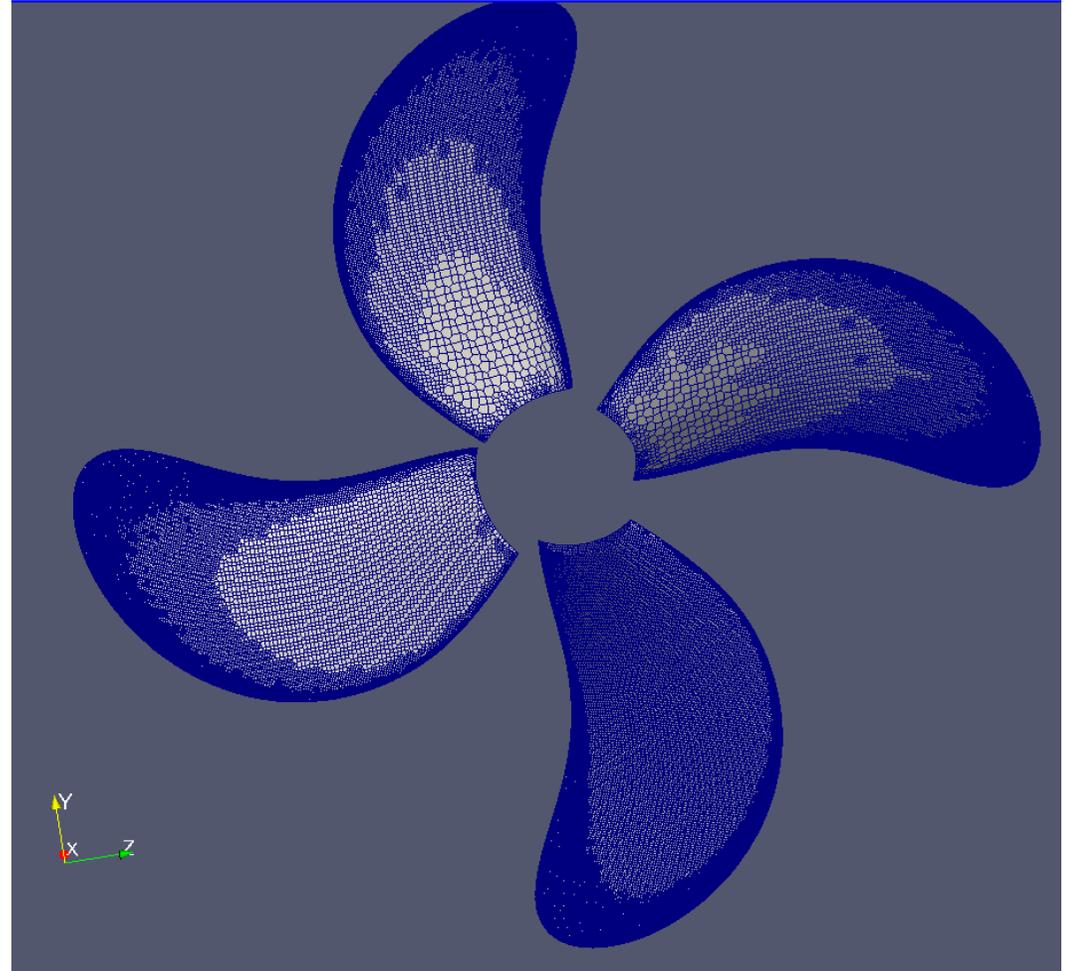


refinementSurfaces



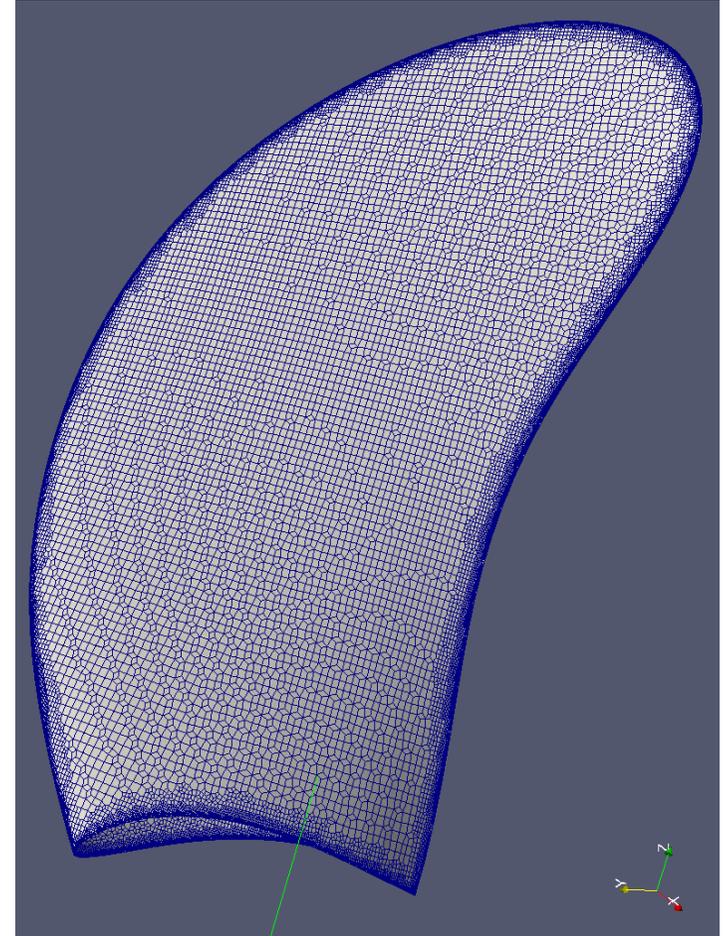
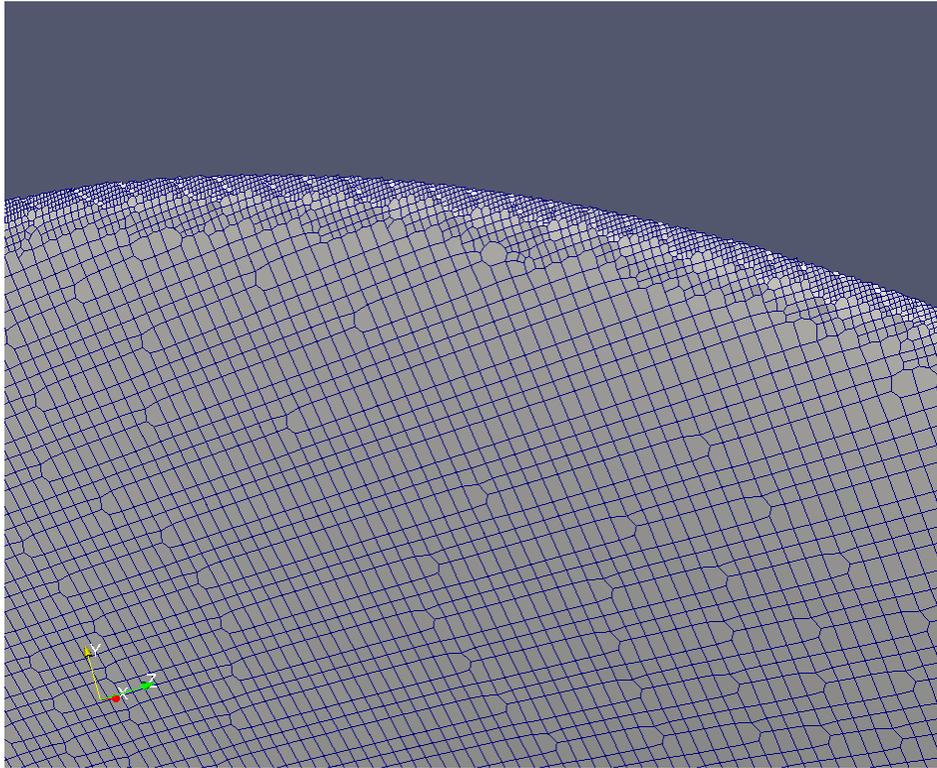
refinementSurfaces

- ❖ RefinementSurfaces의 최대 level과 최소 level을 변경하여 격자생성



nCellsBetweenLevels

- ❖ 결과값은 우수하나 완벽하지는 않음
- ❖ 시간이 오래 소비됨



❖ OpenFOAM을 이용한 선박 저항 및 추진기 계산

▣ SnappyHexMesh는 변경할 수 있는 parameter가 너무 많아 사용이 불편함. 모든 parameter를 control할 수 있는 장점이 있음

▣ 격자생성 시 SnappyHexMesh는 많은 시간이 요구됨

➔ OpenFOAM에서 기본적으로 제공되는 application을 이용하여 선박 저항 및 추진기 성능에 대한 계산 가능성 확인