

3D reconstruction: A study of the effect of resolution and colour

Paul Bourke
March 2014

In the following an attempt is made to determine the effects of image resolution and colour of photographs on the quality of 3D reconstructions. A fixed pipeline is chosen for all cases and the software chosen is considered to be one of the better on the market at the time of writing, namely PhotoScan. The sample set used consist of 17 photographs of a 2.5D staircase from the Dragon Gardens in Hong Kong, the site of the James Bond movie "The man with the Golden Gun" (1974). A 30mm fixed focal lens was used on a Canon 5D Mk III (22 MPixels full frame sensor) to photograph the stairs from positions that ensured an image overlap of at least 1/2 an image width or height. The reconstruction from all images at full resolution is shown below in figure 1.



Figure 1. Reconstruction (not a photograph)

The original 17 photographs were successively reduced by a factor of 2 down to 1/8 of the originals, the most reduced image set being 750x500 pixel resolution. Additionally a grey scale image set was created at full resolution. These images sets were then each used to create a reconstructed 3D model. The summary of images resolution, sparse and dense points and resulting triangles are summarised below.

Original	Photograph size: 5760 x 3840 pixels. Sparse points: 64,000. Dense points: 19,600,000. Triangles: 20,000,000 (Capped)
Greyscale	Photograph size: 5760 x 3840 pixels. Sparse points: 82,700. Dense points: 19,200,00. Triangles: 20,000,000 (Capped)
1 / 2 scale	Photograph size: 2880 x 1920 pixels. Sparse points: 15,600. Dense points: 4,600,000. Triangles: 10,300,000.
1 / 4 scale	Photograph size: 1440 x 960 pixels. Sparse points: 16,600. Dense points: 1,170,000. Triangles: 2,600,000.
1 / 8 scale	Photograph size: 750 x 500 pixels. Sparse points: 3,450. Dense points: 380,000. Triangles: 690,000. Clearly visible geometric distortion, see below.

"Capped" means the triangle count was constrained to a maximum of 20 million, the reconstruction would have otherwise created more triangles.

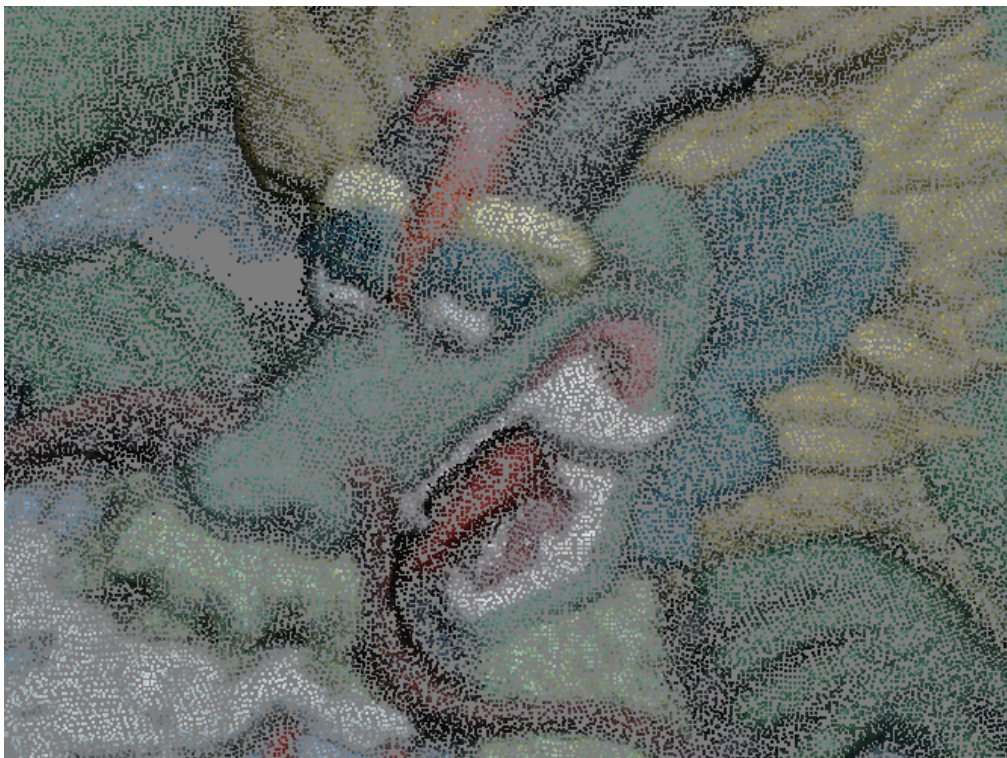


Figure 2. Incorrect reconstruction from the lowest resolution image set.

For the rest of this discussion the results from the 1/8 scale reconstruction, figure 2, will not be considered further since the result was a clearly distorted reconstruction. It also confirms the observations from other experiments showing that image resolution and focus are important to a high quality reconstruction.

Point cloud comparisons

In what follows a visual comparison is made of point clouds from each reconstruction, this is primarily an exploration of the point cloud density.



1:4 image set



1:2 image set

Two immediate observations are that there is a significant improvement between the 1:2 and 1:1 images and, perhaps surprisingly, the point cloud resulting from the greyscale images is comparable to those resulting from the full resolution colour images.



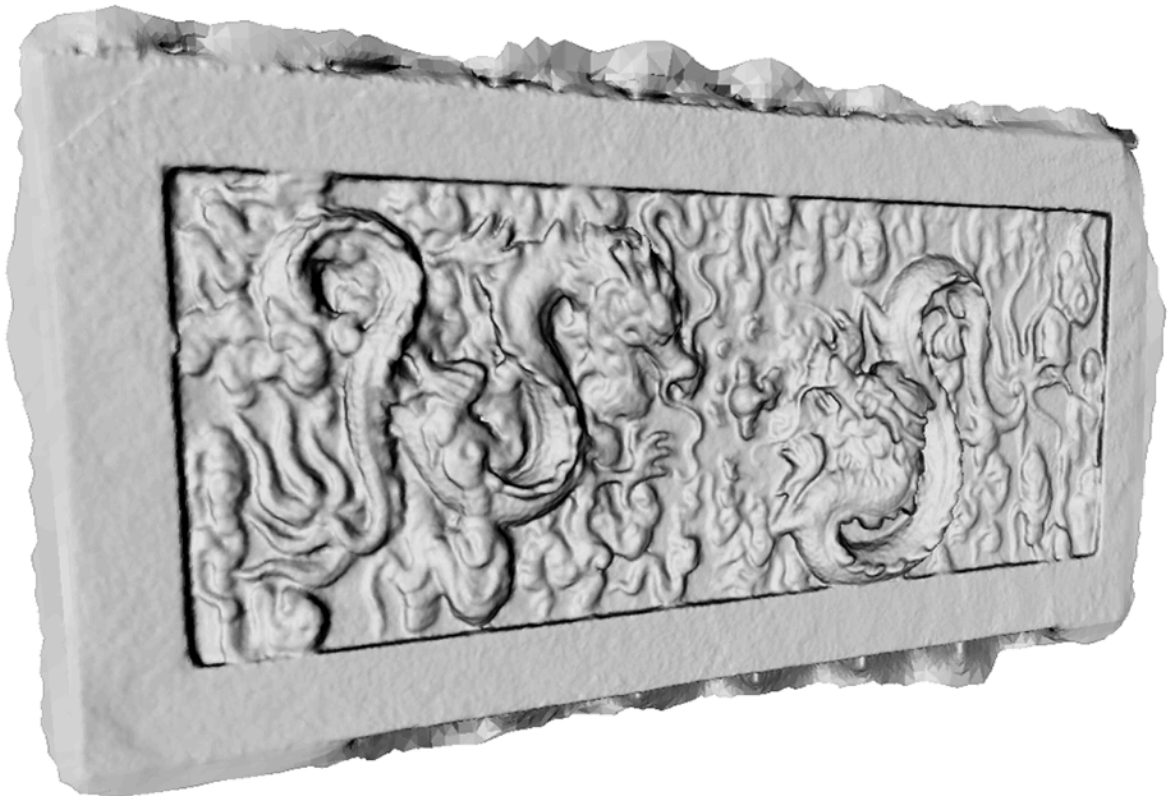
1:1 image set



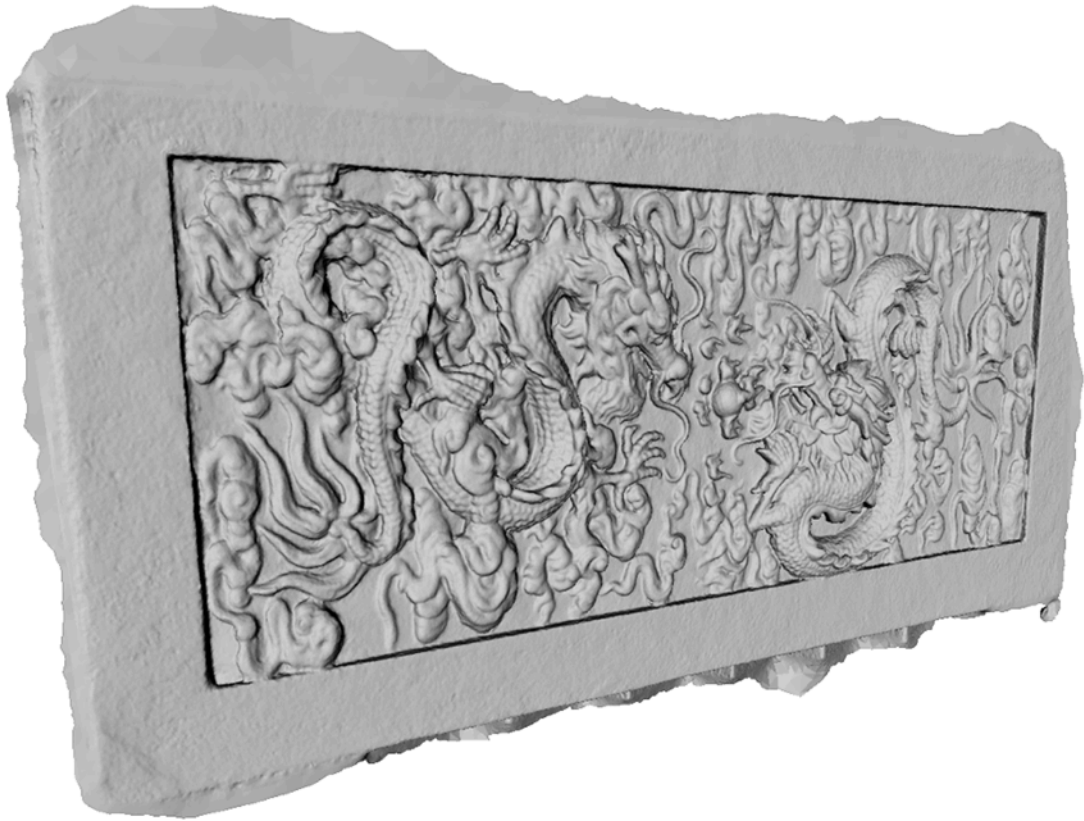
1:1 greyscale image set

Mesh comparisons

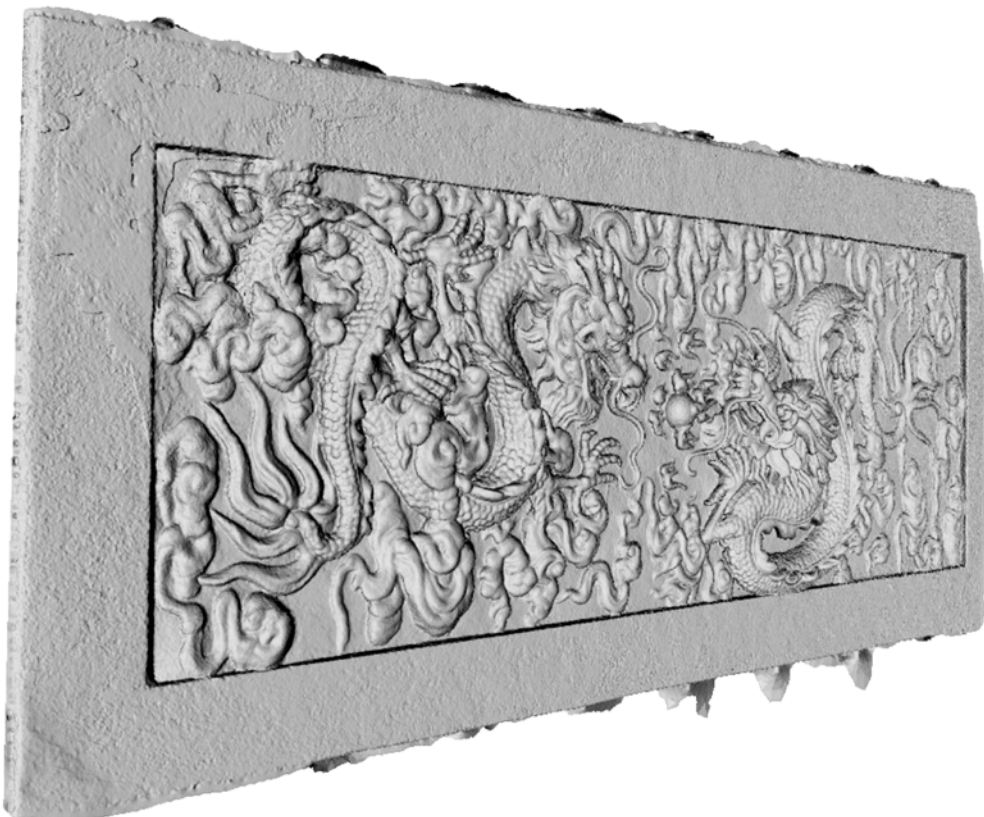
An attempt at comparisons between the generated meshes is presented below, acknowledging that this is problematic given the limited resolution available for this document. There is clearly an improvement all the way from 1:4 scale images to 1:1 scale images and little difference between 1:1 colour and 1:1 greyscale.



1:4 image set



1:2 image set



1:1 image set

A major difference between 1:2 and 1:1 is the structure of the surrounding concrete, the increased detail on the scales of the dragon and the generally sharper features of the transition from the flat background to the raised content.



1:1 greyscale image set

Similar comparisons can be made with the textured reconstructions except it is harder to make judgments on the mesh quality due to the texture information. The 1:4 image and 1:1 image results are shown below for a zoomed in section, the 1:1 structure is clearly sharper, on the whiskers say and horns.



1:4 image set



1:1 image set



1:1 greyscale image set

As per previous comments, the reconstruction from the grey scale image seems just as good as the colour one.