복원된 3차원 점들로부터 3차원 객체 모양 구성

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Construction of 3D shapes of objects from reconstructed 3D points

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요 약

Estimation of 3-D objects from 2-D images is inherently performed by either motion or scene features methods as it has been described in different literatures. Structure from motion as a method employed in this study uses calibrated camera and reconstructed 3-D points from the structure of the scene for reliable and precise estimates. In this study we construct 3-D shapes using color pixels and reconstructed 3-D points to determine observable differences for the constructed 3-D images. The estimation using reconstructed 3-D points indicates that the sphere is recovered by the use of scale factor due to its known size while the one obtained by using color pixels has look similar to the former but different in the scales of the axes.

1. Introduction

The process of constructing 3-D scenes from 2-D images is referred to the study of Structure from Motion [1, 2]. Many algorithms including the random sample consensus (RANSC), have been established to solve, model and estimate SfM because is one among the core problems in computer vision [2]. Meanwhile SfM is gaining recognition because of its impetus in solving various problems from a diverse of fields i.e. geosciences, cultural heritage structure analysis to mention a few [3]. Within the mentioned fields thereof, the major applications are navigation, visualization and animation of which 3-D scenes are constructed from 2-D images [3]. Most of the studies have dedicated their estimation strategies in either calibrated or uncalibrated cameras being used with specified algorithms followed for the sake of recovering camera motion and reconstruction of the 3-D structure of a scene from two or more images at large [4]. In this study we will use a calibrated camera to estimate the 3-D reconstructed points from the camera matrices and the color pixels obtained from each reconstructed color point to summarize and give the corresponding features of the obtained 3-D structures.

2. Methodology

During the process of constructing 3-D structure from the 2-D, there are several procedures involved that includes determination of points of correspondence, estimation of correspondence matrix, computation the motion of the camera, match a dense set of points between the two images, determine the 3-D locations of the matched points, detecting an object of a known size in this experiment we use a sphere to represent the earth structure and recovering the actual scale of the sphere that lead to a metric reconstruction. We used computer vision tool box from MATLAB that has 3-D shape construction codes with structure from motion from two views to determine the 3-D points obtained by a function *triangulate* that reconstructs matched points from two images and camera matrices. We also determined the color pixels of each reconstructed point by the function *sub2ind* that determines the color index of each reconstructed point and returns the linear index equivalent to the row and column subscripts of the size matrix and matched points' matrix. We used *pointCloud* function to measure the physical world surfaces and geometrical shape fitting to 3-D point clouds of our image that has a spherical shape representing the earth. We finally used the *pcfitsphere* function that returns a geometrical model that describes sphere with its features as shown in the 2-D image then reconstructed to 3-D by a rotation followed by a linear translation projection. From the obtained results by using MATLAB functions as detailed in the foremost part of this paragraph we construct a 3-D surface by using constructed 3-D points and another surface by using color pixels.

3. Experimental Results

Two images of the same scene were merged so as to determine the points of correspondence between the two images by using *extractFeatures* followed by *matchFeatures* functions in MATLAB. The next step was to determine the strongest corner points in the first image that were used as vision racking points for the image in 2-D by matching the correspondence points from the second image with the matched inliers

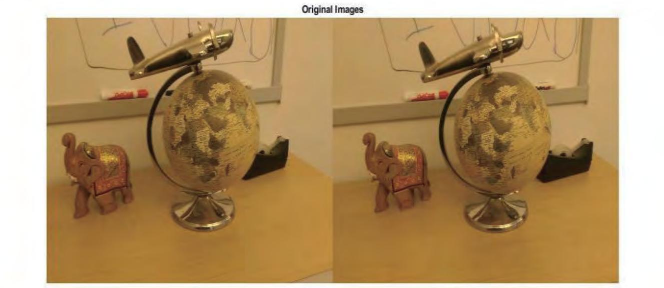

Fig. 1. Original Images merged together

Fig. 2. Strongest corner points from the first image

Lastly from point cloud the sphere was obtained as a result of 3-D reconstructed surface from the two combine images from the same scene in the first step. Hence this procedure thoroughly stipulates how to recover a camera motion and reconstruct it to a 3-D structure from two images taken with a calibrated camera at a same scene.

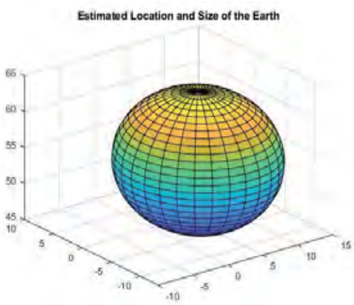

Fig. 3. Estimated location and surface of the earth

We draw a 3-D surface made by the reconstructed 3-D points from the same image in 2-D and the resulting surface was a sphere that looked similar to the one reconstructed by the functions enumerated in the paragraph methodology. We used the functions *delaunay* that formulates a matrix representing the set of triangles that make up the triangulation. The matrix is of size m-by-3, where m is the number of triangles within a matrix. Each row of a new formulated matrix specifies a triangle defined by indices with respect to the points.

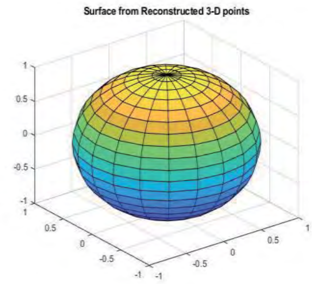

Fig. 4. A sphere drawn by using reconstructed 3-D points

We also draw another sphere using the same functions used to obtain Figure 4 using the corresponding color pixels extracted from RGB color model. The resulting figure is also a sphere of the same nature but different magnitudes in terms of axes.

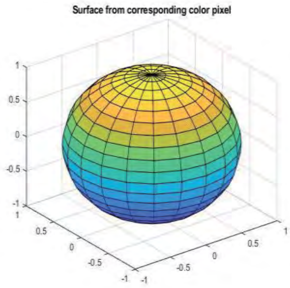

Fig. 5. Surface from corresponding color pixels

Generally the spheres generated by the corresponding color pixel and the corresponding 3-D points have the same features which are preferably different from the features of the sphere obtained by the first method that involved a number of steps to extract the sphere from the real image as shown in the first paragraph of the experimental results and discussion.

4. Conclusions

In this paper, we conclude that both shapes recovered from the reconstructed 3-D points using the scale factor and color pixels are the same sharing the same features and properties with a minor difference in the scales for the axes. Generally the spheres generated by the corresponding color pixel and the corresponding 3-D points have the same features which are preferably different from the features of the sphere obtained by the first method that involved scale factor to construct the sphere from the 2-D image as shown in the first paragraph of the experimental results and discussion.

Acknowledgment

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References

[1] Zuffi, S., Kanazawa, A., Jacobs, D., & Black, M. J., "3D Menagerie: Modeling the 3D Shape and Pose of Animals", *Proceedings IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* pp. 5524-5532, 2017
[2] Xiang, T & Cheong, L, "Understanding the Behavior of SFM Algorithms: A Geometric Approach" International Journal of Computer Vision. Vol. 51, No 2, pp.111–137, 2003.
[3] Wey et al., "Applications of Structure from Motion: a Survey", Journal of Zhejiang Univ-Sci C (Computer & Electronics). Vol. 14, No.7, pp.486-494, 2013.
[4] Hartley, R & Andrew, Z., "Multiple View Geometry in Computer Vision", 2nd Edition. Cambridge, 2000.