A Novel Dodging Method for Colored Terrestrial LiDAR Point Clouds

Quan Li, Xiaojun Cheng, Wang Guo
College of Surveying and Geo-informatics, Tongji University

Terrestrial LiDAR (Light Detection and Ranging) has gained its popularity in three dimensional reconstructions for its fast speed and high accuracy. Besides detailed geometric information, current LiDAR systems can also obtain color information. The refined texture can be rapidly and automatically generated by these colored point clouds. However, the colors of the point clouds of the same targets from different scan stations may vary significantly due to the environmental effects, thus leading to unsatisfactory visual results of the 3D model texture. In this study, a new dodging method for colored point clouds has been proposed. This method takes the RGB values as three-dimensional coordinates and carries out color dodging through the 3D coordinates transformation. Compared with previous methods which often convert three-dimensional point cloud data into two-dimensional images, the proposed method can avoid the loss of precision due to data conversion and also improve the computing efficiency. The colored point clouds of an ancient pagoda were used to testify the efficiency of the proposed method. And the results indicated that the proposed method had effective improvement in the quality of the point clouds colors. The difference among the color intensity and saturation were greatly reduced. The texture generated by the dodging results showed perfect visual results.

Introduction

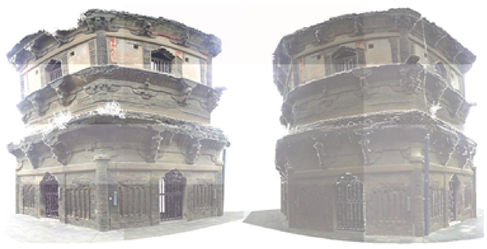
In three dimensional reconstructions, the fidelity of the model depends greatly on the model texture and during 3D modelling procedure, the fineness of the texture can be rather demanding. In current research, most three dimensional reconstruction with LiDAR data, the texture of the model consists of images acquired by external digital cameras. The acquired images need to be corrected and cropped before texture-mapping to the 3D model.

In order to get the complete point clouds of the target, it often needs to be scanned in different stations and from different angles. Although through this way the completeness of the target point clouds can be guaranteed, the influence of the illumination to the scanning results has not been taken into consideration. The colors of the point clouds can be significantly affected by the illumination angles and surrounding occluders. The colors of point clouds from different scan stations can be varied a lot.

Original

Traditional Dodging Method

Several dodging methods for 2D RGB images have been developed and most of them can be realized automatically. For instance, the MASK dodging method can derive relatively good results but also can cause local fuzziness and color distortion and this method is only applicable to single image dodging. The Wallis dodging method can intensify the brightness and contrast of the darkened area of an image and is applicable to multiple images. And the Retinex dodging method can maintain the fidelity of the image color and is applicable to single image dodging. However, this method cannot be used to process images with uneven distribution of color contrast.



Wallis

MASK

Experiment

Reference

Original

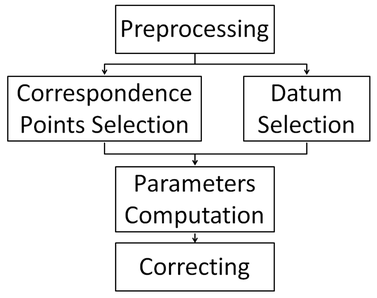
Corrected

Improvement of color transformation model & Correcting Procedure

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} k_R & n_G & m_B \\ m_R & k_G & n_B \\ n_R & m_G & k_B \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \Rightarrow \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} k_1 & \omega_G & -\omega_G \\ -\omega_B & k_2 & \omega_R \\ \omega_G & -\omega_R & k_3 \end{bmatrix} \begin{bmatrix} R'' \\ G'' \\ B'' \end{bmatrix}$$

$$\Downarrow$$

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} k & \omega_G & -\omega_G \\ -\omega_B & k & \omega_R \\ \omega_G & -\omega_R & k \end{bmatrix} \begin{bmatrix} R'' \\ G'' \\ B'' \end{bmatrix} + \begin{bmatrix} \Delta R \\ \Delta G \\ \Delta B \end{bmatrix}$$



Results & Conclusion

Registration result of 3 scan stations using original point cloud data

Registration result of 3 scan stations using point cloud data with corrected color

The proposed method can derive fine, unified and realistic texture which can meet the requirements of most 3D modeling applications.

Instead of transforming the 3D point clouds into 2D imagery and applying traditional dodging methods, this method takes the color values of each point as coordinates in different color spaces. Through coordinate transformation the color of each point can be modified.