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Calibration Specification for Terrestrial Laser Scanners

地面激光扫描仪校准规范

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Calibration Specification for Terrestrial Laser Scanners

1 Scope

This Specification specifies the calibration method of static terrestrial laser scanner (hereinafter referred to as scanner), which is suitable for the calibration of pulse or phase scanner. Scanners of other principles may also be calibrated with reference to this Specification.

2 Normative References

This Specification quotes the following document:

JJF 1071-2010 The Rules for Drafting National Calibration Specification

For the dated documents, only the versions with the dates indicated are applicable to this Specification; for the undated documents, only the latest version (including all the amendments) is applicable to this Specification.

3 Terms

For the purpose of this specification, the following terms and definitions apply.

3.1 Target

Scan target with geometric center and may be used for calibration. This Specification uses a spherical target.

3.2 Absolute distance

The distance between the origin of the internal coordinate system of the instrument (the starting point of distance measurement) and the center of the target.

3.3 Relative distance

The distance between target centers.

3.4 Reference distance

The distance between target centers as a reference value.

5 Metrological Characteristics

5.1 Radial repeatability

Under a set of repeatable measurement conditions, the measurement precision for the measured value of the absolute radial distance of the same fixed target.

5.2 Target repeatability

Under a set of repeatable measurement conditions, the measurement precision for the measured value of the target center coordinate (point position).

5.3 Indication error of radial distance

The difference between the measured value and the reference value of the relative distance along the measuring axis.

5.4 Indication error of spatial distance

When scanning and measuring targets at different distances and orientations in space, the difference between the measured value and reference value of the relative distance.

6 Calibration Conditions

6.1 Environmental conditions

Calibration shall be performed under the conditions specified by the manufacturer or agreed by the user. Ambient temperature and its rate of change shall affect the uncertainty of the calibration result and shall be considered in the uncertainty report.

6.2 Etalon for calibration

It is recommended to use the measurement-calibration device or etalon listed in Table 1; and it is allowed to use other measurement-standard equipment that meets the uncertainty requirements for calibration.

Table 1 -- Measurement-Calibration Equipment and Technical Requirements

SN	Measurement-calibration equipment and etalon	Technical requirements
1	Target	Diffuse reflection, non-transmission spherical target (aluminum products with sandblasted surface are recommended). The diameter is no less than 100mm, and the diameter change is no more than 0.1mm
2	Calibration device for radial distance	Provides a series of linear reference distances covering the calibration range, such as moving a target from one location to

floating guide rail is better than 0.5μm+0.5 ×10^{-6} *L* (*k*=2). When the measurement is estimated at the farthest 80 m, the standard uncertainty is as follows:

$$u_1(L_{si}) = \frac{0.5 \times 10^{-3} + 0.5 \times 10^{-6} \times 80 \times 10^3}{2} \text{mm} = 0.02 \text{ mm}$$

C.4.2 The uncertainty component $u_2(L_i)$ introduced by the measured value L_i of the radial distance

C.4.2.1 The uncertainty component $u_{21}(L_i)$ introduced by the spherical target changing with temperature

The aluminum spherical target with diameter of 200mm shall be used in the measurement; it has a temperature linear expansion coefficient of 23.6×10^{-6}°C^{-1}. Assuming that the temperature during calibration differs from the temperature of the spherical target by 5°C, it is uniformly distributed. According to the temperature correction formula, the standard uncertainty is as follows:

$$u_{21}(L_i) = \frac{23.6 \times 10^{-6} \times 5 \times 200}{\sqrt{3}} \text{mm} = 0.01 \text{ mm}$$

C.4.2.2 The uncertainty component $u_{22}(L_i)$ introduced by spherical target shape error

The radius error of the spherical target shall cause the deviation of the spherical center coordinates. Through the calibration by the coordinate measuring machine, the maximum change in diameter is no more than 0.1mm; and it is uniformly distributed. The standard uncertainty introduced thereby is as follows:

$$u_{22}(L_i) = \frac{0.1}{\sqrt{3}} = 0.06 \text{ mm}$$

C.4.2.3 The uncertainty component $u_{23}(L_i)$ introduced by the measurement repeatability of radial distance

If the radial distance is repeatedly measured for at least 10 times, the uncertainty introduced by the repeatability is as follows:

$$u_{23}(L_i) = \sqrt{\frac{\sum (L_i - \overline{L})^2}{n-1}} = 0.52 \text{ mm}$$

Combining the above three items, the uncertainty introduced by the measured value L_i is as follows:

$$u_2(L_i) = \sqrt{u_{21}^2(L_i) + u_{22}^2(L_i) + u_{23}^2(L_i)} = 0.53 \text{ mm}$$

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