DATA VISUALIZATION AND RENDERING WITH BLENDER AND VTK

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INTRODUCTION
Introduction

What:

Use Blender and VTK to produce more realistic renderings of data generated in OpenFOAM

Why:

- High quality visualizations are exciting to look at and can attract the interest of non-science types.
- Good for marketing images or other applications where form might outweigh function
- Not a suitable alternative to a standard post-processing program such as Paraview or Ensight

Objectives of this tutorial:

- Learn Blender UI
- Export data from Paraview and import in Blender
- Understand basics of material properties in Blender
- Learn how to create cameras
- Learn how to setup lights
- Perform basic rendering in Blender
- Demonstrate direct VTK/Blender integration
Software Overview

Blender:
- Open source 3D rendering software
- [www.blender.org](http://www.blender.org)
- [www.blenderartists.org](http://www.blenderartists.org)
- Large community and actively developed
- Reasonably stable
- Highly scriptable
- Current release is 2.5x
  - Based on **Python 3.x**
  - Very nice interface
  - Faster, higher quality rendering
- Blender 2.49b is used during this tutorial
  - Based on **Python 2.x**
  - Slower rendering
  - Not as user friendly

VTK:
- Visualization Toolkit
- Powerful open source C++ Libraries useful for manipulating data by Kitware
- Paraview is based on VTK
- VTK contains **Python 2.x** wrappers
- Currently **no Python 3.x** support

*Basic knowledge of OpenFOAM, Python, and Paraview are assumed for this tutorial*
### Method 1

**Simple:**

A. Generate OpenFOAM data  
B. Visualize in Paraview  
C. Render in Blender  

**Pros:**

- Requires fewer Blender skills  
- Most users are already familiar with Paraview  
- **No scripting needed**  
- Models can be moved to Blender 2.5x  

**Cons:**

- Cannot render animations (or it would be very painful to do so)  
- Requires the intermediate step of using Paraview  

### Method 2

**Complex:**

A. Generate OpenFOAM data  
B. Use VTK python wrapping to read data into Blender with blenderVTK.py module  
C. Render in Blender  

**Pros:**

- Everything done from inside of Blender  
- Capable of rendering animations/time-dependent data  

**Cons:**

- Scripting required with both Blender and VTK modules
INTRODUCTION TO BLENDER
Staring Blender and Understanding the UI

• From a terminal type “blender”
• Mouse buttons are different from most programs:

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
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<tbody>
<tr>
<td>LMB</td>
<td>Move 3d Cursor</td>
</tr>
<tr>
<td>RMB</td>
<td>Select</td>
</tr>
<tr>
<td>MMB</td>
<td>Rotate Model</td>
</tr>
<tr>
<td>Shift + MMB</td>
<td>Pan</td>
</tr>
<tr>
<td>Ctrl + MMB / Scroll</td>
<td>Zoom</td>
</tr>
</tbody>
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• Other Important Shortcuts

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<td>Shift + MMB</td>
<td>Pan</td>
</tr>
<tr>
<td>Ctrl + MMB / Scroll</td>
<td>Zoom</td>
</tr>
<tr>
<td>Esc</td>
<td>Stop Current Action</td>
</tr>
<tr>
<td>Ctrl + Z</td>
<td>UNDO!</td>
</tr>
<tr>
<td>F12</td>
<td>Render Image</td>
</tr>
<tr>
<td>Tab</td>
<td>Switch between object and edit mode</td>
</tr>
<tr>
<td>Shift + D</td>
<td>Duplicate</td>
</tr>
</tbody>
</table>
Staring Blender and Understanding the UI

- Option Buttons
- Window Mode
- Switch Views
- Switch Between Object/Edit Mode
- Default Cube
- Light
- Camera
- 3d Cursor
- Axis Triad

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Staring Blender and Understanding the UI

1. RMB between frames
2. Click “Split Area”
3. Create Second Area
4. RMB Camera in 3D view
5. In small Frame LMB View>>Cameras>>Set Active Object As Active Camera

We can now see the 3d View, plus the view the camera will see
First Render

Press F12 to Render
Rotating/Translating/Scaling Geometry

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<tbody>
<tr>
<td>G</td>
<td>Grab</td>
</tr>
<tr>
<td>S</td>
<td>Scale</td>
</tr>
<tr>
<td>R</td>
<td>Rotate</td>
</tr>
<tr>
<td>(G,S,R)</td>
<td>(X, Y, Z)</td>
</tr>
</tbody>
</table>

Grab, Scale, or Rotate along X,Y, or Z axis

Create Simple 3 Point Lighting:
1. RMB the light source
2. Shift + D to duplicate
3. Drag new light to behind the box and then LMB when in place
4. Shift + D to duplicate again
5. Drag new light to the side of the camera and LMB to place
6. These are the fill, backlight and key lights
Second Render
Press F12 to Render
It’s starting to look a little better
Adjust Light Properties

Adjust the Key Light:

The key light should be about 2X as bright as the fill:

1. RMB the key light
2. Select the Shading tab (F5)
3. Double click the Energy Box and Adjust to 2.00
4. RMB the back light
5. Change Energy to 0.5
Third Render

Press F12 to Render
The lights are getting more realistic
Add a ground plane (mesh object)

Now add a ground plane:

1. ‘Spacebar’ >> Add >> Mesh >> Plane
2. Plane will be added at the 3d Cursor
3. ‘S’, ‘10’ to scale 10 units
4. ‘G’, ‘Z’, ‘-1’ to move it down 1 unit in the Z direction
Fourth Render

Press F12 to Render
The lights are getting more realistic
VISUALIZE IN PARAVIEW/RENDER IN BLENDER
Read VTK data into Paraview

1. Open Paraview (Earlier than 3.10) – Not sure why the export tool does not work in 3.10
2. Open exampleFluid.vtk
3. Open monkey.stl
Generate Data in Paraview

1. Select the fluid file and create a stream tracer filter
2. On the Stream Tracer Filter:
   I. Set the Vectors to U
   II. Set the seed location to (-2,0,0)
   III. Change the number of seed points to 30
3. Select the Stream Tracer and add a Tube filter
   I. Change the radius of the tubes to 0.05
4. Color the Tubes by U
Export Paraview Data

1. Hide the Fluid Box
2. File>>Export>>vrml

The vrml exporter is WYSWYG—therefore make sure everything you want exported is shown/colored the way you like.
Prep Blender for Paraview Data

1. Switch the box on the right to the outliner mode
2. Then select the box
3. Deleted the box by pressing 'X' and clicking the ‘Erase selected Object(s)’
Import Paraview Data into Blender

1. Import the vrml file:
   I. File>>Import>>X3D and VRML97
   II. Select the file
   III. Select Load
   IV. Select 'OK' to import the hierarchy

2. The data from Paraview loads into blender with some other data such as lights and viewpoints
Clear out Excess Paraview Data

1. Shift+Click each of the “Direct Light” (not the “lamp”) objects and the “viewpoint” object in the outliner panel
2. ‘X’ to Delete all of these objects
Sixth Render

1. Rendering the plane, monkey, and streamlines
Turn on Data Color Map

1. Select the streamlines (RMB)
2. Click the button for the material context
3. Turn on ‘Vcol Paint’
Seventh Render

1. Rendering the plane, monkey, and Colored streamlines
Adding New materials:

- It’s usually most efficient to use materials already created and import them instead of creating from scratch.

1. Download a .blend file with materials of interest.
2. Append the new .blend file to the current file.
3. File>>Append or Link>>Colored Glass.blend>>scene>>scene.
4. Click Load.

The new materials should now be part of the library.
Render Button

1. Select the monkey (RMB)
2. Go to the materials settings
3. In the MA:Link to Object field, change to CG001
Render Button

1. Rendering the plane, monkey with glass properties, and Colored streamlines
Rotate the Geometry and Clean up the Shadows

1. Rotate the monkey and the streamlines 90 degrees to better face the camera
2. ‘R’ – to rotate, ‘X’ – for the X axis, ‘90’ – for 90 degrees

5. Remove the shadows from the Fill and BackLights by:
   • Select the backlight
   • Select the material tab
   • Uncheck the Ray Shadow tab
Change the Camera Position

Adjust the camera to zoom in on the subject
1. Select the camera (RMB)
2. Click use 3d manipulator and 3d translator
3. Grab and slide the arrows to move the camera
Eighth Render

1. Rendering the plane, monkey with glass properties, and Colored streamlines
INTEGRATING VTK AND BLENDER USING BLENDERVTK.PY
Blender has a python interpreter. Using the VTK python wrappers and a module called VTK blender by University of Alberta CS department.

This module can iterate through animations or time dependent data.
VTKPython Demo

Steps to running the UAICT Demo:

1. Copy VTKBlend.py to /usr/lib/python26/ (You will need to sudo for this command)
2. Open the VTKBlender_demo2.py
3. Go to the rendering tab
4. Click ANIM

This demo works by using VTK to generate the data and then replace a mesh file with the new mesh data at each time step.
Conclusions:

• Blender is a great tool for high-quality rendering
• There is a bit of a learning curve, but it is manageable
• Blender 2.5X is much nicer and faster, however, it is built on python3.0 (VTK is 2.x only) and it currently does not import vrml files directly
• Blender 2.49 files can be opened in 2.5x, so if 2.5x is preferred, the file can be imported in 2.49 and then used in 2.5x
• Blender is not a suitable alternative to Paraview or other true data visualization package
• Rendering is an art and is a fairly in depth subject
References and Useful Links

Article on Setting up 3 Point Lighting:
http://www.3drender.com/light/3point.html

Blender Materials:
http://www.freewebs.com/blendermats/

University of Alberta CS department:
http://www.ualberta.ca/CNS/RESEARCH/Vis/VTKBlender/index.html