

Additional Reading Material

Creating 2D Channel Geometry and Mesh

Defining a block in OpenFOAM

While defining the blocks, the order in which the vertices are specified plays an important role. The order in which the vertices are defined decides the local coordinate system of the block. This local coordinate system is independent of the global coordinate system which was used to specify the vertex coordinates earlier. The local coordinate system only dictates how the meshing parameters are defined for the block. All the other lists, such as vertices, edges etc. use the global coordinate system to specify the parameters.

The `blockMesh` requires this local system to be right-handed. If x_1 , x_2 and x_3 are the three axes that define the block, it would be right-handed if the right thumb points towards the x_3 axis when the fingers are curled from x_1 axis to x_2 axis. This coordinate system dictates how the meshing parameters are defined for the block.

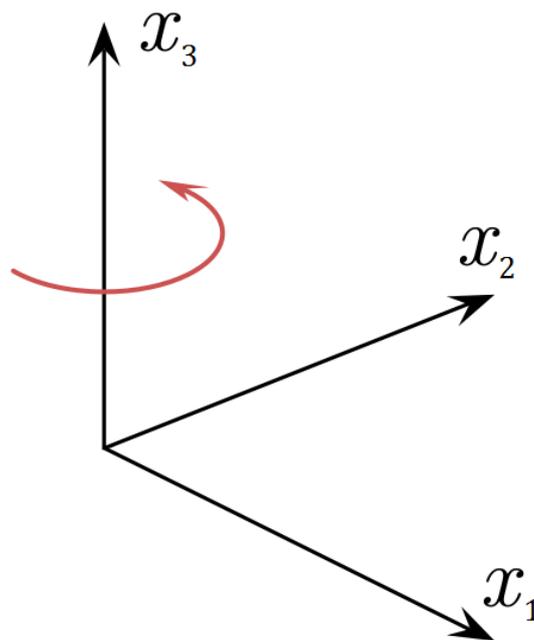


Figure 1. A right-handed coordinate system. The arrow signifies the curl of the right fingers.

Since `blockMesh` only allows hexahedral blocks to be defined, it requires eight vertices to define the block.

Consider an arbitrary block (fig. 2) defined as follows

```
hex (a b c d e f g h) (n1 n2 n3) simpleGrading (e1 e2 e3)
```

The first entry of the block, vertex *a*, defines the origin of the local coordinate system. The direction travelled from vertex *a* to *b* is the x_1 direction. Similarly, the x_2 direction is described by the movement from vertex *b* to *c*. The vertices *a*, *b*, *c*, *d* define the plane $x_3 = 0$.

The x_3 direction is described by the movement from vertex *a* to *e*. Similarly, vertices *f*, *g* and *h* can be found by moving along the x_3 direction from vertices *b*, *c* and *d* respectively.

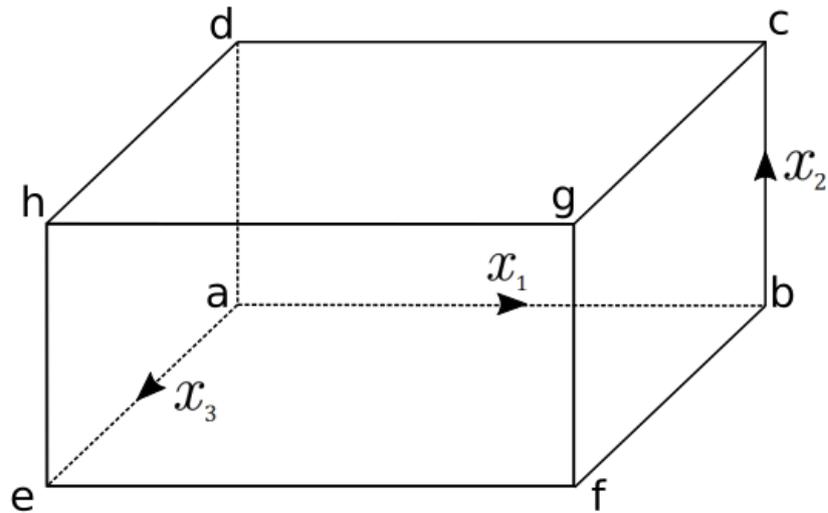


Figure 2. An arbitrary block and its vertices.

In the block definition, n_1 , n_2 and n_3 describes the number of cells along the x_1 , x_2 and x_3 directions respectively. Similarly, e_1 , e_2 and e_3 describes the expansion ratios along the x_1 , x_2 and x_3 directions respectively.

The geometry of the channel and its vertices are shown in fig. 3.

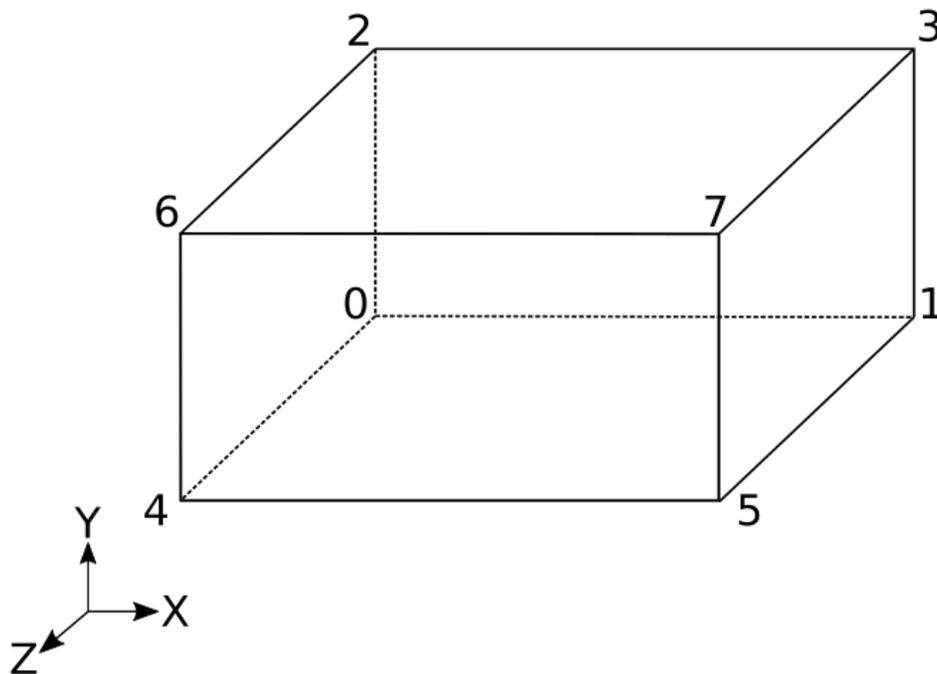


Figure 3. Channel geometry and its vertices.

In this tutorial, we had defined the block as

```
hex (0 1 3 2 4 5 7 6) (40 25 1) simpleGrading (1 1 1)
```

In fig. 3, the coordinate system shown is the global coordinate system. In this tutorial, we have decided to match our local coordinate system for the block with the global coordinate system

such that, x_1 is in the direction of x -axis, x_2 is in the direction of y -axis and x_3 is in the direction of z -axis.

Following the convention described earlier, the direction travelled from vertex 0 to 1, which describes the x_1 direction, is along the x -axis. Similarly, the direction travelled from vertex 1 to 2, which describes the x_2 direction, is along the y -axis and the direction travelled from vertex 0 to 3, which describes the x_3 direction, is along the z -axis. Therefore, the local coordinate system of the block matches the global coordinate system.

As defined, there are 40, 25 and 1 cell along the x , y and z axes respectively. The expansion ratio is 1 along all directions.

A block can be defined in multiple ways. Let's consider an alternate definition of the block as follows

```
hex (0 2 6 4 1 3 7 5) (40 25 1) simpleGrading (1 1 1)
```

Note that only the order in which the vertices are ordered has been changed. The meshing parameters are unaltered. Following the convention to determine the local coordinate system, we find that the direction travelled from vertex 0 to 2 will now describe the x_1 direction, which is along the y -axis. Similarly, the direction travelled from vertex 2 to 6, which now describes the x_2 direction, is along the z -axis. Also, the direction travelled from vertex 0 to 1, which now describes the x_3 direction, is along the x -axis. Note that the local coordinate system also matches the requirement of being right-handed.

Since the meshing parameters are defined based on the local coordinate system, the block now has 40, 25 and 1 cell along the y , z and x axes respectively. This clearly shows how the order of the vertices used to define a block affects the definition of its meshing parameters.

A good practice, while defining a block, is to consider the vertices of the lower xy -plane of the geometry first and order them counter clockwise when viewed along the negative z -axis. Then move to the higher xy -plane and order its vertices the same as that of lower xy -plane. The first definition of the block uses this method.