A NEW TECHNIQUE FOR 3D MEASURMENT USING 3D PRODUCER

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Abstract

The paper describes a study using video captured by 3D producer. An off-the-shelf NuView 3D adapter and a Cannon camcorder were used to capture 3D-video footage. The NuView allows two distinct views (left and right view) to enter the single lens camcorder. A simple single convergence control in the NuView allows the user to obtain 3D view of near and far objects. The research involves the calibration of the system for 3D measurement. A stereo-digitizing photogrammetric workstation was used to determine the accuracy of the system. The results show that system can achieve a depth accuracy of 45 mm and 60 mm at object distances of 3 and 5 m respectively. The horizontal accuracy is approximately two times more accurate than the depth.

Key words and phrases: *3D measurement, 3D producer, camcorder 3D video footage, Camcorder calibration.*

1.0 INTRODUCTION

The objective of this paper is to introduce a 3D measurement technique using 3D producer. Digital video footages were obtained by filming objects using 3D producer which is mounted onto the lens barrel of a Digital Video (DV) camcorder. The paper includes a discussion of the basic principle of 3D producer, the technique for the determination of the principal distance of the stereo-imaging system and the quality of the 3D measurement.

According to the NuView manual, the 3D producer uses a field–sequential technique to capture stereo-images for a single lens camcorder. Video image consists of odd and even fields. Accordingly, the producer uses mirrors to direct the incoming light rays onto the left and right viewing windows. A set of alternating shutters allows the right and left perspective view to be imaged onto the CCD. The timing is roughly one-sixtieth of a second per view. Each frame of video footage consists of view from the left window as odd fields and view from the right window as even fields. Consequently, each frame is field-decoded to form left and right stereo-images. Stereopairs of images can be orientated and digitized in a stereo-photogrammetric workstation.

The use of 3D video for crime investigation has been reported by Baldwin (2005). The author argued that the use of 3-D images, whether photographs or drawings, does have an important role in visualizing an incident. Problems with 3-D photography/video in its current form include: the extra work required to properly view the images and the possibility that the person viewing the image has a visual defect preventing them from seeing the image in 3-D. However, modern equipment digital cameras/camcorders and 3D viewing system are readily available to capture and properly view the images. Video animation is currently used in criminal, traffic, and civil cases by both prosecution and the defense attorneys. Consequently, holography, video animation and digitization of images will, in the near future, make viewing three-dimensional images a norm rather then a rarity. In the research a new device is used to investigate the suitability of the system for accurate 3D measurement of human subject in motion.

2.0 EQUIPMENTS

NuView 3D producer

The 3D producer allows direct recording of field-sequential 3D video onto the camcorder tape format (Fig. 1). The field of focus can be adjusted or set by the users. For example, the user may want to start the 3D viewing at a distance of 1, 2 or more metres away. The stereoscopic parallax is zero at the setting and the value increases from that point away from the camcorder. Consequently, the depth increases as the stereo-parallax increase.

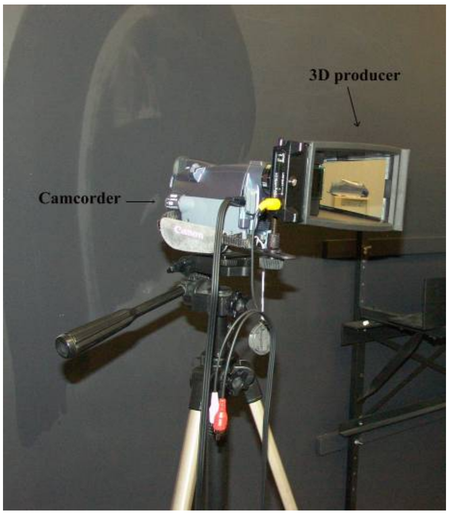

Fig. 1. A 3D video system. Note the 3D producer is attached to the lens mount of the camcorder.

Camcorder

A Cannon camcorder was selected for this research project. The camcorder has a focal length ranging from 7.1 to 105 mm. The camcorder becomes a 3D video system when NuView is mounted onto the camcorder lens barrel.

3.0 METHODOLOGY

Design and calibration of a portable camera calibration control frame

Fig. 2 shows a control frame used in the calibration. Retro-targets were placed on the frame at four levels of depth (0, 25, 50 and 75 mm). The coordinates of the Retro-targets on the control frame were obtained using photogrammetric technique. Four convergent images were taken of the control frame and an EO device using a Sony FSC 828 digital camera. A bundle adjustment was carried out using Australis bundle adjustment software. RMSs of the coordinate were 0.08, 0.08 and 0.09 in the x, y and z-axis respectively.

Fig 2. A calibration range constructed for the research.

3D video system calibration

Calibration of the 3D video system was carried out using the constructed calibration range. Both the camcorder lens and the 3D producer were set to focus at infinity. Three sets of four short convergent video footages of the range were recorded during the calibration. Australis was used to compute the system lens parameters using the images (Chong 1999; Fraser 2000).

Evaluating the measurement accuracy of a stationary object

Objects were placed at 5m in front of a test range. A short five-second video footage of objects were recorded and each video frame was decoded to extract individual left and right view of the object. Two stereopairs were selected for stereo-digitizing in a DVP stereo-workstation. Interior, relative and absolute orientations were carried out on each stereopair. The coordinates of the test range was used to carry out the absolute orientation. Test points on the object were digitized for further study.

Evaluating the measurement accuracy of an object in motion

The 3D video system was set up to record a human subject walking toward the system (Fig. 3). The path of the subject's walk was marked according to the distance from the imaging system. The distance from the system to the test range was set at 5 m and markers were placed at 3.5, 4 and 4.5 m position. The subject would stop moving at each marker momentary. The markers were used to determine the accuracy of the motion tracking.

The video frames were decoded to extract individual left and right view of the subject at the marked positions. Three stereopairs were selected and Australis was used to carry out interior and exterior orientations. The computed markers' positions were compared with the true position to determine the accuracy of tracking human movement.

Fig. 3. A stereo-pair showing a human subject movement being tracked.

4.0 RESULTS

The test result using a single object average 35, 36 and 52 mm in the x, y and z respectively. The test results of human subject motion are listed in the Table 1. In the table dx, dy and dz are the difference between true and measured coordinates.

Table I. Results of human motion tracking.

Position marker	dx (mm)	dy (mm)	dz (mm)	3D distance (mm)
3.5 m	12	17	28	35
4.0 m	14	20	31	39
5.0 m	21	24	62	70

5.0 CONCLUSION

A 3D producer was used to obtain stereo video footage of object and human subject. The system is easy to operate and the decoding software is very user friendly. The results of various tests show that the system is capable of obtaining accurate 3D measurement using a single camcorder. As the resolution of off-the-shelf camcorder is coarse the video footage can only achieve sub-centimetre accuracy under ten metres object distance. Nevertheless, the stereo video footage can be viewed in 3D perception satisfactorily.

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