3-D Laser Scanning Landslide Deformation Monitoring and Data Processing Based on Computer Cluster

Shuhui Jiang\(^a\), Xinjie Deng\(^b\) and Mingjian Chen\(^c\)
Chongqing Jianzhu College, Chongqing 400072, China.
\(^a\)jsh0529@126.com, \(^b\)1499548393@qq.com, \(^c\)376674265@qq.com

Abstract. Landslide monitoring is an important technical means for monitoring and forecasting landslides. At present, three-dimensional laser scanning technology has been applied to deformation monitoring, such as landslide monitoring. The three-dimensional laser scanning technology can measure the three-dimensional coordinates of the object surface with high precision, high density and high speed, thus describing the details of the surface in detail. It has been successfully applied in static shape measurement. Computer cluster is widely used in various computationally intensive tasks because of its high performance and good scalability. Combined with the deformation information of deformation monitoring points, the deformation trend of landslide body is effectively monitored and predicted. In order to process the obtained data in a timely and rapid manner, the computer cluster performs the absolute orientation of the sequence point cloud collected in different periods to complete the coordinate system, and then acquires a set of points of different periods of point cloud data at the same position of the computer cluster. The data was compared and analyzed. In addition, the acquisition of ground-type 3D laser scanner data does not require the deployment of monitoring points, which can reflect the surface morphology of the landslide more quickly and accurately than the traditional monitoring means, and then obtain the surface deformation value.

1. Introduction

Three-dimensional laser scanning technology has the advantages that traditional measurement methods do not have. It does not need to bury monitoring points in advance, does not need to touch landslide body, has high measurement accuracy, fast monitoring speed, can reflect the overall deformation trend of landslide body, and can quickly obtain high-precision, high-density three-dimensional point cloud data [1]. Supported by the visual human-computer interaction integrated development environment of computer cluster, the system realizes unified scheduling, coordinated processing and efficient parallel processing. Various natural and human factors have complex effects on the stability of landslides, so monitoring is still the main means of landslide warning, especially for landslides with rapid development of deformation rate, and its deformation monitoring is extremely important [2]. The 3D laser scanning technology can quickly respond to the overall trend of landslides without touching the landslide. The measurement accuracy is high and the speed is fast. The cloud technology and computer modeling are used to judge the trend of landslide movement, so as to prevent disasters. And due to the uneven force of each part, the deformation of each part is irregular [3]. In order to obtain the deformation information of the landslide as a whole more accurately and comprehensively, new methods and means are needed in the process of deformation monitoring design, data acquisition and data processing. Among them, surface displacement deformation monitoring is not only the most important for landslide monitoring, but also the fundamental basis for determining the stability of landslide body [4]. Its specific practice is
to carry out multiple observations on the deformation monitoring points in different periods, and determine the deformation law of the landslide body in three-dimensional space according to the change of the plane and elevation displacement of each monitoring point [5].

Clusters of computers are connected by some structure (such as hubs, etc.). Supported by the development environment of parallel programming and interactive control of visualization software, the main node dispatches and coordinates the processing sub-processors to achieve an efficient parallel processing system [6]. Three-dimensional laser scanning uses grid scanning mode to measure surface points with high accuracy, high density, high speed and prism-free. It has the characteristics of high time resolution, high spatial resolution and uniform measurement accuracy. It can understand the detailed deformation and overall change of landslide body in detail [7]. In order to reduce the workload and improve the accuracy, the same station can be selected during the two phases of scanning, and the instrument can be set at the same control point. Landslide monitoring features of ground scanning also need portable power supply, notebook, tripod and other equipment. In the specific work, the whole system is based on the same operating platform, through software support to achieve a variety of sensors centralized management [8]. When using the scattered point cloud data collected in different periods for deformation monitoring and analysis, the scattered point cloud is first oriented, that is, the coordinate system is unified, and then a reference plane or reference plane is determined [9]. Divide the huge task into several subtasks, let each blade server handle one of the subtasks, and store all the data needed to process the subtask on the local hard disk of each blade server. The improvement of precision has opened up a broad prospect for the application of photogrammetry in deformation monitoring. This method of precision close-range photogrammetric deformation monitoring is widely used in the deformation monitoring of large landslides [10].

2. Materials And Methods
In practical use, cluster are intermingled, such as high availability computer cluster, which can also balance user load among its nodes. Monitoring landslide surface displacement has the most intuitive, easiest to measure, and can best reflect the real dynamic characteristics of landslide. At the same time, the texture information of the scanned object is supplemented by using high resolution digital camera to acquire the image data of the scanned entity. The output of the model reconstruction of the scanned entity must be fused with the point cloud data and texture data to realize the possibility of high precision monitoring under certain environmental conditions. It is difficult to find homonyms in scattered point cloud data, and some even do not exist homonyms. Due to laser divergence, even if the laser beam falls at the same point, any point within the laser spot may be recorded, and the coordinate points recorded after return may not be the same. In the process of landslide deformation monitoring, the data information should be concentrated in the unified coordinate system, and combined with the stability state around the observation points to ensure that the three-dimensional coordinate design is more reasonable and reliable.

Since most computer cluster systems use commercial workstations and general LAN networks, node hosts and system management are relatively easy and reliable. The control point is selected at a relatively stable place far away from the landslide body, where all points can see each other. Monitoring points before and after the landslide are selected on both sides of cracks with obvious deformation of the landslide body. In order to obtain high-precision monitoring point measurement data, blue and white targets matched with a three-dimensional laser scanner are used as monitoring points. The reflector is made of advanced reflective material. When placing the reflector, it should be distributed around as far as possible, with the height staggered and facing the scanning direction, so as to avoid too large an included angle between the scanning direction and the front direction of the reflector. The point cloud splicing technology is also called relocation, registration or flattening technology in different occasions. Its essence is to coordinate the data point cloud measured under different coordinate systems. The key of the problem is the coordinate transformation parameter rotation matrix and The translation vector is obtained. The same coordinate position, because the central axis of the landslide is not a straight line, there is a certain degree of curvature. To ensure that the starting point of the profile is consistent in the
sequence point cloud, the sampling interval is also consistent, and the profile data at the same coordinate of the scattered point cloud in different periods is obtained. The characteristics of the 3D laser scanning system are shown in Table 1.

| Characteristics | Obtain | Feedback |
|-----------------|--------|----------|
| Non-contact     | 5.88   | 7.15     |
| Penetrability   | 6.72   | 6.47     |
| High-density    | 5.31   | 5.05     |

The spatial position of the scanner center is the origin of the instrument coordinate system, which is determined by the attitude of the scanner after alignment and leveling. The X-axis is the direction of the mesh line. The Y-axis is perpendicular to the X-axis in the plane and downward clockwise. The Z-axis is perpendicular to the plane, as shown in Figure 1.

Fig. 1 Scanner 3-D coordinate sketch

In order to calculate the deformation, it is necessary to find the homonymous points from the point cloud data in each period and calculate their coordinates. It is not necessary to redesign computing nodes, operating system and compiling system. The construction focuses on data communication and parallel programming, which greatly shortens the construction time of the system and does not coincide with each measurement point. However, scanning measurement and processing is not based on single point, but on point group. Because the shape of the object is complex or the area is too large, it is impossible to get all the data of the whole scanned object at one station. It is necessary to scan the object from different angles and positions according to the actual situation. Then, the point cloud scanned by each station can be spliced together to get the complete point cloud data of the object. The data in each node of the computer cluster need to be communicated in order to be accessed by other nodes. The most important factors affecting the spatial accuracy of three-dimensional point clouds are the laser beam emission density and the distance between the scanner and the observed object. In general, we increase the density of laser velocity emission to obtain high-precision 3D topographic point cloud data with a certain observation distance. When the data information is processed in the same coordinate system, it can be modeled and analyzed, and a three-dimensional three-dimensional model is obtained to analyze the deformation of the landslide. The centroid of the slice point cloud is fitted to obtain the central coordinate of the point cloud of the cross section, which is the coordinate of the node at the central axis.

The height difference between the monitoring point and the control point can be obtained by transmission. Thus, the settlement of the monitoring point can be obtained by regularly observing the height difference between the monitoring point and the control point. The monitored point coordinate data is shown in Table 2 and Figure 2 below.

| Point position | X(m) | Y(m) | H(m) |
|----------------|------|------|------|
| A1             | 500  | 1000 | 1000 |
3. Result Analysis and Discussion

The view of three-dimensional laser scanning is limited, so it is often impossible to get the complete data of the scanning area at one time. Therefore, it is necessary to scan the scanned object from different perspectives and positions for several times, and finally eliminate the gross errors of the scanned point cloud data. There are many users requiring simultaneous services, which require high throughput and response time. Cluster system has many advantages, such as low price, good reliability, high throughput and abundant system resources. Three-dimensional laser scanner can quickly and accurately acquire the complete three-dimensional point cloud data of landslide. Through processing and analysis, it can accurately acquire the deformation information of each part and the overall deformation trend. Spatial parallelism refers to the simultaneous operation of multiple processors, while temporal parallelism refers to the operation of multiple instructions overlapping when a program is executed. The monitoring and analysis of landslide deformation in three-dimensional space are realized. According to the coordinates of the common point, the point cloud measured by different stations is converted into a unified coordinate system to form a whole; the points of different stations can also be determined according to the coordinates of the station and the coordinates of the orientation point. This type of information is needed when using a computer system to visualize a 3D visualization of a target object. The instrument's internal control and calibration system not only controls the joint work of the various systems inside the instrument but also enables effective calibration.

The extraction of the coordinates of the center points of the monitoring point marks is to select part of the point clouds at the pier of deformation monitoring observation from the whole point cloud data, and fit the point clouds into the cylinder of the monitoring pier, and capture the center of the upper surface of the cylinder as the coordinates of the monitoring points. The accuracy of the coordinates of the monitoring points fitted by this method will not exceed that of the whole point cloud scanning. Deformation monitoring module identification can be used to artificially lay simple, inexpensive block signs that can be distinguished from the surrounding landslide as "deformation monitoring blocks". In the monitoring of landslide deformation, there are a large number of scattered rock blocks on the measured landslide, which have a great impact on landslide disasters. It is necessary to identify these rock blocks in the monitoring of landslide deformation. Data transfer and data transfer between various compute nodes are realized, and data processing and data transfer are the core of the entire system. This code can be integrated within a program and complete their respective code functions. It also increases...
the communication complexity in the scheduling process. Selecting a static scheduling method is more efficient when the scheduling goal is to reduce the computation time of a given application. The usual simplified assumptions are that the execution time of the tasks is the same, the communication is not conflicted, and the parallel processors are completely interconnected.

The point cloud data collected in the are processed initially, including point cloud coordinate registration, point cloud clipping and splicing, filtering and point cloud color rendering, so as to make it an organized point cloud data, removing or reducing noise points, solitary points, outliers and the impact of vegetation on topographic survey. So the computing work among the processor nodes is independent of each other. All the communication process is that the main processor distributes the frequency points to the processor at the beginning and collects each result to the main processor at the end of the calculation. Substation scanning method should be adopted to scan the landslide in a large area, that is, to scan the circular area with a certain distance as the radius around the station as the center.

In order to obtain the precise coordinates of the monitoring points, the deformation monitoring points arranged in advance should be scanned with maximum precision. The scanning point cloud of the rock is a large data range. In order to obtain the three-dimensional coordinate data of the monitoring point on the landslide body more accurately, the target of the 3D laser scanner, such as a spherical target, must be placed on the feature point before the operation. Plane targets, etc., when the scene is scanned, set a smaller dot interval for the feature points. After the range is selected, the center of gravity point is calculated in the selected range to obtain the coordinates. The computer cluster system is not only a parallel processing system, but each node is also a separate workstation. Even if the whole system is not efficient in parallel for some application problems, its nodes can still be used as a single workstation.

4. Conclusion
In this paper, three-dimensional laser scanning landslide deformation monitoring and data processing of computer cluster are studied. Through the analysis of the accuracy of monitoring points, it is found that the three-dimensional laser scanner can meet the third-class monitoring accuracy requirements. In order to obtain deformation monitoring points, it is necessary to distinguish each "deformation monitoring block" from the point cloud data containing intensity information and color information, and then process the point cloud on the deformation monitoring block. At the same time, the coordinates of the target can be measured by the total station, and the mean value of the two is taken as the same name of each station splicing, and the stitching precision of the point cloud is improved. Through the network connection between the clusters, the large-scale computing area is divided into several parts and sent to the computing nodes of the cluster platform for simultaneous processing, thereby realizing the refinement of the segmentation granularity. The application of ground 3D laser scanning technology to the field of landslide hazard monitoring undoubtedly has broad potential. Strengthen the application of 3D laser scanning technology, and obtain better deformation information. Through the calculation of deformation points, effectively recognize the deformation, so as to develop effective prevention and control measures to prevent and control landslide disasters.

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