Assignment 3: 3D Vector Visualization

Objective: In this assignment, you'll explore vector data like velocity of air flow inside a cavity of size 18x18x10. In Assignment 2, you've already explored temperature and pressure distribution of airflow inside the same cavity. Now you'll explore velocity of air flow. At first, you'll explore global velocity. Next, you'll analyze velocity distribution along the boundary, inside the cavity, along the start and end of z-axis. You'll also explore the plane of symmetry and establish a relationship between temperature (as you did in Assignment 2) and air flow (velocity) inside the cavity.

To do lists:

Global velocity distribution: Explore global velocity inside the cavity. Use '**vtkStructuredPointsReader**' as you already used in Assignment 2 to read velocity data (Please find attached the velocity.dat file). Use '**vtkArrowSource**' as '**glyph**' to explore velocity direction. Use the following specification for **vtkArrowSource**. Set the arrow source as input to **vtkGlyph3D** as shown below:

```
vtkArrowSource arrow
     arrow SetTipResolution 6
     arrow SetTipRadius 0.25
     arrow SetTipLength 0.5
     arrow SetShaftResolution 6
     arrow SetShaftRadius 0.125
 vtkGlyph3D glyph
    glyph SetInputConnection [reader GetOutputPort]
    glyph SetSourceConnection [arrow GetOutputPort]
    glyph SetVectorModeToUseVector
    glyph SetColorModeToColorByScalar
    glyph SetScaleModeToScaleByVector
    glyph SetScaleFactor 3.5
```

Lastly, use vtkPolyDataMapper with glyphs as input. You'll have to color the velocity data as follows:

```
eval glyphMapper SetScalarRange [[[[reader GetOutput] GetPointData] GetVectors]
GetRange]   Here, glyphMapper is of type vtkPolydataMapper.
```

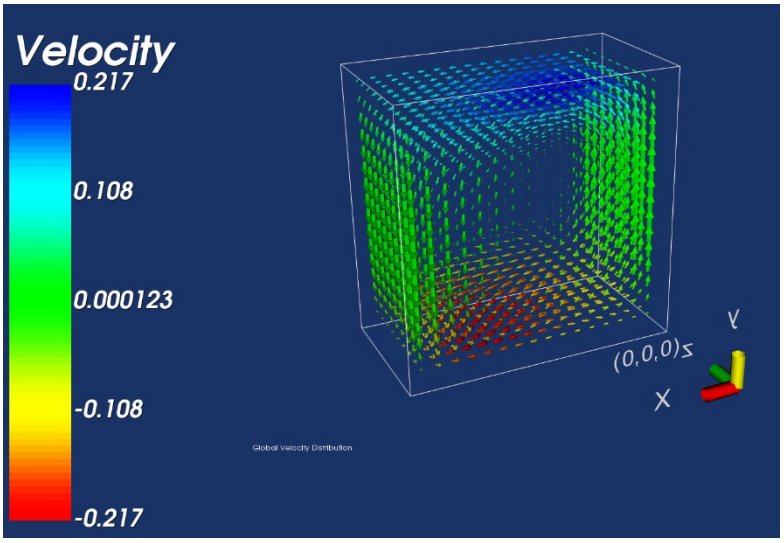

Figure 1: Global Velocity Distribution inside the Cavity.

Velocity Exloration inside the Cavity:

Now, explore the air flow distribution inside the cavity. You need to use vtkRungaKutta4 method for velocity distribution inside the grid. Next, you need to use vtk StreamTracer that takes as input some seed point and finds velocity at discrete intervals via integration. Next, the traced path of the velocity is wrapped in a tube for better visualization.

Some part of the code is shown below:

```
vtkRungeKutta4 integ2
vtkStreamTracer streamer2
    streamer2 SetInputConnection [reader GetOutputPort]
    streamer2 SetStartPosition 1.0 1.0 9.0
    streamer2 SetMaximumPropagation 500
    streamer2 SetInitialIntegrationStep 0.2
    streamer2 SetIntegrationDirectionToBoth
    streamer2 SetIntegrator integ2


vtkTubeFilter streamTube2
    streamTube2 SetInputConnection [streamer2 GetOutputPort]
    streamTube2 SetRadius 0.05
    streamTube2 SetNumberOfSides 12
    streamTube2 SetVaryRadiusToVaryRadiusByScalar
```

Again, you need to use vtkPolyDataMapper which takes vtkTubeFilter as input. You need to use a number of seed points for proper exploration of velocity distribution. Explore velocity distribution along the boundary by taking some seed points at the boundaries of the cavity. Similarly, explore velocity distribution inside the cavity. Try to explore whether there is any vortices. When vortices are formed, suddenly velocity becomes perpendicular to the original flow.

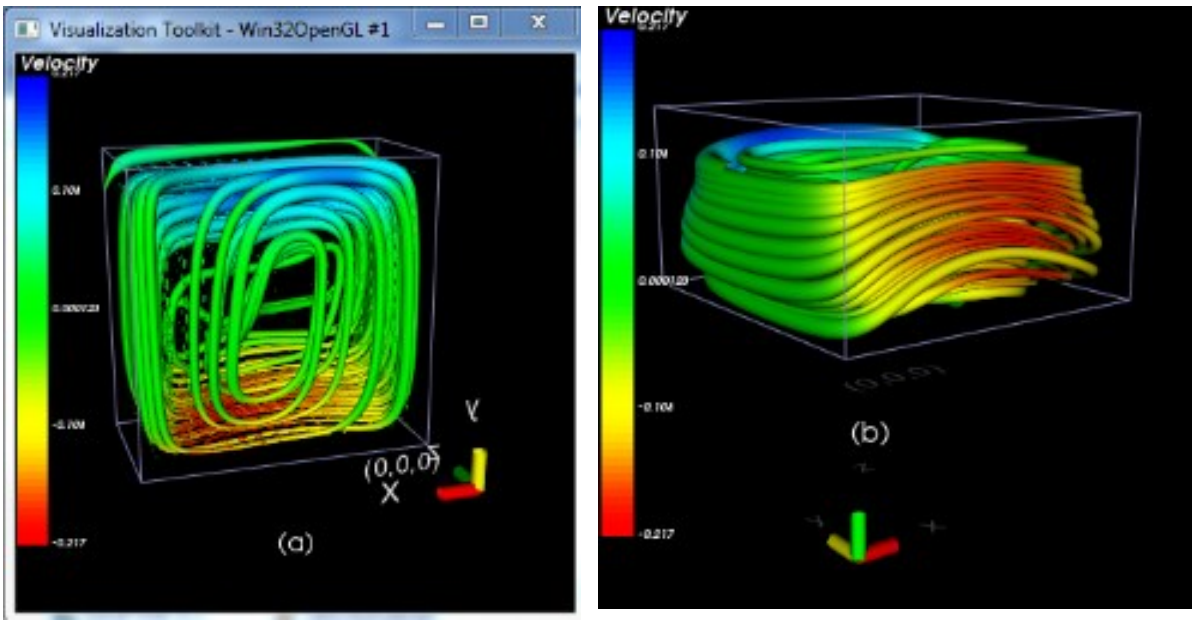

Figure 2: Velocity distribution (a) along the boundary and (b) inside the cavity.

Velocity Exploration along z-axis:

Explore velocity at the start (z =1)and end of Z-axis (z = 17). Take some seed points as mentioned above. Explain velocity distribution along the z-axis. Can you identify the plane of symmetry? Can you draw a relationship between velocity and temperature distribution.

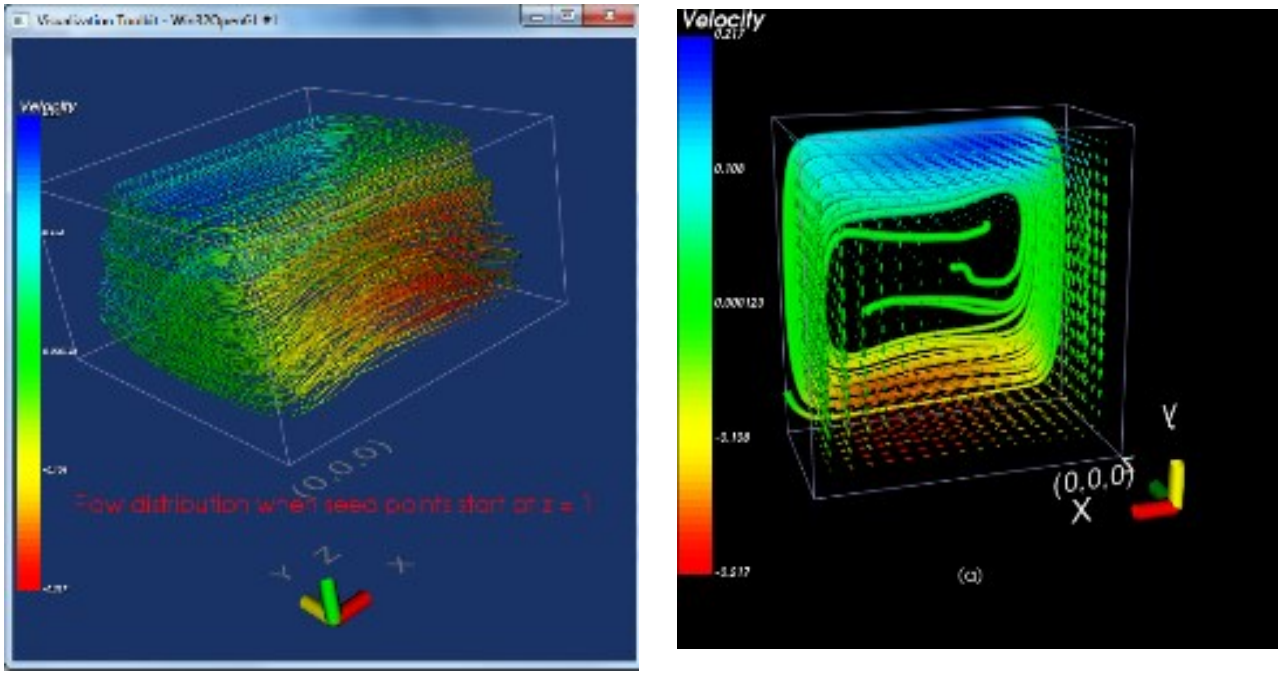

Figure 3: (a) Air flow distribution at z=1 and (b) z =9.

Implementation and Submission: This is not a group assignment, each student needs to do the assignment. You're expected to do the assignment using VTK using tcl wrapper. Submit all the necessary codes that you need to write to explore velocity distribution. Write down your analysis in a pdf file named **3DVectorVisualiztion.pdf**. Submit all vtk codes and pdf file in a zipped file named **LastName_FirstLetter ofFirstName_Assignment3.zip**.

Submission deadline is **Friday, November 17**.

This assignment carries 20% of the course evaluation.

Acknowledgement: The instructor is thankful to the University of Leeds, UK and Professor Bahari Belaton of Universiti Sains Malaysia for the data used in this assignment.