Experimental 3D Digital TV Studio

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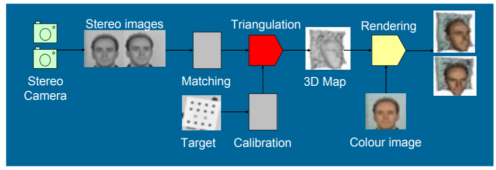
Introduction

The Michelangelo project had as its objective the development of advanced 3D capture facilities for use by medical science, ergonomics, digital media and in the production of computer games. The system was to be designed for rapid, repeated high-speed 3D image capture.

•A radical concept: **Creation of a spatio-temporal model** of a studio space.

This gives a full 3D model of all the action (being up-dated in real-time), which can be viewed from any direction: a true 3D movie.

•A unique expertise: Generation of **photorealistic 3D models** from image pairs.



Generation of photorealistic 3D models

That technology is the culmination of over a decade of research into 3D imaging at the University of Glasgow. It is based on the matching of the stereo images: the calculation of the horizontal and vertical displacement of each pixel between one image and the other. This data combined with camera calibration values allow the triangulation of each point and the generation of a range or 3D map. Finally, it can be combined with a colour image to produce a photorealistic 3D model.

Data capture system

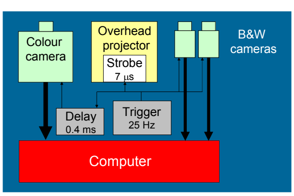
▪Capture of stereo and texture images

The basic component of the system is termed a pod and comprises a group of **3 TV cameras** (**two B&W and one colour**) and a PC equipped with frame grabbers. The monochrome cameras are used to extract range data and the colour camera records skin, clothes and hair texture.

The 3 TV cameras (640 x 480 pixels)

▪Ease stereo matching process

Since human skin is relatively featureless at the resolution available using video cameras, correlations between stereo pairs of images lack well-defined maxima. We overcome this problem by projecting onto the subject a random speckle image using an overhead projector. This gives a more rugged correlation surface, but could potentially introduce artefacts into the pictures taken with the colour cameras.



Interconnection of components of a pod

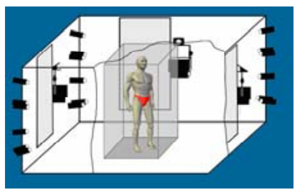
▪Synchronisation of images

The stereo pair of images is taken synchronously under speckle illumination at a frequency of 25 Hz. It is then followed by the capture of a texture image under uniform illumination. We use Strobe illumination to provide the speckle.

Digital studio

▪Dimensions and layout

The 3D studio we have developed was designed so that we could capture the data from a scene fitting within a two metres side cube. Typically, we can capture the motion of a single actor. The scene is imaged by a total of 24 TV cameras arranged in 8 pods located in the studio corners.

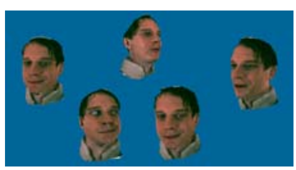


Layout of the studio with its 24 TV cameras & 4 OHPs

▪Calibration procedure and data merging

Before the system can be used, it has to be calibrated: a calibration target has to be seen by all cameras and software calculates a geometric model of each camera and its orientation in a common coordinate system. The system is then able to combine 3D data from each pod to produce complete 3D models. The whole process is parallelised so that the processing power of the 8 PCs available is exploited.

Results



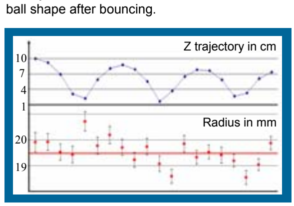
3D speaking head in experimental film

▪Validity of the concept

We generated sequences of photorealistic 3D models using a configuration for head imaging and non-photorealistic ones for body imaging - better illumination is required for body imaging.

▪Accuracy

The accuracy of the system is 1/160 of the distance from the pod to the subject. Capture of a ping-pong ball bouncing, shows that the accuracy of the measure of the radius is 0.2 mm. The system also detects the distortions of the ball shape after bouncing.



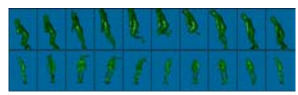
Trajectory & radius of a ping-pong ball bouncing

Conclusion

▪World's first 3D studio

▪**"True" 3D film:** the public can interactively choose their viewpoint while watching the film.

▪**3D capture of a jump:** Alternative imaging techniques require ~10 s of capture time!



3D jump with time freeze

▪Future work

▪**Occlusion prevention & correction**: More cameras, frame interpolation & templates

▪**Better illumination:** More powerful strobes

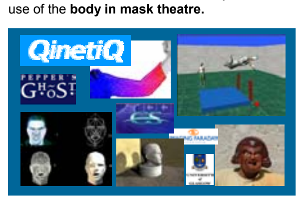
▪**Real time processing: GRID** parallelisation

Applications

▪3D motion analysis: **Soft tissue deformation** for animation of virtual characters and design of protective military equipment.

▪Computer graphics animation: Generation of character's **complex facial movements**.

▪"True" 3D films: **Fictions** and analysis of the use of the **body in mask theatre.**



Applications and partners

Award

A H Reeve Premium awarded by the IEE Council (2004) for the following paper: **An Experimental 3D Digital TV studio** by *W. P. Cockshott, S. Hoff and* ***J.-C. Nebel***, IEE Proceedings - Vision, Image & Signal Processing, Vol. 150, Issue 1, pp 28-33, 2003.

Acknowledgements

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