Variable FOV of Target Laser Tracking System

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Abstract. In this paper, based on the research of the basic principle of laser tracking measurement, a variable field of view laser radar tracking measurement system was designed. The system can be divided into three parts: laser scanning and ranging module, data processing module and double galvanometer field of view capture tracking module. According to the application requirements, the overall scheme of the optical system and mechanical structure was determined, and the three-dimensional model of the tracking measurement system was established. Based on the debugging of the system, tracking measurement experiment of targets field of view was completed. Through the experimental study of the variable field of view, the results show the feasibility of the variable field of view measurement target. Advantage analysis was performed by comparing the experiments of full field of view scanning. The variable point field system has a higher point cloud density than the full field of view. It can meet various tasks such as equipment manufacturing and installation, engineering measurement, and construction demand.

1. Introduction
When the laser sensor measures the target, the target area usually only occupies a part of the measured area. Even when measuring a wide range of information, it is generally unnecessary to perform point-by-point measurement on the entire measurement area, so only need to make the partial measurement. Determine According to the obtained target with in the scan range, the data quickly collected at feature point. This can greatly reduce the scanning range and data processing pressure and improve the measurement efficiency. For information acquisition of high-speed moving, it is difficult to measure the real-time spatial position and trajectory of high-speed moving point targets, due to the limitation of scanning frequency. The 3D imaging technology order to adjust the monitoring distance for the distance of the dynamic object, improves the efficiency of target discrimination by obtaining the function of multiplier scanning within a certain scanning range, and utilizes the modular design method and digital signal processing algorithm, get real-time information, such as speed, acceleration, motion trajectory, etc., and easy to operate, flexible assembly, reliable system.

2. The basic principle of variable Fov laser tracking system
The variable-view laser radar system needs to be equipped with software such as laser ranging system configuration software and galvanometer scanning control software. The entire laser radar system selects the laser range finder LDS30 and the two-axis galvanometer scanning system. The target position is tracked by the LDS30 and the scanning field of view is changed by the two-axis galvanometer scanning control order to track the scanning target. The laser data processing work, the laser scanning system tracks the target, and the variable viewing field mainly by controls the rotation of the galvanometer by the scanning galvanometer system, the distance measurement of the laser range finder and the preprocessing of the laser data. Control the two-axis galvanometer scan.
The laser ranging LDS30 sampling frequency is 30000HZ, the work of the laser range finder and the galvanometer control are controlled by the galvanometer control card respectively, which can achieve the synchronization and independence. During the scanning process, after receiving the corresponding data, the control card can be uploaded to the upper computer for processing, it is not necessary to consider the terminal board to control the scanning of the two galvanometers. This approach increases the flexibility, controllability, and real-time performance of the system. The terminal board can achieve the generating signal of the motor at any working frequency through the pulse frequency division technology, and it is convenient to add and upgrade the system function. The control board can receive pre-processing of laser data. The overall composition of the laser scanning system is shown in Figure 1.

![Figure 1. Hall effect](image)

The pulse method means that the laser range finder measures the time difference L between the transmitted pulse and the received pulse by measuring the time difference ∆t between the transmitted pulse and the received pulse by a timing chip with a precision of microseconds (μs), and sets the light speed to c.

\[ L = \frac{c \times \Delta t}{2} \]  

The phase method means that the laser range finder obtains the time difference ∆t by measuring the phase change of the continuously modulated laser beam during transmission and reception, and sets the speed of light to c and the modulation frequency to w, then the distance value L is

\[ L = \frac{c \times \Delta t}{2} = \frac{c \times \Delta \phi}{2w} \]  

Since the phase method has a long measurement time and a short measurement distance with respect to the pulse method, contour scanning and long-distance measurement of a fast target cannot be satisfied. Therefore, this topic uses the laser range finder of the pulse method.

### 3. Overall design of variable view target tracking system

On the basis of comprehensive consideration of the usage requirements and existing conditions, in order to meet the requirements of tracking and measurement of different types of targets in different working environments, achieve high-precision tracking and measurement of the measured object, and complete different tasks in different states, the lidar should have the following characteristics:

1. Lidar ranging system usually has high precision and versatility;
2. The latest scientific and technological achievements are widely used in lidar ranging system, advanced optoelectronic technology and components are also used to maximize the automation level of equipment and reliability of the system;
3. Under the premise that the main performance indicators such as accuracy meet the requirements, minimize the volume and weight of the equipment to facilitate the transportation of equipment and reduce the time and cost of transportation consumption;
4. Increase the flexibility of the device by modularizing the mechanical structure, so the system can be applied to target measurement in various occasions;
5) The equipment should have short response times and good maneuverability, so the calibration time of the equipment is reduced, which gives the equipment highly extensive application;

6) Designed according to the ergonomic design concept to achieve the coordination of operators, machines and the environment.

By calculating the basic parameters of the galvanometer, the field of view of 25°×25° can be obtained (If the target limit range is set to 5m, the field of view will be 2.3m×2.3m). Figure 2 shows the schematic diagram of the laser scanning of global field. After the target entering the field of view, the scanning mechanism is shown in Figure 3. From the global 16×16 scan to the centralized scan 5×5, the point cloud acquisition with a 10x point cloud density can be achieved at the same laser ranging point cloud sampling frequency.

![Figure 2. Spatial scanning full field of view](image1)

![Figure 3. Spatial scanning variable field of view](image2)

4. Experiment

The variable field of view target tracking system was developed to measure the variable field of view of the field of view concentrated to the target range when moving targets. Therefore, it is necessary to verify the system scheme through the comparison test of the full field of view and the variable field of view. The full field of view scanning is shown in Figure 4. The target data is collected using the invisible LDS30 laser ranging. In order to make the target scan intuitive, the test chart uses visible laser display to detect the actual operation of the target full field of view. Through the laser range finder, the full coverage of the target field of view is scanned, and the target is still in the field of view. By continuously capturing the image of the full-view of the target, it can be found that the effective view point of the scanning field is concentrated in the first frame. The target of the graph is covered by the scanned laser, and the effective target time for scanning is relatively small.
The point cloud of the moving hexahedral target was acquired by the variable field of view tracking measurement experiment. Comparing the measurement experiments of the first group of full field of view, the measured target is uniformly separated from the field of view of the tracking measurement system, and the target is tracked and measured from the entrance to the exit. Figure 5 shows the measurement information when the target enters the field of view from the field of view to the field of view. When the target moves in the field of view, the variable field of view measurement test continuously captures the target in the range of the variable field of view. The target is always within the coverage of the field of view change.

Dense point cloud data obtained during the experiments in full field of view and variable field of view were fitted through post processing. Using pre-programmed LABVIEW programs, the system can send commands, receive and store data, display measurement results and more in real time. Data processing is performed afterwards to extract valid data from the raw data stored by the system and remove unreasonable data. Then the valid data is imported into the Matlab software for calculation. Figure 6 shows the full field of view point cloud map. Since the target is a hexahedron, there are differences between the reflections of the laser across the surface. Figure 8 shows the hexahedron point cloud processing results measured by the 15°×15° variable field tracking and measurement system.

Through the variable field of view scanning to improve the target point cloud scanning density, it can be clearly found through experiments that the target point resolution and the number of feature points after the late point cloud data screening are about 1.8 times of the full field of view scanning.
can be seen that the point cloud density of the variable field of view is much higher than that of the full field of view.

5. Conclusion
In this paper, a comparison test of the full-view and variable-view fields of the laser radar is carried out. Through the experimental system data collection and comparison analysis: the full-view point cloud data and the variable-view target data collection find that the point cloud density of the target point cloud data density variable view field under the same target is about 1.8 times of the full-view point cloud density. The variable field of view laser tracking system has a huge advantage in detecting targets and tracking targets. geomagnetic storms

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