ANSYS Fluent Meshing Watertight Geometry Workflow

Workshop 4: Generic Aircraft Geometry

For this workshop, the available CAD geometry was of the aircraft as shown in fig. 1 enclosed in a sphere.

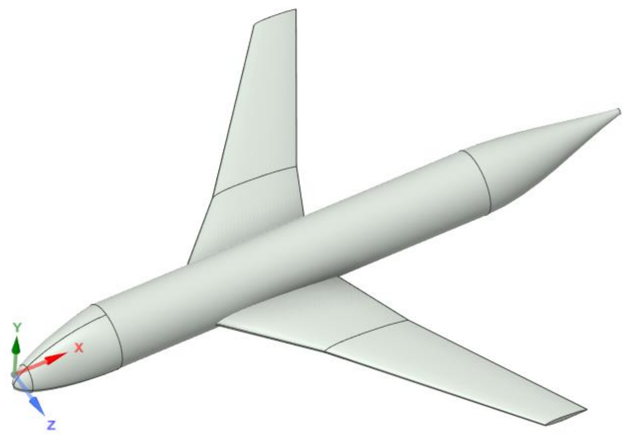

Fig 1: CAD geometry of the Aircraft

The enclosure has been built around the aircraft body, keeping the far-field distance in mind. In the enclosure, the aircraft geometry was treated as a void and the whole enclosure was cut in half owing to its symmetricity as shown in fig. 2. The center plane will be set to symmetric boundary conditions to reduce the computational resource requirements.

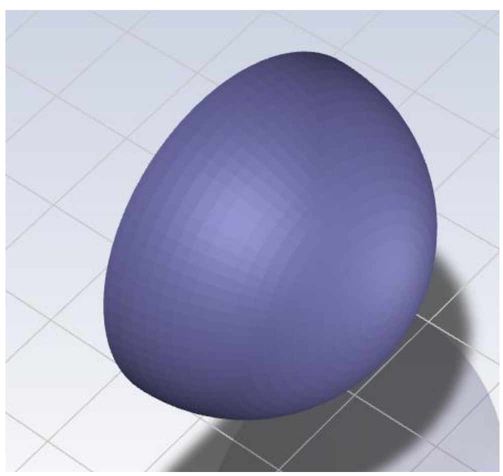

Fig 2: The enclosure half section used for meshing

Double precision is enabled for meshing. This simply means that 64 bits are used for the representations of the numbers instead of 32 bits used in single precision. The meshing is performed on 4 processors.

Local sizing of 0.5 mm has been added on the wing leading and trailing edge. Fig. 3 shows the local refinement box within which the refinement layers will be defined. The specified mesh size was 2 mm which will be used as a soft sizing control for mesh size in the local refinement regions. The defeaturing size was set at 20 mm, this is used to create a wrapping surface around the selected objects and create a rough shape.

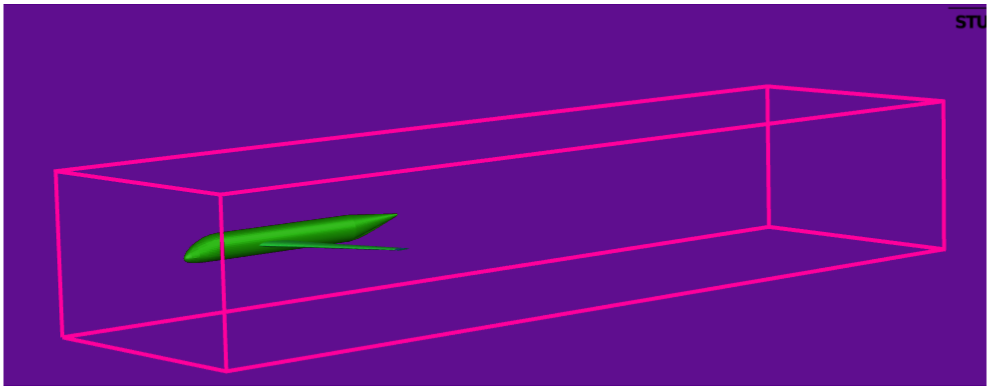

Fig 3: The box for generating local refinement regions

Local refinement regions (BOIs) were defined using the offset method. The offset is done for the fuselage and wing. Two types of BOIs were created –

1. Boundary layer levels – This is done by scaling the surface of the selected geometry equally in all directions concerning the centroid of the selected geometry. For the meshing purpose, the boundary layer height was set as 200mm, and 2 boundary layer levels were used. Boundary layer height controls the maximum offset the farthest boundary layer can be created. The number of boundary layer levels controls the maximum number of levels that can be created in this offset.
2. Wake levels – It is like the boundary layer levels, but the wake levels are not equally scaled in all directions. These are expanded in the wake regions of the geometry based on the flow direction. The offset in the downstream direction is controlled by the wake growth factor and in the other directions using the Cross-wake growth factor. For the meshing purpose, the wake growth factor is set as 2, the Cross-wake growth factor as 1.1, and the number of wake levels as 2.

Fig. 4 shows both the boundary layer levels and wake levels around the aircraft geometry. For both the BOIs, the defined mesh size is used to define the cell size and it increases by a factor of two between successive levels, as set.

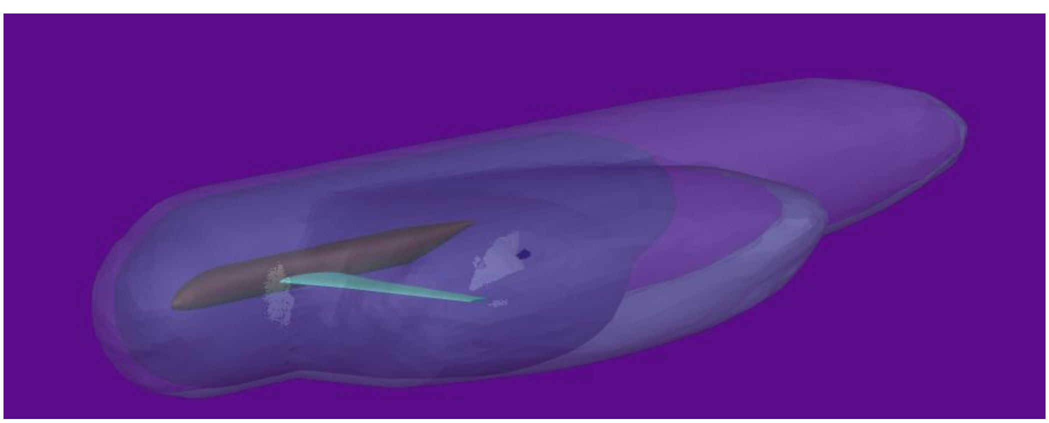

Fig 4: Boundary layer levels and wake levels around the aircraft geometry

For the surface mesh, the curvature normal angle was kept at 12 deg., to capture all the curved features on the aircraft. Fig. 5 shows the surface mesh generated within the local refinement regions. The gradient in the boundary layer and wake layer is clearly seen between the two levels. Fig. 6 shows the surface mesh generated on the aircraft geometry based on the selected parameters for surface mesh.

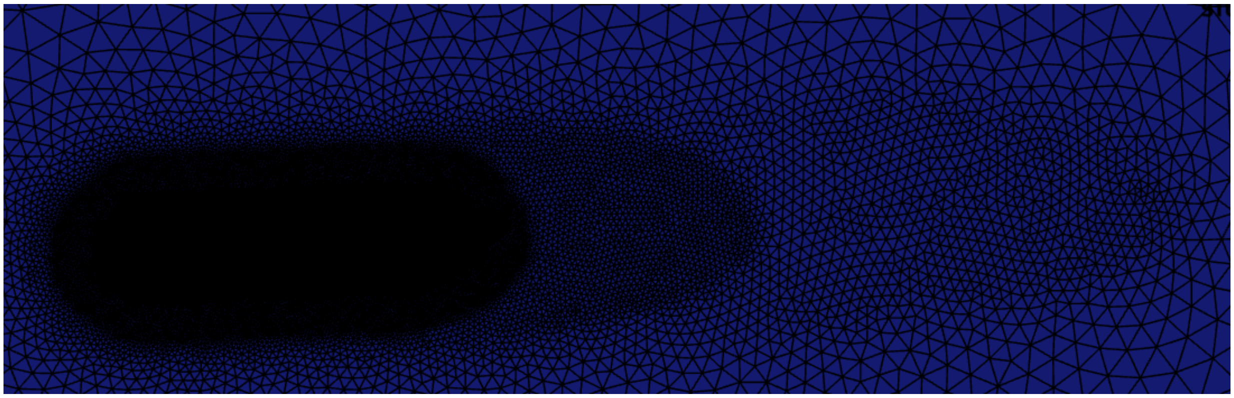

Fig 5: Surface mesh generated in the local refinement regions around the aircraft geometry

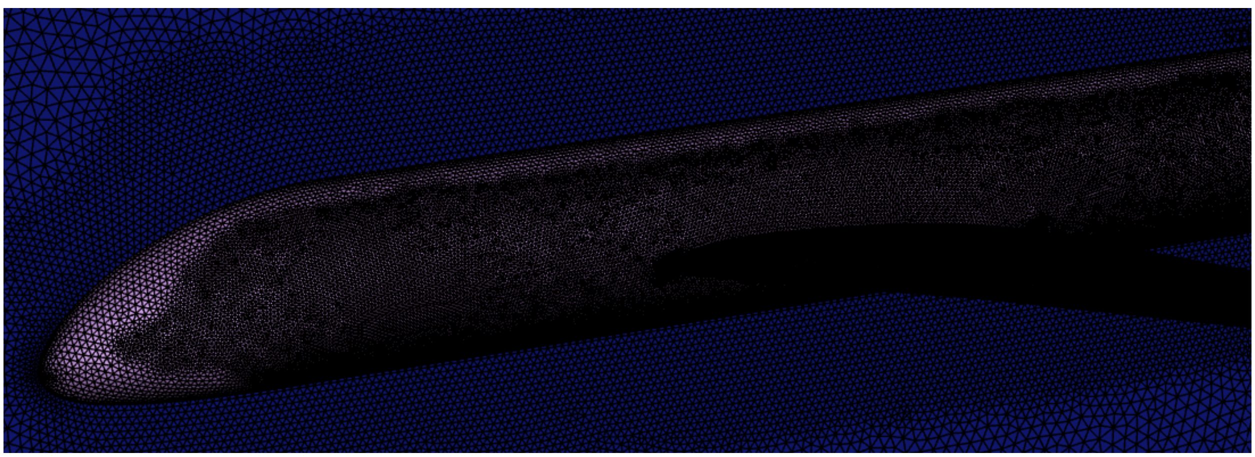

Fig 6: Surface mesh generated on the surface of the aircraft geometry

Boundary layers were added using the last-ratio method as the offset method type. The last-ratio method provides the option to control the first height to control the y+ value of the mesh. The transition ratio allows to control of cell size transition between the core mesh and boundary layer level mesh. First height is set as 0.05 mm. The transition ratio was kept at the default value of 0.272.

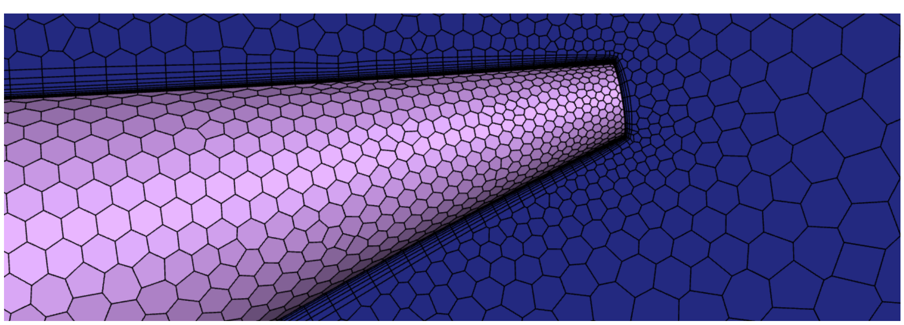

Fig 7: Boundary layer in the volume mesh near the tail of aircraft

Fig. 7 shows the boundary layers generated in the volume mesh near the tail regions of the aircraft. For the start, the number of boundary layers was kept at 10 to ensure proper capturing of the boundary layer flow behavior, but it can be increased if more precision is required in external aerodynamics simulation over aircraft.

For the volume mesh generation, three types of volume fill with method is used and the best quality of the mesh is generated based on the orthogonal mesh quality and the total number of cells generated. Table 1 shows the types of fill-with method and the corresponding parameters associated with the method.

Types of mesh	Mesh orthogonal quality	Total mesh count
Hexcore	0.05	3960961
Poly hedra	0.15	2497720
Poly hexcore	0.15	2336173

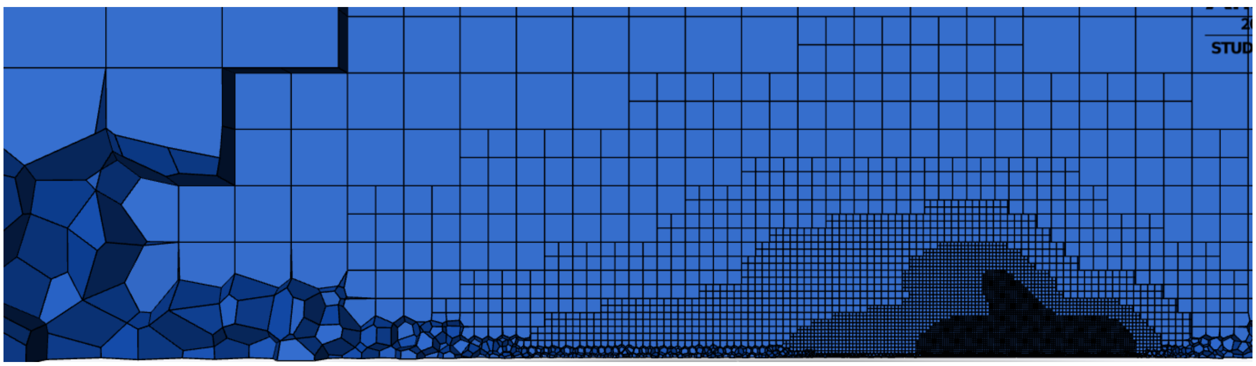

Fig 8: Poly hexcore mesh in the computational domain

Based on the results, the poly hexcore method was selected as the best mesh for this geometry. Fig. 8 shows the computational domain filled with poly hexcore. The overall mesh count is much less compared to the Hexcore mesh. In the near regions of aircraft, hexcore mesh remains but in the far regions, these hexcore meshes are replaced by poly hexcore which leads to the reduction in the overall cell count.