

High-Resolution Relightable Buildings from Photographs

Francho Melendez
The University of Manchester

Mashhuda Glencross
The University of Manchester

Gregory J. Ward
Dolby Canada

Roger J. Hubbard
The University of Manchester



Figure 1: (Left) Input Data: 10 of the 40 photographs taken for the wide-baseline sequence, and Material Exemplars. (Middle and Right) Model rendered under novel view-points and lighting conditions.

1 Introduction

We present a quasi-automatic image-based building reconstruction system that recovers fully relightable models by approximating both albedo and sufficient textured surface detail to reproduce complex self-shadowing effects. Albedo and surface geometric detail are recovered through an exemplar-based transfer approach. We focus on a simple data capture, inexpensive equipment and automatic processes. This system provides perceptually high-quality models approximating well the visual appearance of the real building.

2 System Structure

Employing a standard uncalibrated digital SLR camera, we capture two types of image data under diffuse lighting conditions as input to our model recovery pipeline; a hand-held wide-baseline sequence, and textured material exemplar image data consisting of a flash and a no-flash fronto-parallel view of a representative material. The wide-base line sequence is used to recover a low-resolution model that recovers the global structure of the building and to reconstruct a texture map. Exemplars capture the material properties in accessible areas. We transfer the albedo and high-frequency geometric detail from these exemplars to the full model. The system pipeline is divided into the following steps:

- **Gross-scale geometry:** We use automatic *Multi-view Stereo* techniques to recover the global structure using the wide-baseline sequence.
- **Multi-view texture mosaicing:** An automatic texture reconstruction algorithm uses *Markov Random Fields* to optimally combine the multi-view data into a combined texture map.
- **Material Exemplars:** Flash/No-flash image pairs are used as samples of the different materials present in the building façade. *Surface depth hallucination* [Glencross et al. 2008] estimates albedo and surface detail for these exemplars.
- **Albedo and Surface Detail Transfer:** We transfer surface detail and albedo from the exemplars to the texture mosaic using Histogram Matching resulting in a per-texel depth map [Melendez et al. 2011].
- **Geometry Fusion:** A frequency-based method is used to combine both geometries resulting in a high-resolution model.

The process is automatic apart from simple cleaning of the gross scale model. This consists of removing excess geometry, and a user

guided segmentation process of the texture map to assign exemplars with different regions in the model.

3 Exemplar Based Transfer Approach

The main contribution of this work is the idea of approximating the material properties and surface detail of a model by transferring them from a series of exemplars. This can be potentially included in any reconstruction pipeline to add high-frequency detail and albedo, transferred from exemplars to the recovered texture.

4 Results and Conclusion

Figure 2 shows the plausible appearance recovered with our system by comparing side-by-side a photograph¹ with a rendering of the model under approximately matched lighting conditions.

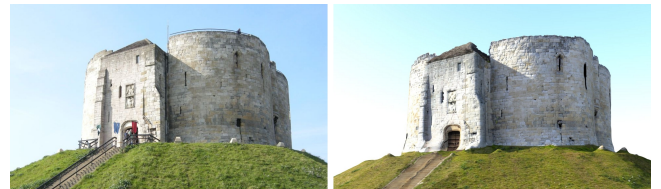


Figure 2: (Left) Photograph, (Right) Synthetic Rendering.

This system provides a low-cost way to acquire highly detailed relightable models through a simple capture process and with modest user interaction, appropriate for a range of visualization and entertainment applications. These models represent a great improvement over the traditional low resolution plus texture models, and allows us to reproduce self-shadowing effects which have been shown to be important to provide perceptual plausibility.

References

- GLENCROSS, M., WARD, G. J., JAY, C., LIU, J., MELENDEZ, F., AND HUBBOLD, R. 2008. A perceptually validated model for surface depth hallucination. *ACM SIGGRAPH* 27, 3, 59:1 – 59:8.
- MELENDEZ, F., GLENCROSS, M., WARD, G. J., AND HUBBOLD, R. J. 2011. Relightable Buildings from Images. *EG 2011 - Areas Papers*, 33 – 40.

¹<http://www.nicolaconforto.com/erasmus/img/york20080927>