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Detection and Digital Representation of Ancient Architecture Damage Based on Laser Point Cloud: Case Study of the Zhengding Ancient City Wall

Jinyun Wang

Beijing Normal University, Faculty of Geographical Science, State Key Laboratory of Remote Sensing Science, Beijing, China (201831051030@mail.bnu.edu.cn)

Abstract: In view of the qualitative digitization and quantitative analysis of the damage status of ancient relics, this paper presents a method to automatically extract the surface damage area of the Zhengding Ancient City Wall located in Zhengding County, Shijiazhuang Hebei Province in Central China. The existing city walls are considerably damaged because of various historical reasons and the development and construction of the town during which most of the brick walls were removed . 3D laser scanning technology is applied for external scanning and internal modelling of the city wall surface. Information is acquired from the point cloud model using various software and hardware platforms and various information extraction algorithms to achieve automatic information acquisition about damaged areas of the ancient building; then, this damage is calculated, its degree, shape, and distribution is visualized and a scientific and informative guide for restoration and protection is provided. First, the point clouds of the damaged area were detected from the acquired laser point clouds using spatial change detection. Then, the micro-deformation damage area is supplemented by extracting the local feature of the point cloud model. Finally, the quantitative calculation and visualization of the extracted damage area is conducted. The experimental results show that the damaged region can be extracted effectively based on change detection and geometrical features. Different principles on which the selected methods are based lead to different extraction and optimization criteria. Therefore, by combining a variety of information extraction methods, the quantification and distribution of the damage status of cultural relics can be more comprehensively expressed, which can provide important data for the renovation and restoration of relics.

Keywords: three-dimensional modeling; point cloud; terrestrial laser scanning; ancient architecture; building preservation