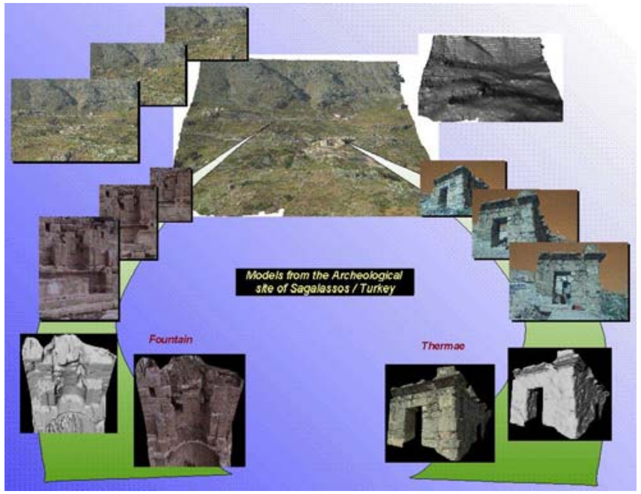
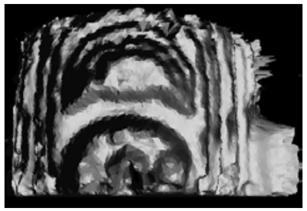
Reconstruction Results



Reconstruction of archaeological objects.

Original image of the entrance hall of the museum.



3D-Geometrie und VRML-Model of the entrance hall.

Literature

KOCH, R., POLLEFEYS, M., VAN GOOL, L.: Multi-Viewpoint Stereo from Uncalibrated Video Sequences. Proceedings of European Conference on Computer Vision ECCV'98, LNCS Series Vol. 1406, Springer, 1998.

POLLEFEYS, M., KOCH, R., VAN GOOL, L.: Self-Calibration and Metric Reconstruction Inspite of Varying and Unknown Internal Camera Parameters. Int. Journal Computer Vision 32(1), pp. 7-25, Kluwer, 1999.

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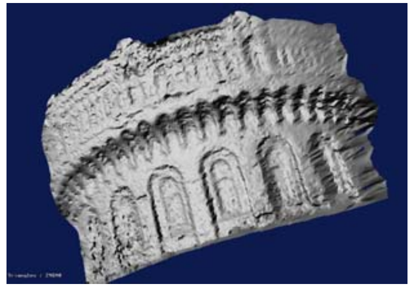
3D-Modelling from Images



Procedure

The aim of this system is the geometrical and visual modelling of objects from images taken by an uncalibrated freely moving camera. The system works without markers and without restrictions on the camera movement so that hand-held camera images and even snapshots may be used for modelling. This system may be used very successfully for a photo-realistic reconstruction of 3D-scenes. Since no camera calibration of any kind has to be known the reconstruction accuracy is not comparable with metrical image capturing systems. A typical reconstruction takes a few hours depending on the complexity of the model. As an example the photo-realistic reconstruction process of the entrance hall of National History Museum in London is shown. The single steps of this fully automatic process are described in detail in the following chapters:

Image acquisitions and preparation: First photographs of the object to be reconstructed must be taken in best possible quality. Standard consumer market cameras (either digital or analogue) can be used for this task. In case of analogue cameras a scanner is needed for digitalizing the images. It is also possible to use digital video cameras (MiniDV, DV-CAM) as a picture source if they support a progressive scan modus. Digital cameras with approximately 2 Megapixel are an ideal image source for the algorithm. Care has to be taken to take pictures with enough overlap. The overlap is necessary to allow the correspondence search for many interest points in enough images.

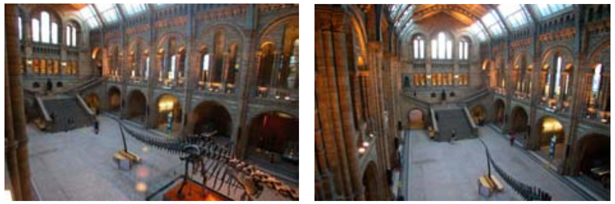


Fig. 1: Original images of the entrance hall.

In order to achieve this overlap a prominent and easily visible point on the object is chosen. The camera should always be aimed at this point while taking the photographs. Typical is a change of the image content of no more than 10-15% between subsequent images. With a typical lens it is ideal to take an image approximately every 5 to 10 degrees while moving around the object. In cases where this constraint cannot be fulfilled a manually image stabilizing pre-processing step can help.

Calibration and depth-estimation: In the next step a number of correspondences between striking interest points of different photos are calculated. These interest point correspondences are then used for the estimation of a projective camera position and orientation in 3D space. In the following self-calibration process the internal camera parameters, e.g. the focal lengths, are estimated. Since no internal camera calibration is known it is not possible to calculate metric reconstructions. Only the relative object-geometry can be retrieved. If a metric reconstruction is required, the reconstructed 3D-model can be scaled in a post processing step if a distance within the object is known. After finishing the self-calibration process, the reconstruction starts. Using the camera position and orientation which has been estimated in the self calibration process standard stereo algorithms can be used on the images. Analysing two images at a time the images are mapped to the standard stereo case (parallel image planes). This process is called rectification.

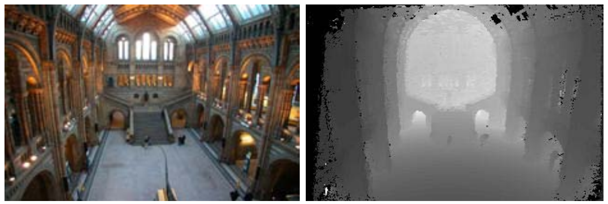


Fig. 2: Color image and according depth image.

The new epipolar rectification using polar coordinates can be used to rectify images with any camera orientation. After the rectification process, standard stereo correspondence analysis using small surface regions is used to calculate dense depth images for every input image. In every pixel of the depth image the distance between the object represented by the pixel to the camera centre is stored. It is also possible to use multi-view-stereo matching algorithms to calculate high quality depth images. Interpolation is used to get rid of small regions with either missing or incorrect depth information. Figure 2 shows a depth image of the entrance hall of the museum.

3D-Modelling: In the last process step all depth images are fused together and are then used to build a 3D-surface-mesh. A original image is used as a texture on this triangular mesh. The 3D-model is then exported into a VRML file. It can be viewed with any standard viewer or can be imported into 3D-CAD-Systems like 3D-Studio. The reconstructed 3D-models give a very realistic impression of the object and can be used in a large number of applications. Figure 3 shows a view of the reconstructed 3D-model as it can be seen during a simulated flight through the entrance hall of the national history museum in London.

Fig. 3:Virtual view of the entrance hall.