

# Enhancing Vehicle-borne Lidar Field Data Quality Methods

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**Abstract:** Reviewed the basic principle of Vehicle-Borne Lidar system, introduces the components of vehicle-borne scanning system as an example of SSW, a new production of Lidar production designed by Chinese academy of surveying. analyzed about main factors of data of Lidar running scanned, on the project of Tongliao, Handan, Dandong, some methods of enhancing data's quality of scanned have been given here, for using this system widely, this could lay a foundation for further market towards the technology.

**Keywords:** vehicle-borne scanning system, running scan, data quality, methods

## 1. Introduction

Measurement technology of vehicle mobile laser scanning, also known as the vehicle Lidar technology, is the rise from 1990s, widely used in recent years in the geography space data acquisition of laser scanning, CCD digital camera, GPS, IMU, computer and some other technology measure in an amount of equipment, has the advantages of fast speed, high precision a large amount of information, and other advantages, is widely used in such as: Wisdom City, city 3D model construction and other fields[1].

From the traditional error theory, data quality directly depends on the three main aspects of operating personnel, equipment, environment and etc...

At present, many extensive and very fruitful research has been completed from the single machine calibration, calibration, system calibration combination integration aspects, made a lot of achievements, from the degree to ensure the equipment working accuracy, scholar Han[4] on the municipal road elevation data accuracy system was discussed, also effectively protect the quality data collection. And the operator business quality effect on the result is gradually reduced; this is mainly due to the modern instrument mostly with scanning button operation, as long as a little training in normal operation, no influence on quality, can be ignored.

According to actual work of China's independent intellectual property rights, China Research Institute of Surveying and mapping of the SSW system combined with

the practice, sweeping Tongliao, Dandong, Handan and other places, analyzes the influence factors of field data acquisition quality, taken to improve the quality of data collection, summary gives beneficial solutions, received the ideal effect, have certain reference significance to improve the quality of external push scan data.

Field data mentioned in this article refers only to the original data from the external links collected (Raw Data), calculation, calculation of link error because of the model, the algorithm contains, rounding, data not involved in industry.

## 2. The positioning Principle of Lidar System

Vehicle-borne Lidar system is mainly composed of laser scanner, POS, digital camera and its corresponding fixed mechanical parts and control signal system.

The positioning principle of simple description for the [2,3,4]: laser scanner and laser pulse emission records from launch to return to the time difference (or phase), is determined from the central O to object P scanner detected distance S; which is fixedly connected with the system of POS synchronous recording of each laser pulse and fixedly connected with the attitude angle; together with the GPS receiver coordinates GPS antenna center moment of each pulse; digital camera is collected image data. Because the laser scanner, POS (IMU+GPS), digital camera is composed of mechanical component tightly fixed, motion, attitude synchronization, these values can

be calculated according to the center from their mounting dimensions were converted into the scanner.

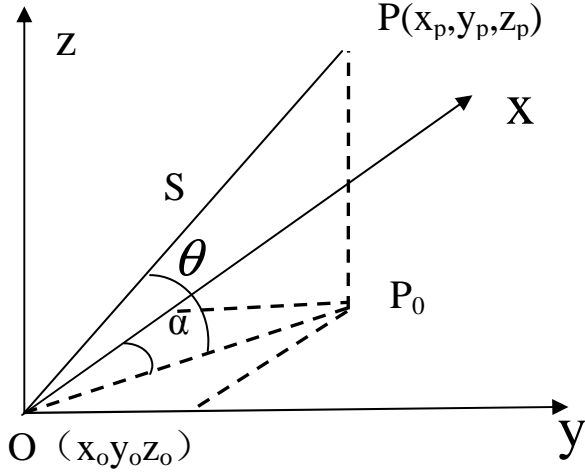


Figure 1. Positioning Principle of Lidar System

$$x_p = x_o + S \times \cos \theta \times \cos \alpha$$

$$y_p = y_o + S \times \cos \theta \times \sin \alpha$$

$$z_p = z_o + S \times \sin \theta$$

The 3D coordinates of points can be calculated by the following formula

### 3. Running Scan Field Work with Vehicle-borne Lidar

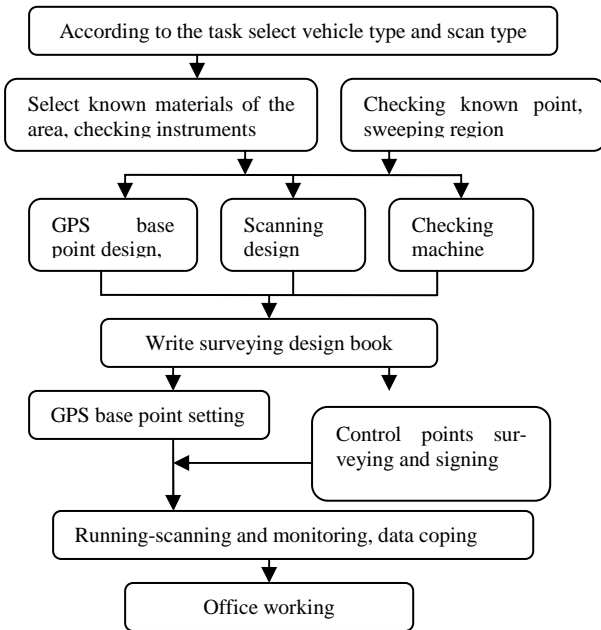


Figure 2. Whole Field Work of Running Scanning with Lidar

### 3.1 Classification of Lidar Data Quality

To reflect the Lidar data quality indicators include two. One is the objectivity of the data, i.e. data properly reflect the geographic location of objects, or relative position, with the reference of the size, which is the data is correct; on the other hand, integrity, whether to collect enough information, there is no necessary data, the main features of the data. Lost or blank, it is possible to main characteristic of geographical objects collected data ensure the traditional terms of Surveying and mapping in the "no leakage", avoid mass data. The former ensures the accuracy of the data, which ensures the integrity of the map content.

In addition, found in the work, sometimes the power, data connection, strong magnetic field and other accidental factors also can cause the GPS base station, mobile station GPS, IMU data, Lidar data, image data, odometer data is abnormal, these should be observed at work.

From the above analysis, data quality will be fixed by following factors [4]: GPS, IMU measurement accuracy and navigation accuracy, mainly reflected in two aspects of each sensor measurement accuracy and navigation accuracy;

The measurement precision of laser scanner, mainly reflected in the accuracy of the instrument measuring accuracy, precision and conical scan angle;

Measurement accuracy between the sensor location parameter, rigid binding between the sensors, and will not change because of attitude change carrier, can be integrated in the instrument precision calibration before use.

### 3.2 GPS Base Station Setup and Initialization

GPS base station requirements in the technical proposal, installed in accordance with requirements of the GPS system.

The main requirements are as follows:

- (1) GPS receiver must be checked daily, and clear the storage card before starting work;
- (2) Setup correctly;
- (3) switch on and off must be correct;
- (4) Staff must be a full-time person and the batteries be charged before use;
- (5) Be sure safe during working.

Initialization should follow the following principles;

- a) Position: near the starting point of scanning route;
- b) Time extent: at least 20min;
- c) Begin time: GPS base station receiver must begin record;
- d) Initialization: during this period, to avoid off staff; monitoring each indicator lamp at any time and others.

### 3.3 Running Scanning

Scanning operation refers to the whole process of operation area complete the scanning operation according to the design of routes, including the selection of station, initialization, scanning, end of process, including for inspection at any time.

The main requirements are as follows:

- a) During all scanning, Guided by a guiding vehicle in front of about 100 meters off the scanning car, be sure confirm the traffic road are available;
- b) Velocity: 20KM/H speed slow driving through the planning of route;
- c) Monitoring scanning state indicating lamp all the time;
- d) Replacement of the full memory card using the cleaned card;
- e) To avoid obstacles to guide the car into the scanning process, such as a wire, lower branches, etc.

### 3.4 Ending

End process and initialization is similar, in addition to follow the first principle, should also pay attention to:

- a) Position: near the end of scanning route;
- b) Time extent: cannot be reduced

The observation of the indicating device and correct shut down.

### 3.5 Control Point Surveying

Control points refers to the use of professional surveying equipment, such as GPS, total station and other precise determination, determination can be scanning to sweep the obvious characteristics along the ground point data, special markers, can be used to check, verify the correctness of scanning broom or used to correct measurement and control point and scanning data.

- a) To guarantee the achievement of the measurement datum, projection system and project task requires strict consensus;
- b) enough; position is obvious, easy to object feature point cloud interpretation;
- c) The use of simple method, ensure the measurement precision, satisfy the need of engineering.
- d) The original data to save, check, pretreatment must be pay attention to, before not confirmed that the preservation is good, do not delete the original recording media file;
- e) Make clear each workers complete workflow, clear their work in the whole process of work status, clear their job responsibilities;
- f) Correct settings such as the reference ellipsoid, the central meridian, the output data format parameters and consistent, to avoid errors caused by the time delay;
- g) Automatic extraction of manual extraction, complement each other, human interaction is necessary to have a suitable;

- h) Each data quality checks must pay attention to, can use repeatedly scan the object feature points of the point cloud to be preliminary judging quality.

Found on the coincidence point cloud overlap poorly, deviate from the field survey data, graphic distortions of point cloud data to focus on examination, directional point into the necessary re solution.

## 4 Data Quality Evaluation

Includes two aspects of correctness and subjectivity, this work only within the industry solution can rear work completed.

### 4.1 The Correct Evaluation

Using feature points of certain features of the point cloud data, such as angle, corner, wire rod, repeated scanning data, and the extraction point coordinate value, read and record the work, calculate the coordinate difference between these points, and then calculate the statistical parameters, which can reflect the scanning accuracy, deviation lead to the detective gyroscope drift, vibration and other factors, effect.

Much homework results, deviation of these coordinates can be considered results no quality problems in the 4 cm below, otherwise must be confirmed. System of regular translation can be considered to be caused by instrument working environment or other factors, can be introduced into the control point 2.3 mentioned results, identify which scan results is correct, according to the control point results for point cloud corrected, repeated point cloud solution; lack of laws should confirm is offset due to the measurement results, the scanning point cloud data, calculation, feature point extraction that link problems, and then take response measures.

### 4.2 Integrity assessment

Integrity is an important index to judge the quality of map products. Is refers to between the expression elements and specification of the corresponding map scale amount relation, is the result of rational choice of map elements.

Complete the application of vehicle scanning system of map products, elements should express should not and manual survey and mapping products are different, so it must be a reasonable trade-off criterion.

According to our car scan job experience, the main factors influencing the integrity

- a) The scanning path scanning season, occlusion caused by unreasonable, resulting in lack of point cloud data. This situation can be fully taken into account in planning the scanning line, the scanning operation season;
- b) The characteristics of point cloud data are scarce, resulting from deviation. In special sections of the slow, pause, parking and other measures to improve the density of point cloud;

c) Easily through the narrow road electric tricycle and other means of transport, area scan job into the large vehicles can not enter.

For the roadside drains, the mainland table lack scan data of the region, the round-trip sweeping vehicle route near the roadside, adjust obstacles to scanning broom, increase the density of point cloud.



(a,b) Two type of Traffic Sign



(c) Surveying Rod for Scanning  
(d) One Typical Corner of Walls

Figure 3. Sign of Main Control Points Sign

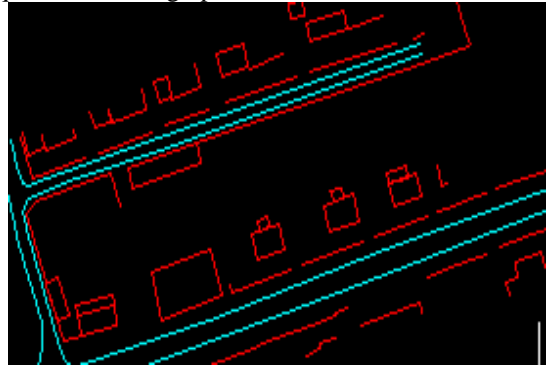
### 4.3 Result

Here are some typical results of projections.

### 5 Conclusions

Operation practice shows that, only the strict exclusion of foreign trade data of gross error, can the industry solution, cloud point extraction, map decoration map links to obtain high quality results, hope the above job summary can provide a reference for the vehicle borne laser car scan

job, accumulate experience for the popularization of scan acquisition of Geographic data.



(a) DLG map by auto-extraction



(b) 3D model of street with zero grades

Figure 4. Sign of Control Points (Dandong)

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