Applied Mechanics and Materials
ISSN: 1662-7482, Vols. 333-335, pp 1492-1495
doi:10.4028/www.scientific.net/AMM.333-335.1492

Online: 2013-07-15

New Technology of Surveying and Mapping in the Application of Deformation Monitoring

Yanping Feng [1, a], Tianzhu Zheng [2,b]

[1]Land resources and Urban Planning Institute, Shijiazhuang University of Economics, Shijiazhuang, Hebei, 050000, China

[2]Basic Courses Department, Xingtai Polytechnic College, Xingtai, Hebei, 054035, China

[a]xdd0311@sina.com, [b]110342665@qq.com

Keywords: 3D laser scanner, point cloud data, deformation monitoring

Abstract. Deformation monitoring is one of the engineering measurement tasks. Three-dimensional laser scanning technology as a new technology has developed in recent years. With its high accuracy, high density, real-time and initiative, it wins great favor of people in the industry. Its unique technical advantages and characteristics make it widely used in many fields. The article summarizes the application of deformation monitoring methods and discusses the characteristics of ground 3D laser scanner, its working principles, its application in the field of deformation monitoring and some problems that should be considered.

Monitoring of Deformation

The main task of deformation monitoring of buildings is to monitor the building over time in the spatial information, the greatest degree to obtain continuous space deformation data, analysis of deformation regularity of buildings, change trend of building effective forecasting, to ensure building security operation [1]. With the development of science and technology of Surveying and mapping development and progress, deformation monitoring technology is also constantly enriching and improving. The method of deformation monitoring usually include the conventional geodetic methods, special geodetic methods, modern geodetic surveying and photogrammetric method.

The conventional geodetic method includes laid into a network to determine the monitoring network of one-dimensional, two-dimensional, three-dimensional coordinates of the adjustment, as well as various intersection method, polar coordinate method, the geometric leveling method, trigonometric leveling method, it is by measuring the direction, angle, length and height equal to general method of deformation monitoring of the earth routine instrument use. The conventional geodetic instruments mainly include: optical theodolite, optical level, electromagnetic wave distance measuring instrument, electronic theodolite, electronic level, electronic total station instrument etc.

Modern geodetic methods mainly include, the deformation monitoring which based on a total station instrument, based on GPS deformation monitoring, based on digital photogrammetry and based on 3D laser scanning technology. Modern geodetic method has the obvious advantage which compared to the traditional geodetic, it can obtain the three-dimensional coordinates of each point of the deformation body required by measuring instruments. Modern geodetic methods, unlike traditional geodetic as by measuring the deformation of one-dimensional coordinates of the point, the two-dimensional coordinate comprehensive three-dimensional coordinates of the deformation point, that save time and effort. Modern geodetic instrument used mainly include: Total Station (Robot), GPS receiver, digital camera (digital sensor), 3D laser scanner [2]. Photogrammetry as a kind of a method of remote sensing data collected can be used for the measurement of various forms of. Previously, the specialization, the price of more expensive equipment, the work needed to environmental constraints, data processing technology is complex, processing cycle is long, slow information feedback and other reasons it is difficult to get good promotion. In recent years, with the rapid development of computer technology, the use of high quality digital camera and high resolution measuring instruments, photogrammetry has entered the era of digital photogrammetry, digital photogrammetric point determination accuracy has been significantly improved, Photogrammetry has opened wide future in the application of deformation monitoring due to the precision is improved. GPS as a modern space positioning technology new, has been gradually in more and more fields to replace the conventional optical and electronic measuring instruments, the application of GPS can be said to be a revolutionary change measurement technology, GPS positioning technology has got fast popularization and application in the monitoring of deformation, become a new type of very the development potential of the deformation monitoring method, classical static measurement and dynamic measurement method is the main method of GPS for deformation monitoring.

Deformation Monitoring Based on 3D Laser Scanning Techniques

Laser ranging technology has been used for decades, but the laser measuring technology non-contact 3D laser scanning equipment can be realized just in recent years with the development of automatic control technology, in the surveying and mapping industry, 3D laser scanning technology is a high technology after the GPS technology, 3D laser scanner is a three-dimensional measurement instruments, because of its fast scanning speed, without contacting the measured target, dark and night will not affect the work of the field, measuring point position precision high, high degree of automation, information rich, point density is high, the universal application of very fast. The instrument does not depend on the level surface, is not affected by the precision of the geoid, the technical advantages determine the three-dimensional laser scanning technology will have a wide application prospect in the field of deformation monitoring. A ground 3 dimensional laser scanning system is mainly composed of three parts: the scanner, the controller (computer) and the power supply system is shown in Fig. 2. Laser scanner itself consists of laser ranging system and the laser scanning system, but also the integration of CCD and instrument internal control and correction system. In the instrument, the two synchronous mirror quickly and orderly rotation, laser pulse emitter emits a narrow beam of the laser pulse are swept the area to be examined, measurements of each laser pulse emitted from the surface to be measured and then return to instrument the elapsed time (or phase) to calculate the distance, at the same time scanning control module control and measurement of each pulse laser angle, and finally calculate the 3 dimensional coordinates of the laser point on the object to be measured in [3], the basic principle of terrestrial 3D laser scanner measurement as shown in Fig. 2.

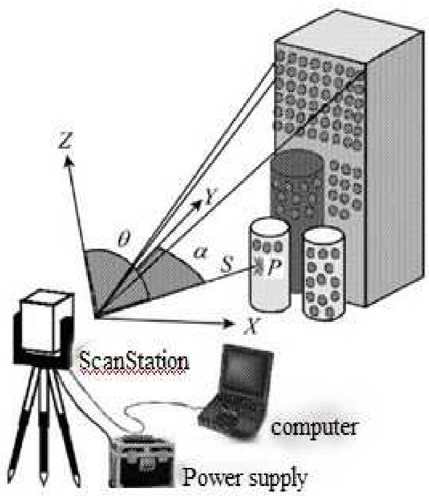

Fig.1 The terrestrial 3D laser scanning system

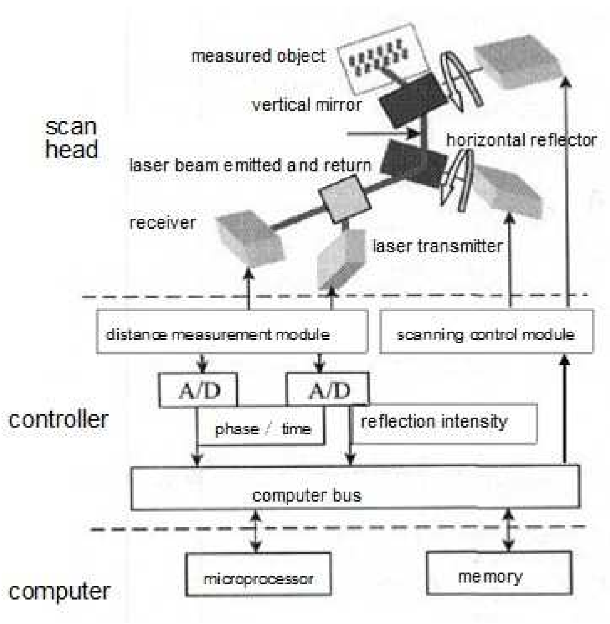

Fig. 2 The basic principle of terrestrial 3D laser scanner measurement

Classification and Main Technical Parameters of Terrestrial 3D Laser Scanner

Laser Scanner Terrestrial 3D laser scanner measurement method can be divided based pulse; based on phase difference; based on the principle of triangulation distance. Uses can be divided into indoor and outdoor type. That is, long-distance and short-distance different. Usually data based on the phase difference between the principle of three-dimensional laser scanner odometry is shorter, only 100 meters or so. While based on the pulse principle of three-dimensional laser scanner odometry is longer measurement range of up to 6 kilometers. Leica Pulse 3D laser scanner ScanStation C10, for example, Leica 3D laser scanner the ScanStation C10 has a full field of view angle measurement level accuracy of dual-axis compensator, a good working distance, speed scan, can be combined, may upgrade and integrate into routine measurements, with powerful Cyclone post-processing software, easy to complete the scan data processing. The main technical parameters are as follow [4]:
Laser Color: green, wavelength 532nm
Laser Class: 3R (IEC 60825-1)
Single ranging accuracy: 4mm
Single measurement point accuracy: 6mm
Scan range: 300 m @90%; 134 m @ 18% reflectivity (recent scan range of 0.1 m)
Scan speed: maximum speed of 50,000 points / sec
The scan spot diameter: 0-50m range: 4.5mm
Scan point spacing: spacing; smallest self-define the horizontal and vertical direction is less than 1mm
Scan field of view: vertical 270 °, horizontal360 ° [5]

Application of 3D Laser Scanner in Deformation Monitoring Field

The non-contact measurement of 3 dimensional laser scanner, large area, high density point cloud data collected 3 dimension data, for 3D laser scanning system in the application of building deformation monitoring provides a good means of monitoring, the deformation monitoring field has to be widely used. The monitoring steps are to lay control network and to collect point cloud data. In order to be able to accurately reflect the building's vertical, displacement, tilt, deflection, crack, swinging and rotating shape variables, scanning process is divided into: station, directional, coarse and fine scanning. The overall framework of the building is coarse and rough scanning, the subsidence monitoring points and can reflect the building deformation feature points accurately scan. After the acquisition of point cloud data, the need for interior point cloud data processing of a series of point cloud data. Software is a 3D laser scanner supporting post processing software. Point cloud data processing process is divided into: point cloud splicing, point cloud pre-processing and modeling. Through comparison of two fine scanning results, we can get the bits of transitional variables.

Characteristics of Ground 3D Laser Scanner and the Problems of Deformation Monitoring worth Considering

It is difficult for us to make direct use of 3D laser scanning data, since the three-dimensional laser scanning system gets a large amount of point cloud data, and due to the multiple range images of a target, point cloud scattered and no entity feature parameters etc. As for the concept of deformation monitoring with 3D laser scanning technology, the theory of researching deformation monitoring related to 3D laser scanner and the methods of data processing and its further application are mainly reflected in the following aspects:

The deformation monitoring of three-dimensional laser scanner is not applicable to the deformation monitoring based on point, especially suitable for measuring objects and details of the measurement surface complex, or by the deformation feature, its artificial projection feature information instead of deformation monitoring point, which is suitable for monitoring the object without deformation monitoring point.

There are some problems to fully research 3D models of buildings and matching models. Three-dimensional laser scanning is the deformation of the 3D point cloud data collected and surface texture information, large amount of data processing, 3D data model of the building can be establish by point cloud information, texture information use to establish the simulation model of the building and get the deformation required by the overall contrast of two models in different periods. To obtain the deformation amount involved in the model matching problem, model construction has certain subjectivity.

The results of deformation monitoring of building is on the whole building monitoring object model for stress analysis, and the analysis of deformation based on the points are different in essence, so it is necessary to this aspect of the deformation analysis of the theory and method of mining.

At present, there are no national standards and specifications of three-dimensional measurement. There are also no standards of charges. Thus, it brings a lot of difficulties to the practical work, causing confusion in the market and quality can not be guaranteed. Now we need to lay down national technical standards and norms, as well as corresponding standards of charges. Also, we need to study standards of evaluating model accuracy and to establish evaluation system for monitoring data accuracy.

The 3D laser scanner can quickly and accurately determine the surface, volume, section, contour etc., conveniently to transform 3D model into CAD system [6]. But the 3D laser scanner is a black box system. It is difficult to be tested and proofread, and is also not fully qualified for the job of engineering measurement with high precision, such as engineering measurement and industrial measurement. large amount of data processing need special software and the equipment cost is too high.

Finally, we need to improve the further development of the existing functions of data processing software and new functions. Besides, we need to develop integration with other sensors, such as integration with photogrammetric / CCD, integration with dynamic measuring vehicle, mutual use of its advantages in order to expand applied fields and improve work efficiency. We must improve the further development of existing data processing software and new function and study the standards of 3 dimensional laser scanners from static measurement to dynamic.

References

[1] Han Ziye，Xue Xingqiao: The Chinese Journal of Geological Hazard and Control, Vol. 16 (2005), p.138-141

[2] Zhang Zhenglu: *Engineering Geodesy* (Wuhan University Press, Wuhan 2005).

[3] STAIGER R: *Terrestrial Laser Scanning Technology,* Systems and Applications [A]. 2nd FIG Regional Conference, Marrakech, Morocco, December 25, 2003 [C] . [s. l.] : [s. n..], 2003.

[4] Xu Jinjun, Zhang Minwei: Bulletin of Surveying and mapping, (2007), p. 47-50,70.

[5] Information on http://baike.baidu.com/view/1848119.htm.

[6] Hong Libo, Wang Yanmin, Guo Jingjun, Chen Pinxiang:Bulletin of Surveying and Mapping, (2008), p. 1-5