INTEGRATION OF 3D SfM MODELS WITH GIS

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Keywords: 3D models, SfM, GIS, integration This paper is being submitted as a poster to the IPCV'12 conference.

Abstract

In this paper, the application of structure-frommotion computer vision technique for 3D reconstruction is studied. Furthermore, a method to integrate the resultant 3D models into Geographic Information Systems is proposed. Structure-frommotion is a low cost and fast alternative to other 3D reconstruction techniques such as LIDAR or Stereography.

1. Introduction

3D reconstruction has recently been receiving a lot of attention from researchers in Computer Vision field. In the same way, Geomatics has been experiencing an increased interest among researchers and consumers, thanks partly to the development of web-based Geographic Information System tools such as Google Maps.

In 3D reconstruction there are several techniques that allow us to produce models of the exteriors of buildings. These techniques can be active and passive [1]. Among active techniques, LIDAR is the most used. LIDAR systems allow the reconstruction of buildings by sending pulses of light to the surface and measuring the round trip time (RTT) of the pulses [2]. Among passive techniques, SfM is probably the second most used technique, just after stereography. Unlike Stereography in which two or more cameras are needed, SFM allows 3D reconstruction by using only a single camera [3].

While the integration of Geographic Information Systems with 3D models captured by LIDARs is quite common, the integration with models from SfM is still to be achieved. In the latter case, the integration is cheaper and easier. This is because LIDARs require high cost devices to generate 3D models, while SfM only needs one camera.

In this paper, a method to integrate the 3D models generated from a structure-from-motion pipeline to a Geographic Information System is proposed.

The rest of the paper is organized as follows: in section 2 related work is described. In section 3, our proposed method for integrating 3D models generated

by using SFM algorithm with Geographic Information System is detailed. Finally, conclusions and future work is presented in section 4.

2. Related Work

Related work can be found in the Phototourism project [4]. Phototourism uses a structure-from-motion pipeline to reconstruct 3D places from the photos stored in Internet images databases such as Flickr. However Phototourism does not mention any integration to a Geographic Information System, which is the main objective of this paper.

There is hardly any work that focuses on the integration of Geographic Information System and 3D SfM models. However, previous work that integrates the resultant 3D models from a LIDAR 3D reconstruction process to a Geographic Information System can be found [5].

3. Methods and system overview

The proposed integration process is divided into 5 phases. The system input is a set of images captured using a low-cost imaging system (Figure 1).

In the first phase the system searches for local features in the captured images using the SIFT algorithm [6].



Figure 1. Input images captured using a low-cost imaging system

In the second phase, features from one image are matched with features from the other images. If the 2D positions of the features in one image and their 2D positions in the other images are known, the 3D position of the camera and the feature points can be obtained using a process called Bundle Adjustment [7]. The output of this phase is a set of 3D sparse points and the 3D position of the cameras (Figure 2).



Figure 2. 3D sparse points

Then a technique called Multi-View-Stereo (MVS) [8] is used. The output of this phase is a set of 3D dense points (Figure 3).



Figure 3. 3D dense points

In order to obtain a mesh from the point cloud a Poisson Surface Reconstruction algorithm is applied [9] followed by a process called Vertex Attribute Transfer, which transfers certain attributes such as textures to the mesh (Figure 4).

Finally in order to reduce the number of polygons, a technique called Quadric Edge Collapse Decimation is applied [10]. At this point, the model is ready to be exported to a Geographic Information System.

4. Conclusions and future work

A method to integrating 3D models reconstructed by using SfM algorithm and GIS are proposed. This integration can be a scalable, low cost alternative to the integration of 3D models obtained using LIDAR. Future work can be done in further process automation and optimization.



Figure 4. Post processing results

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