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TC8 Chairman: James Hsu, Honorary Chairman, Taiwan Telematics Industry Association.
TC8 Vice Chairman: Ming-Whei Feng, President, Institute for Information Industry
TC8 Vice Chairman: Henry Meng, Vice President, Institute for Information Industry.
TC8 Secretary: Jamie Chang, Institute for Information Industry.
Technical Editors: Dr. Kai-Wei Chiang, Dr. Chung-Yen Kuo, Dr. Chi-Kuei Wang, Dr. Pei-Ling Li, Dr. Cheng-An Lin, Yu-Hua Li, Department of Geomatics, National Cheng Kung University.

The list of TAICS association members participating in this guildline formulation is as follows:
ArcRan Information Technology Inc. (互聯安睿資通股份有限公司)
GCOM Technologies Co., Ltd. (吉康科技有限公司)
Taiwan Telematics Industry Association (社團法人台灣車聯網產業協會)
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National Cheng Kung University (國立成功大學)
A Test Lab Techno Corp. (晶復科技股份有限公司)

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Foreword

This is a guideline regulated and published by the Taiwan Association of Information and Communication Standards (TAICS) with the approval of the TAICS council.

The guideline does not suggest all the safety precautions. The related safety maintenance and health operations shall be established and the relevant regulations shall be obeyed before applying this standard.

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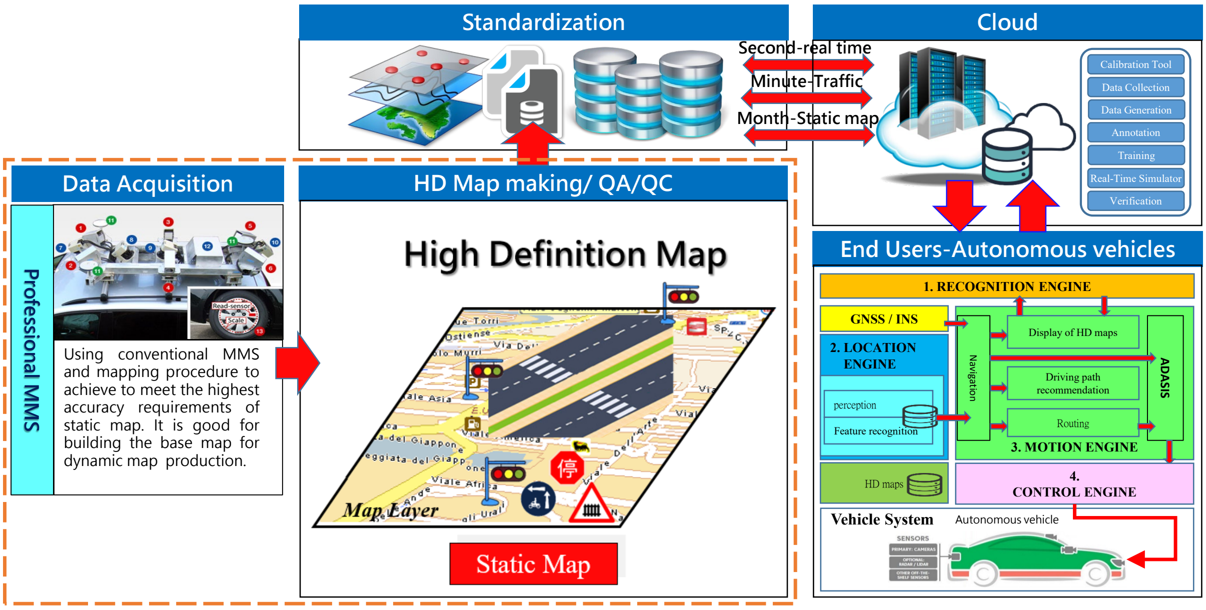
Introduction

With the development of Intelligent Transport Systems (ITS), autonomous vehicles will become a brand-new mode of transportation in the future, which is expected to reduce tens of millions of deaths and injuries caused by human factors in traffic accidents every year. The Society of Automotive Engineers International has developed a method that classifies autonomous vehicle systems into six levels (Level 0-5). For the existing vehicles available in the market, the Advanced Driver Assistance Systems (ADAS) at Level 2, and the fully autonomous vehicles without human control is above Level 4 for minimum driving safety risk. In order to achieve functional safety above Level 4, the core technology is to obtain accurate position information of vehicles on the road. In addition, according to the safety guide for driving advanced vehicles, if build navigation equipment to the level of autonomous driving, it is bound to be the vehicle navigation accuracy has been improved to above sub-meter level. Due to blocked or reflected signals in urban areas, the satellite positioning technology is unable to accurately position autonomous vehicles in lanes. Concerning the safety and hardware costs, in addition to the integration of sensing components, including cameras, Light Detection And Ranging (LiDAR), Global Navigation Satellite Systems (GNSS) and Inertial Navigation Systems (INS), it has been important to the operation of autonomous driving technology to use High Definition maps (HD maps) equipped with vehicle navigation information to provide reliable and robust environmental prior information.

According to the ISO 18750 layer architecture (8) of Local Dynamic Map of ISO 18750, high definition maps, as static data, are basic base map information, with the purpose of assisting in accurate navigation, making accurate lane-level road network information and providing mobile computers to make driving decisions. Hence, in addition to showing equally scaled lane information, the horizontal absolute accuracy of the feature block should be less than 20cm and the three-dimensional absolute accuracy should be less than 30cm, so as to effectively provide the sub-meter grade lane positioning for the autonomous driving technology. Accordingly, in consideration of existing mapping techniques and demands for high definition maps, this guideline provides system platform operation specifications of produced high definition maps, this guideline base on the Mobile Mapping System (MMS) which equipped with LiDAR's map data collection operation platform to provide the operating specifications of the system platform for producing high definition maps. Before the execution of the surveying and mapping task, the current and after the execution of the surveying task, principle reference implementation measures such as operating procedures and inspections and evaluations for continuing internal tasks. The ultimate goal is to make the accuracy and resolution of the maps meet the needs of changing environment and apply to our complex and highly mixed traffic patterns, so as to ensure the high definition maps quality and effectively connect with the requirements of automatic driving.

1. Scope

This guideline is for data collection, production, quality control and verification procedures of high definition maps by mobile mapping systems (such as land surveying and mapping industry), and the scope of the high definition maps supply chain architecture is shown in the dotted box in Figure 1. Its purpose is to ensure that the horizontal absolute accuracy of the finally output vector maps containing feature blocks is less than 20cm and the three-dimensional absolute accuracy is less than 30cm. See the reference data for the detailed accuracy specifications (2)(4).



Using conventional MMS and mapping procedure to achieve to meet the highest accuracy requirements of static map. It is good for building the base map for dynamic map production.

Figure 1 High definition maps supply chain architecture

2. Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes the requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[1] ISO 18750:2018 Intelligent transport systems- Co-operative ITS- Local dynamic map

3. Terms and definitions

All terms defined below are applicable to the standards.

3.1 Land Surveying and Mapping Industry

It refers to technician offices, companies or technical advisory institution engaging in surveying and mapping business under the Land Surveying and Mapping Act. As for the scope of surveying and mapping business, "surveying" means taking land as the target to collect, analyze, calculate, add value to, integrate and manage geographic data with spatial distributive characteristics on, above and below the surface of the earth, and "mapping" is to show landforms, ground features or various natural or cultural data based on surveying results.

3.2 Feature Block

It refers to the mapping range containing one or more feature points (or interest points), such as landmarks, road sign stripe and other final products of high definition maps.

3.3 High Definition Maps (HD Maps)

They refer to static basic base map data, providing reliable and robust environmental prior information for operation of autonomous driving technology to help mobile computers to make driving decisions. The mapping data, layer categories, characteristics, attributes and metadata can be fully used by vehicle navigation systems. The horizontal absolute accuracy should be less than 20cm, and the three-dimensional absolute accuracy should be less than 30cm.

3.4 Global Navigation Satellite System (GNSS)

It refers to a global independent timing and spatial positioning system which users obtain real-time satellite information by their satellite signal receivers to calculate their positions (longitude, latitude and altitude) and the accurate time. There are global positioning systems, such as the Global Positioning System (GPS) of the United States, the GLObal NAvigation Satellite System (GLONASS) of Russia, the Galileo of Europe and the BeiDou Navigation Satellite System

(BeiDou) of China, and regional navigation satellite systems of Japan (QZSS) and India (IRNSS).

3.5 Inertial Measurement Unit (IMU)

Inertial Measurement Unit (IMU) are devices to measure objects' inertia, such as triaxial angular rate and acceleration, including three-axis gyroscopes and triaxial accelerometers.

3.6 Inertial Navigation System (INS)

Inertial Navigation System (INS) integrates inertial measurement units and calculating units, and can directly calculate objects' navigation information such as relative positions and attitude information in real time.

3.7 INS/GNSS

By integrating the inertial navigation system and global navigation satellite system, an INS/GNSS, also known as an integrated INS/GNSS positioning and orientation system, combines the characteristics and advantages of the two systems and can provide high-precision and seamless positioning and orientation results.

3.8 Real-Time Kinematic (RTK)

It refers to an immediate addressing technology in which a joint network comprised of one or more consecutive master satellite observation stations is used to estimate positioning errors within covered areas and rover correct errors based on the observed data and estimates of adjacent master stations. A master station is a physical ground base station, making consecutively static satellite positioning survey; while a rover is a coordinate point to be calculated which consecutively moves relative to the master station.

3.9 Survey Grade Multi-Constellation and Multi-Frequency GNSS Receiver

A receiver is an electronic device receiving radio signals from an antenna and demodulating; multi-frequency means that satellite signals in more than two frequency bands can be received, such as L1, L2 and L5 frequency bands; and multi-constellation means that more than two kinds of satellite system signals can be received, such as GPS, GLONASS, Galileo and BeiDou.

Survey grade means that it supports multi-constellation and multi-frequency carrier phase measurement receiving and real-time kinematic positioning technology, equipped with a receiving antenna that resists signal interference and multipath effects. In a surrounding environment where the elevation angle of the receiving antenna is above 10 degrees without signal blocked, the three-dimensional absolute positioning accuracy of the processing result should be less than 6cm.

3.10 Light Detection and Ranging (LiDAR)

It refer to an optical remote sensing technology that calculates the accurate distances from sensors to objects based on the time interval between the pulse laser light and its reflected signals. If the pulse laser light's emission angles are additionally provided, the relative two-dimensional or three-dimensional coordinates of object points can be calculated. The outputs are generally called point clouds.

3.11 Direct Geo-Referencing (DG)

It means that integrated INS/GNSS positioning and orientation systems provide exterior orientation parameters of camera photographing centers (perspective center) and LiDAR scanning origins. With other known conditions, the absolute spatial positions of target points on image and LiDAR point clouds can be directly calculated.

3.12 Mobile Mapping System (MMS)

It refers to a surveying and mapping platform with direct geo-referencing abilities that combine an integrated INS/GNSS positioning and orientation system, LiDAR or image sensor. With high mobility and high accuracy, it can quickly obtain high-accuracy three-dimensional spatial information in a large field.

3.13 Odometer

Odometer, also known as a speedometer, is a sensor calculating vehicle velocity based on tire revolutions to calculate vehicle driving distances.

3.14 Zero Velocity Update (ZUPT)

It refers to a reduction algorithm that returns the triaxial acceleration measurement to zero after integration when known, observed or assumed vehicles are stop, based on the information measured by odometers or other sensors. It is often used as constraints in mobile dynamic navigations.

3.15 Check Points

Check points refer to the points with known coordinates but excluded in the mapping calculation, and they are used to calculate mapping errors and analyze accuracy.

3.16 Control Points

Control points refer to the points with known coordinates and included in the mapping calculation, and they are used to provide absolute coordinates and reduce measurement errors.

3.17 Verification

It refers to a process to calculate sensor errors by specific methods, and calculation results are used to assess whether sensors maintain their original required specifications and performance. There are two verification methods as below:

(a) Instruments should be accompanied by test reports or specification certificates issued by professional verification laboratories while leaving the factory.

(b) Whether instruments still conform to manufacturer specifications should be tested regularly by professional verification laboratories. “Regular” indicates that the test should be properly carried out according to manufacturer requirements for and use frequency of instruments. Please refer to “Section 5.1.3 system test” for items to be verified.

3.18 Absolute Accuracy

The difference between measurement calculation results and known truth values is error. The larger the error is, the lower the accuracy will be, and vice versa. The absolute accuracy is the result of statistical analysis of the above error.

3.19 Relative Accuracy

The difference between measurement calculation results and known truth values is error. The larger the error is, the lower the accuracy will be, and vice versa. The relative accuracy is the ratio between the above error and the measurement.

3.20 Alignment

Alignment, also known as system initialization, refers to the process to find initial orientations when integrated INS/GNSS positioning and orientation systems are started.

3.21 Lever Arm

Lever arm is the position offset of the origin between the two sensor coordinate systems.

3.22 Boresight

Boresight is the rotation of the axial difference between the two sensor coordinate systems.

4. Specifications for High Definition Maps

For the output accuracy and operating environments of high definition maps, detail specifications are shown in Table 1. Considering the commonly used specification levels for mobile mapping systems, the recommended of inertial measurement unit and density of matched auxiliary ground control points is shown in Table 2. The classification of inertial measurement unit by grade is shown in Table 3. The classification of point cloud density by grade is shown in Table 4.

Table 1 Operational specifications for high definition maps by mobile mapping systems

Operation specifications		Description
Specifications for satellite receivers using real-time kinematic positioning technology at rover and master ground control stations		Required to be a survey grade multi-constellation and multi-frequency receiver, and at least support dual-constellation and dual-frequency carrier phase reception
Inertial measurement unit [1]	Grade	Refer to Table 2
	Stability of gyroscope drift	
	Stability of accelerometer drift	
Verification of satellite receivers and inertial measurement unit [2]		Necessary
Data rate of inertial measurement unit		>100Hz
Positioning and orientation accuracy without satellite signal	Horizontal positioning accuracy	< 3 cm
	Vertical positioning accuracy	< 5 cm
	Pitch angle orientation accuracy	< 0.002 degree

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[1] The classification of inertial measurement unit by grade is summarized based on reference data (11); and the hardware specifications are obtained by comprehensively evaluating commonly used hardware of mobile mapping systems, such as SPAN LCI, SPAN LN200 and IMAR FSAS, literature research and practical experience.

[2] Please refer to Section 5.1.3 for detailed prerequisites for verification items and verification institutions.

outage[3] and assistance from odometers (1σ)	Heading angle orientation accuracy	< 0.005 degree
LiDAR verification [2]		Necessary
Camera verification [2]		Necessary
Horizontal positioning accuracy of the matched odometer (without satellite signals)		< 0.05% DT (System accuracy travelling drift rate) Distance Travelled
Point cloud density [4]		At least meet Grade 2 requirements for point cloud density in Table 4
Frequency of zero velocity update [5]	Areas with good GNSS signal quality	Conduct for 1 minute every 10 minutes in principle
	Areas with GNSS signal loss-of-lock or poor signal quality	Conduct for 1 minute every 2 minutes in principle
Auxiliary ground control points [6]		Refer to Table 2
Alignment		Necessary

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[3] Survey grade integrated INS/GNSS positioning and orientation systems mostly adopt the tightly couple based integration architecture, so the two conditions for the above-mentioned satellite signal outage are as follows:
- Less than one visible satellite due to blocked signal effect.
- Less than one visible satellite after deleting the one with its poor signals.

[4] Table 4 selects appropriate point cloud density within the corresponding range based on theoretical estimation of positioning accuracy requirements, current field situation, extraction of feature blocks and final output requirements. Please refer to Section 5.2.1 for detailed methods to check point cloud density.

[5] The frequency of zero velocity update can be determined according to the environment, and can be selectively reduced based on the spacing between auxiliary ground control points. Please refer to Section 5.1.5 for details.

[6] The spacing between auxiliary ground control points can be adjusted according to the difference between the actually used system specifications and the specifications required in this table.

Table 2 Recommendation on grades and specifications of inertial measurement unit and density of matched auxiliary ground control points

Specifications	**Stability of gyroscope drift and accelerometer drift** [7]	**Recommended density of auxiliary ground control points**
Navigation grade	• Stability of gyroscope drift: 0.001-0.01 degree/hour • Stability of accelerometer drift: 50-100μg	Every 500 meters
High tactical grade	• Stability of gyroscope drift: 0.1-1 degree/hour • Stability of accelerometer drift: 100-300μg	Every 300 meters
Medium tactical grade	• Stability of gyroscope drift: 1-10 degree/hour • Stability of accelerometer drift: 300-1000μg	Every 100 meters
Other grades	• Stability of gyroscope drift: > 1 degree/hour • Stability of accelerometer drift: >2mg	Every 30 meters

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[7] 1ug=10^{-6}g, 1mg=10^{-3}g, g=9.8 m/s^2

Table 3 Classification of inertial measurement unit by grade (3)(9)

Efficiency	**Strategic grade**	**Navigation grade**	**Tactical grade**	**Micro Electro Mechanical Systems grade**
Positioning error (pure inertial navigation mode)	< 30 m/h	2-4 km/h	20-40 km/h	50-500 m/min.
Gyroscope drift (degree/h)	0.0001	0.001-0.01	0.1-10	10-3600
Acceleration drift [7]	1μg	50-100μg	100-1000μg	0.1-0.5g

Table 4 Classification of point cloud density by grade

Point cloud density grade	**Application scenarios (three-dimensional positioning accuracy)**	**Point cloud density (pt/m^2)**
Grade 1	Active Control (0.1 m)	2500-10000
Grade 2	Where in Lane (0.5 m)	400-2500
Grade 3	Which Lane (1.5 m)	100-400

5. High Definition Maps Operation Procedure and Check Mechanism

5.1 High Definition Maps Operation Procedure

The process in this guideline is shown in Figure 2, and sub-items are described in Section5.1.1 to Section 5.1.8.

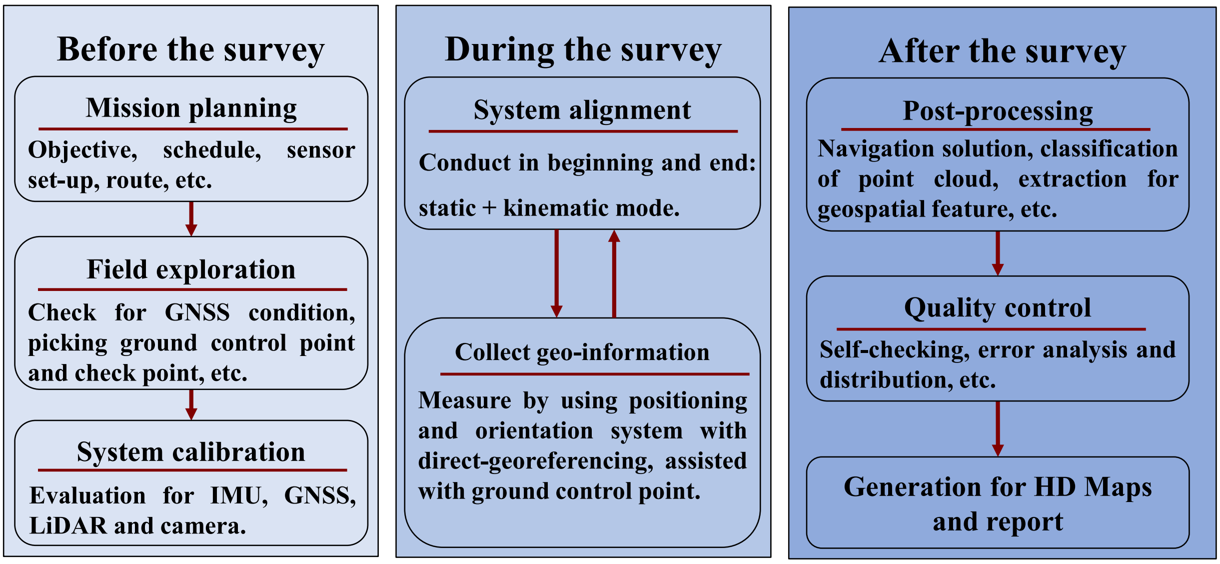

Figure 2 Mobile mapping system process for high definition maps

5.1.1 Task planning

According to the surveying range, the safety conditions, traffic conditions and special environment for surveying should be evaluated in advance, to select instrument types, installation positions and quantity and develop quality control plans and routes.

5.1.2 Field reconnaissance

According to Section 5.1.1 task planning results, operating velocity, instrument operating frequency, position quantity adjustment and check points selection are assessed within the surveying range. According to the satellite positioning observation quality, ground control points or check points are set and task planning correction measures such as the order of driving routes is adjusted. Ground control points and check points can be set by referring to existing rules such as the “採用虛擬基準站即時動態定位技術辦理加密控制及圖根測量作業手冊 operation manual for encryption control and mapping control survey by the real-time kinematic positioning technology at virtual base stations” (13) issued by the National Land Surveying and Mapping Center, Ministry of the Interior. Check points should be evenly distributed within the surveying range.

If it is the first time that the surveying and mapping are carried out in the surveying range, this operation should be executed. This step can be selectively omitted if this task is repeated later within the same surveying range.

5.1.3 System test

Prior to the task execution, the mobile mapping system should be tested through the following verification procedures to confirm its conformity to the manufacturer specifications or obtain its setup parameters. Laboratories, platforms and fields for the test should meet the prerequisites shown in Table 5:

(a) Image sensor: obtain parameters of interior orientation and relative orientation at verification fields of interior orientation and relative orientation of image sensors.
(b) LiDAR sensor: regularly returned to the manufacturers for verification.
(c) Integrated INS/GNSS positioning and orientation system: refer to Table 6 for verification items.
(d) Sensor installation parameters (parameters of lever arm and boresight): conducted at outdoor verification fields regularly or before performing each mapping task.

Table 5 Verification institutions and their prerequisites

Verification institutions	Prerequisites
Verification fields of interior orientation and relative orientation of image sensors	The baseline length and network strength should be considered in the design of man-made targets for field layout. The calculation software used should be able to calculate parameters of interior orientation and relative orientation of image sensors and calculate the parameter accuracy after statistical analysis.
Professional verification laboratory	The inertial measurement unit should be verified and tested by high-precision two-axis turntables in accordance with the procedure recommended in IEEE 1554-2005 (6).
Static verification baseline field	The fixed coordinates of baseline piles should be checked regularly and reach the millimeter level, and the baseline azimuth accuracy should be within 0.0005 degree according to the true north reference line accurately calibrated by total stations.
Dynamic test platform	An integrated INS/GNSS positioning and orientation system above navigation grade should be used as the reference, with the specification more than 10 times better than that of the system under test, to verify the positioning, orientation and constant velocity accuracy of the system under test.
Outdoor verification fields	Satellite signal quality should be considered in field selection, and the absolute accuracy of the coordinates of natural objects or man-made targets as control points or check points should conform to the national surveying standards for existing control points.

Table 6 Verification items for integrated INS/GNSS positioning and orientation systems

	Professional verification laboratory	**Static verification baseline field**	**Dynamic test platform**
Global Positioning System	• Initial check of system output • Initial heading test	• Absolute positioning accuracy verification • Absolute orientation accuracy verification • Absolute constant velocity accuracy verification	• Relative positioning accuracy verification • Relative orientation accuracy verification • Relative constant velocity accuracy verification
Inertial Navigation System	• Initial check of system output • Initial heading test • Specification absolute accuracy verification	• Absolute orientation accuracy verification	• Relative positioning accuracy verification • Relative orientation accuracy verification • Relative constant velocity accuracy verification

5.1.4 System alignment

Following shows the alignment steps for integrated INS/GNSS positioning and orientation system:

(a) Static alignment procedure: the mobile mapping system should be stop for 1-2 minutes to achieve static alignment.

(b) Dynamic alignment procedure: according to the road type available for driving within the surveying range, tracks with sufficient attitude changes are provided to detour at a variable velocity for 10-15 minutes to achieve dynamic alignment. Examples of common types of tracks with sufficient attitude changes in vehicles are shown in Figure 3.

(c) The alignment procedure should be repeated by the reverse model of (2) and (1) after data collection.

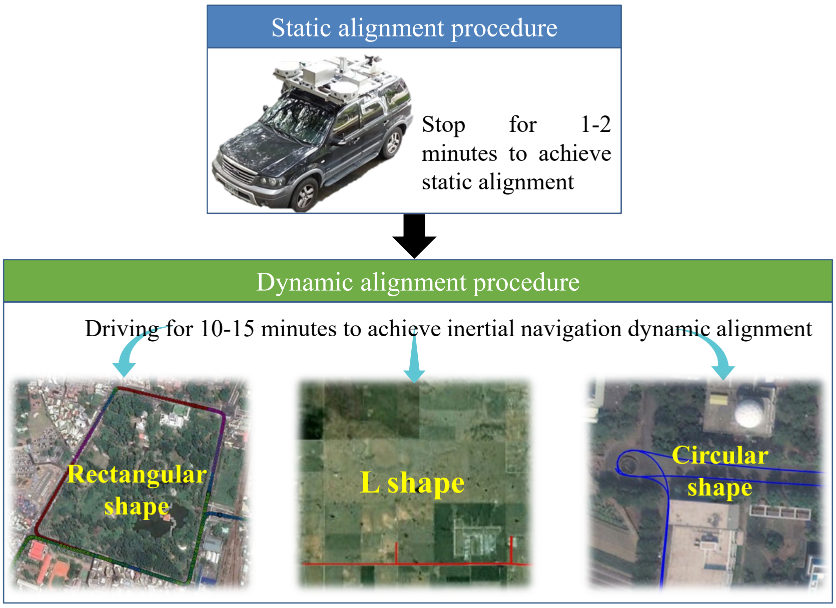

Figure 3 Dynamic alignment procedure

5.1.5 Trusted sources

Following are the details of precautions and measures for data collection of mobile mapping systems:

(a) Operators should constantly check the normal operation of sensing instruments and time synchronization of data. In case of real-time output indexes for sensors, the data collection should be measured comprehensively according to the significances of various indexes of manufacturer manuals.

(b) Table 2 shows the execution principles of auxiliary ground control points. The control points should be local natural objects, artificial structures (such as the corner of road sign stripe) or man-made targets, with centimeter level accuracy. The spacing should be adjusted according to the grade of the adopted integrated INS/GNSS positioning and orientation system, satellite positioning signal quality, surveying environment and execution feasibility. Satellite signal quality determination criteria can be established according to the standard data conversion format of RINEX v3.03 (6).

(c) Zero velocity update should be conducted in an environment where the elevation angle of the receiving antenna is above 10 degrees without signal blocked, at the frequency depending on satellite signal quality in principle: it should be conducted for 1 minute every 10 minutes in case of good satellite signal quality and reception, and for 1 minute every 2 minutes in case of poor satellite signal quality or frequent occurrence of loss-of-lock. In addition to the factors stated in (2), the frequency can be adjusted according to the spacing between auxiliary ground control points: if the spacing between auxiliary ground control points is reduced due to poor satellite signal quality within the surveying range in cities full of high-rise buildings, the frequency of zero velocity update can be reduced relatively; if, within the surveying range such as national highways, signal blocked is rare and it is difficult to conduct zero velocity update, zero velocity update can be exempted or the auxiliary ground control points set by aerial surveys can be adopted.

5.1.6 Data post-processing

Data calculation programs, such as integrated INS/GNSS positioning and orientation system, image sensor or LiDAR sensor, should be processed according to the processing software of various commercial package systems, and the final outputs should conform to Section 5.2.3 check list.

5.1.7 Accuracy check

Please refer to “Section 5.2 High Definition Maps Check Mechanism and Examination Method”.

5.1.8 Map production and report writing

The final output of the checked mapping data should be processed in accordance with the high definition maps content and format standards or demand institutions' entrustment. Moreover, the result report, a corresponding supporting document, should describe the data collection specifications and methods and serve as the metadata of high definition maps, including at least: operation planning data, instrument type and specification, verification report, measurement results and distribution range of control points and check points, image and point cloud scanning report, data post-processing results, self-check results and accuracy analysis. Others should be added according to the requirements of demand institutions.

5.2 High Definition Maps Check Mechanism and Examination Method

5.2.1 Self-check Mechanism

5.2.1.1 Description for self-check of positioning and orientation results (please refer to the red box on the right of Figure 4 for the process)

(a) The purpose is to test whether the influence of the error accumulation caused by satellite signal cycle slip, satellite signal outage and inertial measurement unit drift of integrated INS/GNSS positioning and orientation systems is still within the reasonable accuracy range.

(b) The theoretical errors of specifications required by integrated INS/GNSS positioning and orientation systems listed in Table 1 are shown in Table 7, and the theoretical errors of exterior orientation parameters can be calculated by error propagation. If the discrepancies between direct geo-referencing calculation results and exterior orientation parameter reversely calculated based on control points are smaller than those shown in Table 7, additional auxiliary control points should be considered.

Table 7 Errors and estimates of integrated INS/GNSS positioning and orientation system (3)

Error sources	Estimate errors
Positioning error	2-10 cm
Orientation error	1-5 arc-minutes [8]
Calibration error of lever arm	0.1-0.3 cm
Calibration error of boresight	1-3 arc-minute
Synchronization error	1-2 milliseconds

5.2.1.2 Description for self-check of direct geo-referencing results (please refer to the blue box on the left of Figure 4 for the process)

(a) The purpose is to test and improve the network adjustment results of direct geo-referencing, so as to ensure that the calculated exterior orientation parameters are within the reasonable accuracy range.

(b) The network adjustment should contain a significant number of correctly matched tie points, and error factors (including lever arms and synchronization errors) should be included in the overall adjustment calculation to minimize residual errors.

(c) In case of any known control points in the check area, the regional translation error between integrated INS/GNSS positioning and orientation system and local coordinate datum should be detected and compensated.

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[8] The arc-minute is a unit of plane angle, 1° (degree) =60′ (arc-minutes)

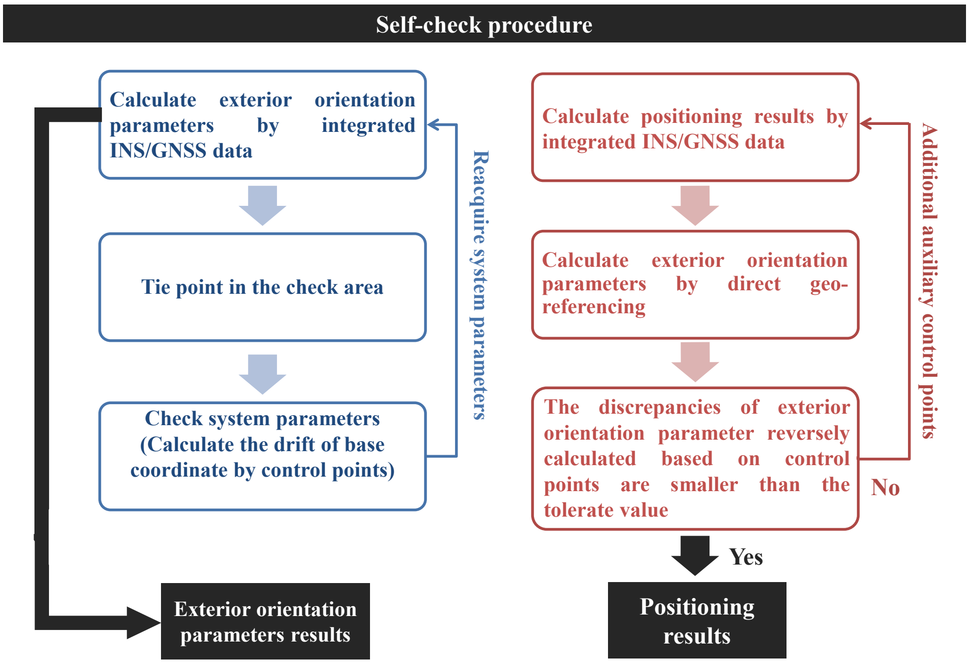

Figure 4 Self-check mechanism of mobile mapping system

5.2.1.3 Description for self-check of point cloud density

It mainly focuses on the point cloud density of road sign stripe and feature blocks. Sampling calculation is adopted to verify whether the average point cloud density of all sample units conforms to the standards. The size of sampled sample units should be adjusted according to factors, such as complexity of surveying environment, appearance and characteristics of feature blocks.

5.2.2 Check points accuracy analysis

Errors between the original check point coordinates, as the reference truth values, and the calculation results of the check point coordinates after data post-processing are quantitatively analyzed. Verification indexes are plane/vertical/three-dimensional orientations, respectively expressed by average error, maximum/minimum positioning error and root mean square error, supplemented by line charts/histograms to examine the error distribution.

If the check results fail to meet the requirements on high definition maps accuracy, the number of ground control points and the times of assistance should be increased according to the method in Section 5.2.1.

5.2.3 Check list of high definition maps operation process and outputs

The check items for the high definition maps operation process and outputs are summarized in Table 8.

Table 8 Check list of high definition maps operation process and outputs

Operation items	Check items	Check methods
Operation planning	Types, specifications and verification results of scanners for mobile mapping systems	Check instrument specifications and verify reports (including INS/GNSS, LiDAR and image sensor).
	Performance of integrated INS/GNSS positioning and orientation systems	
	Mapping operation planning	1. Check whether the scanning range covers the mapping area. 2. Check the GNSS base station distribution and the satellite geometric conditions of the observation session. 3. Scanning parameter setting (including scanning frequency, angle and mobile mapping system velocity).
Control survey	Control survey planning report (including distribution maps and coordinates of control points and check points)	1. Check whether the control points accuracy meets the existing standards or reaches the centimeter level. 2. The check points should be evenly distributed at the test area. Check whether the absolute accuracy meets the existing standards or reaches the centimeter level.

Mobile mapping operation	Calculation results of integrated INS/GNSS positioning and orientation systems	Check whether the positioning and orientation results meet the requirements of high definition map by mobile mapping system accuracy.
	Raw data scanned by mobile mapping systems without post-processing	1. Check the surveying date of source files and whether the surveying routes are consistent with the planned routes. 2. Check whether the time synchronization and coordinate translation of instrument observation data are completed.
Data post-processing	Point cloud density verification	Check whether the point cloud density of sample units meets the requirements of application scenarios.
	Vector layer correctness verification	1. Check whether the attribute information is correct (such as lane type, curvature, width, speed limit and orientation). 2. Check whether the feature block range and road shapes are correct. 3. At the absolute spatial position of the feature block, the horizontal position discrepancy should be less than 20cm and the three-dimensional discrepancy should be less than 30cm. 4. Check whether the mapping data are verified and processed in accordance with the high definition maps content and format standards or demand institutions' entrustment.

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Revision Records

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台灣資通產業標準協會
Taiwan Association of Information and Communication Standards

地　址・台北市中正區北平東路30-2號6樓
電　話・+886-2-23567698
Email・secretariat@taics.org.tw

www.taics.org.tw