Processing Report – Castlerigg Stone Circle

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The data to be processed was supplied by the University of Bristol's computing dept. This is in the form of ascii files of laser scanned data consisting of columns of xyz position data and rgb colour data. The acquisition process generates numerous scans covering smaller areas of the stones. These are edited and joined together producing composite mozaics covering the whole stone or panel of interest before delivery to us. Some of this data was supplied as individual scans (Stone 11) but the mozaic was produced by simply concatenating the files together.

Due to the huge size of data files, some over 1 GB in size, the data could only be manipulated on unix machines over in the Dept of Earth Sciences. The procedure undertaken to process the data was developed by Hobbs and Trinks in that dept. and I followed their method.

Decimation

The first process was one of reducing the data size by stripping the columns of the colour information rgb. This is by a simple unix command, eg for stone 48:

```
awk '{print $1,$2,$3}' stone48.xyz > stone48.r1
```

Three columns of position data xyz remain. This is still too large to process so the data must be decimated to a more manageable size. Again simple unix commands strip out the required subset. For the example of Stone 48 selecting every tenth line for further processing:

```
cat stone48.r1 | awk '((NR%10)==0)' > stone48.r2
```

Further decimations may be required to make the file of manageable size.

Point Cloud display

To generate a point cloud of individual data points the file must be converted to vtk format before display in Paraview. The vtk format requires the addition of a header and a tail to the data set. The tail is two columns of data, column one being the number 1 and column two numbers, starting at zero and increasing by one, until matching the number of lines of the data. The number of lines is found by using the unix wordcount function, wc. Separating the main body and the tail is a line listing the word POLYGONS, the number of lines in the dataset from wordcount and twice the wordcount. The header is listed below. The number of points must be set to the word count.

```
# vtk DataFile Version 3.0
stone41.vtk
ASCII
DATASET POLYDATA
POINTS 16465 float
```

The file must be saved with a vtk extension.

The vtk file can then be loaded displayed and in Paraview. Note that although when loaded the screen will look blank. Click [Display] then Display style [Surface] and select Points of Surface to produce the point cloud.

Surface Display

To view the data set as a three dimensional display in Paraview some initial processing to the decimated data set must be done first then the output ascii file must be heavily edited.

The decimated data set must be triangulated first of all. This is done via the shareware program Tight Cocone. Using Stone 48 as an example the program is run by:

```
$ tcocone-linux stone48.r2 -m1600 stone48.r2
```

The generated output file has the extension .off which contains the main body of data and a two part

tail of triangulation information.

To create the surface model to be viewed in Paraview the two part tail must be split off, extraneous columns of data removed from each part then merged back with the main data body with the additon of a vtk header as described earlier. Using wordcount as the length of the main body of data, split the file into separate sections eg for stone 30:
$ awk 'NR<117851' stone30.off > stone30_tc.vtk
This writes the main data to a new file, the tc of the file name meaning it has been triangulated using Tight Cocone. Split the tail off to a separate file:
$ awk 'NR>117850' stone30.off > 30tail

Use an editor to view the tail and find where the line number at which the tail changes into its second part. Split the tail file into two separate files at this point, an upper called a and lower called b in the example:
awk 'NR<234795' 30tail > 30taila
awk 'NR>234794' 30tail > 30tailb

Remove the unwanted columns of data from the files. For the upper tail we require cols 1 – 4 only, for the lower cols 1 and 2.
awk '{print $1,$2,$3,$4}' 30taila > 30tailaa
awk '{print $1,$2}' 30tailb > 30tailbb

Now combine the two files together into one long file and obtain the word count. Wordcount returns three numbers. For surface display we need to know the last two numbers only.

Open the main file (stone30_tc.vtk in this example) and at the end of the data set add the line with the correct numbers substituted:
POLYGONS wordcount number 2 wordcount number 3

To the top of the data add the vtk header as used in the point cloud display. This tc.vtk file can be displayed in Paraview. The image can be manipulated by using the mouse. Note that it is useful to apply a filter to smooth the surface ie filter/smooth. Use a value of 50 or 75 then [accept]. Screen images can be captured by File/Save View Image.

Processed Data

The Castlerigg site contains 48 stones, 39 main stones forming the circle and 8 forming a rectangular 'inner sanctum'. All were scanned and have been processed. Data was supplied as individual scans of panels and as mozaics of whole stones apart from Stone 11 which was supplied as individual scans only. Stone 11 (spiral stone) is missing some scans along the north, narrow side. This has not affected the processing much as the zone of interest is on the west (inward) facing side and has been captured. The data contains colours of rgb values but this is not used in processing.
The amount of decimation to the data set required for processing each stone varied from a factor of 20 to 500 in the case of Stone 11. Stone 11 being of particular interest was also processed differently in that selected scans over the area of the spiral were processed alone and with less decimation, factors of 10 or 25 applied.
The laser scans were analysed using Paraview and notes taken for use out at Castlerigg site itself.

Rock carvings have been recorded on various stones at Castlerigg namely Stone 5, Stone 10, Stone 11 and Stone 27, and reported on Stone 23. Our results have been reported at BRAG2005 in Bristol in April 2005.