Traversing Complex Environments Using Time-Indexed High Dynamic Range Panoramas

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1 Introduction

Static panoramic photography has been shown to contribute to context-rich descriptions of regions under archaeological study [Allen et al. 2004]. We show that fast traversal through a matrix of dynamic panoramas can allow users to quickly locate specific target features within a complex scene. Results are presented using two large archaeological monuments as a test subjects.

2 Capture and Processing

We collect source images using a camera with a circular fisheye lens, articulated by a custom rotation controller. Capture is automated. The camera is positioned by unidirectional, monotonic rotation around the lens nodal point. Exposures are taken at ten discrete rotation intervals. In order to enable high dynamic range output, three bracketed exposures are acquired for each camera position.

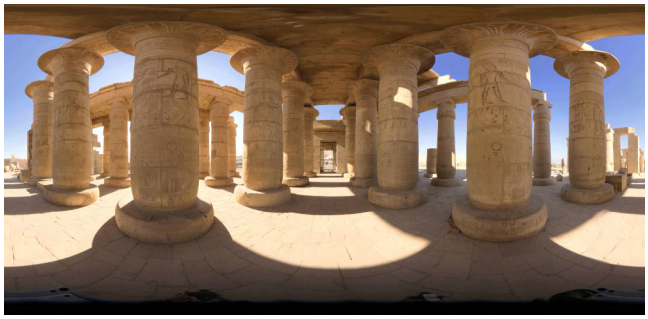

Figure 1. Initial image assembly from fisheye images.

As the capture process iterates, a time-lapse sequence is built frame by frame with each successive revolution of the camera. The rotation period is approximately 1.8 minutes. In the processing steps, source images are geometrically calibrated to account for lens distortion and an HDR representation is computed. A rendered view for one frame of a panoramic sequence is shown in Figure 1.

In our viewer application, we first index the recorded panoramas in a spatial network, using global coordinates recorded during image capture. After initialization, users interactively navigate through the image data using a novel multi-node viewer in which each node represents a different location on the time axis. The user's current position is drawn in the viewer's main window. The 3D location for each image capture location in the dataset is projected in this view as navigation links (Figure 2). By hovering over a given link, the user obtains an interactive preview of the linked panorama. In a separate window, a ground plan of the site enables spatial domain traversal of the scene. Indexed metadata is presented in a third window. View information between windows is updated in real time via an XML data stream (Figure 3).

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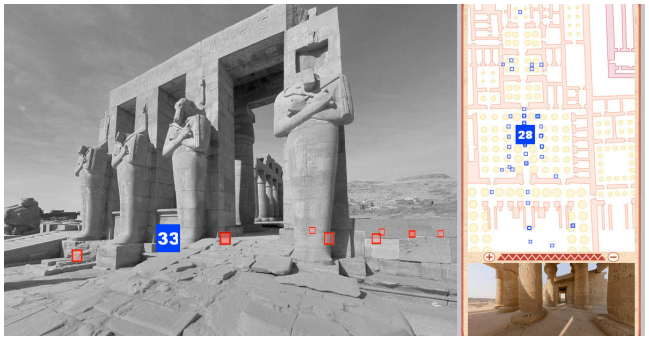

Figure 2. User interface for the panoramic viewer.

3 Results and Validation

To test our system, we acquired 30 time-lapse image nodes in situ at Chichén-Itzá, Mexico. Separately, we acquired 60 image nodes at the Temple of Ramses II, Egypt. Archaeological researchers were asked to use our viewer system to identify 20 specific, non-repeating visual features present in each actual scene. They were then asked to identify the same features by viewing the set of rectified input photos gathered during our capture step. We found the seek time for a given target feature when using our system was faster by a factor of 3.1 for the smaller data set, and a factor of 7.4 for the larger data set. Our approach was shown to be an efficient, low cost technique for interrogating complex real-world scenes. We also found that the time advantage scales with database size.

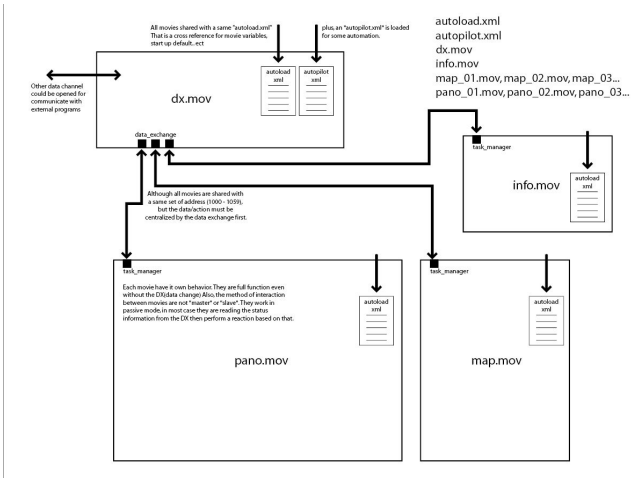

Figure 3. Components of the interactive viewer

References

ALLEN, P., FEINER, S., TROCCOLI, A., BENKO, H., ISHAK, E. AND SMITH, B. 2004. Seeing into the Past: Creating a 3D Modeling Pipeline for Archaeological Visualization. In *Proceedings of the 3D Data Processing, Visualization, and Transmission, 2nd international Symposium on (3dpvt'04),* IEEE Computer Society, 751-758.