



Assignment

Software, Systems and Applications IV - Visualisation

This assignment should be submitted via DUO. The deadline is 2pm on Friday March 13th (Week 19). Submit two files, a python file and a report file in .pdf format not longer than 5 pages including images; at the top of the first page of the document identify yourself using your username. **Use only Python 3.7, pip currently fails to install VTK properly in python 3.8.1.** The marks available for correct implementations/answers to each question are indicated. Partial credit will be given for good attempts. Your marked work will be returned no later than May 4th 2020. The assignment weighting is 34% of the Visualisation sub-module grade. The Visualisation sub-module contributes 25% of the total module mark.

In this project you will be creating an interactive visualisation of the earth using real geographic data acquired via NASA satellites. In particular, you will use elevation data composed of bathymetry (underwater depth of the ocean floor) and topography (land elevation with respect to sea level) data from the NASA Visible Earth Project ([link here](#)). For convenience, all necessary data can be found in DUO. To visualise the data you will be using the open source library VTK - see "important notes" section for more guidance on this. You will combine elevation data with satellite imagery of the earth surface to create a compelling visualisation (earth images also in DUO). Your software will include a GUI to control certain aspects of the visualisation as required by the problem descriptions below.

PROBLEM 1 - 30 MARKS:

You will use the (scalar) elevation data as mapped on a sphere, found in DUO, to create a surface that matches the earth elevation profile. To compute a height map in VTK you should use the `vtkWarpScalar` filter. For an example use, check the `ImageWarp.py` VTK example. To control the amount by which the earth sphere surface moves up and down, `vtkWarpScalar` includes a scale factor. Create a GUI slider to enable interactive manipulation of the scale factor and update the visualisation appropriately. The available satellite image data will be used for texture mapping. In VTK, textures are stored in `vtkTexture` objects fed to a `vtkActor` to enable texture mapping during rendering. The supplied elevation datasets provided in DUO already have texture coordinates in the point attributes for this purpose.

PROBLEM 2 - 50 MARKS:

For the second problem you will visualise elevation using isocontours (aka isolines), corresponding to the set of points where elevation has a particular value. To compute isocontours you will use `vtkContourFilter`. The visualisation that you create should show isolines with elevation values ranging from -10,000 meters to +8,000 meters in 1,000 meters increments. To improve isoline visibility you will wrap the isolines into tubes using the `vtkTubeFilter`. To appropriately select the radius of the tubes and facilitate their visibility (not too big or too small), you will create a GUI slider that modifies this radius. You will also apply a colour map to the isolines that represents their values. The maximal ocean depth should be mapped to a blue color (pick an appropriate hue so that it does not disappear due to the underlying texture) and the maximum mountain height should be mapped to yellow. Values close to the sea level (either positive or negative) should be mapped to desaturated colours between blue and yellow (diverging colour map). The sea level itself (elevation 0) should be shown in red. Colour maps in VTK are defined through `vtkColorTransferFunction` that are then supplied to the mapper via

`mapper.SetLookupTable(< colortf >)`, where `< colortf >` is the name of your colour transfer function. The earth texture map will also be applied for this problem, but on the **un-warped** earth surface (no height-based warping as in the height map case).

PROBLEM 3 - 20 MARKS:

Compile a report, discussing the advantages and disadvantages of each method (height maps vs isolines). Discuss the usefulness of the colour map. Include images that show visualisations of different parts of the world and for different camera perspectives. Include some close-up images. For problem 1, you should include screenshots of the visualisation from appropriate camera angles that convey the presence of the 3rd dimension. Use 2-3 different scale factors for the images and comment on the results. For problem 2, you should include screenshots showing the results obtained for several radii selections.

IMPORTANT NOTES

The provided sphere dataset contains elevation values, normals, and texture coordinates. The sphere is scaled to the radius of the earth in meters. You can quickly view the dataset using ParaView ([link here](#)).

What to submit: You should write a python program that:

- imports the necessary files (elevation and satellite image),
- computes a height map representation and maps the satellite image onto the warped geometry as a texture,
- computes a series of isocontours in 1,000 meters increments in the interval -10,000 meters to +8,000 meters using `vtkContourFilter`,
- displays the resulting curves as tubes using `vtkTubeFilter`, and
- colours the tubes with the suggested colour scale using `vtkColorTransferFunction`.

GUI sliders should be used to manipulate the scale factor for problem 1 and control the radius of the tubes for problem 2. Your program should run by calling its name with two parameters: the sphere elevation data file path/name and the earth texture file path/name.

Guidance on VTK will be provided during the problem class on Friday Feb 14th at 2pm. A FAQ section in DUO will be updated with questions as they arise. VTK is an open source library. You can find a lot of helpful documentation in the VTK Wiki: [link](#). To make sure that you installed VTK correctly, you can try running a sample script: [link](#). More examples of VTK code can be found here: [link](#). The dataset is provided in two different resolutions. You can use the low resolution version for your coding and testing (to not slow down your testing), and the high resolution one to create stunning screenshots.