Digital Urban Road Construction of Zhejiang Province

Technical Guide (Trial Implementation)

Zhejiang Provincial Department of Housing and Urban-Rural Development

August 2021

Preface

In order to implement the decision-making arrangements of digital reform in the province, accelerate the digital reform of the province's housing and urban construction system, to strengthen the guidance of digital urban road construction, the department issued the *Notice of Zhejiang Provincial Department of Housing and Urban-Rural Development on Printing and Distributing the Implementation Opinions on Digital Reform of Housing and Urban-Rural Construction System in the Province* (ZJG [2021] No. 18), proposing that digital urban road construction is an important part of digital reform of urban infrastructure. By building intelligent perception infrastructure, we can realize holographic perception of urban roads and expand intelligent applications such as CVIS, intelligent transportation, health monitoring and intelligent lighting. After investigation and study, and carefully summing up the needs, experiences and practices, this guide is formulated on the basis of extensive consultation.

The main contents of this guide are: 1. General Rules; 2 Terms and Definitions; 3. Basic Requirements; 4. Intelligent Perception System; 5. Central Platform; 6. Construction; 7. Operation, Management and Maintenance; 8. Others.

This guide is managed by Zhejiang Provincial Department of Housing and Urban-Rural Development, and Zhejiang Province Institute of Architectural Design and Research is responsible for explaining the technical contents. If there are any comments and suggestions in the implementation process, please send them to Zhejiang Province Institute of Architectural Design and Research (Address: No. 18 Anji Road, Hangzhou, Zip code: 310006).

Editor-in-chief: Zhejiang Province Institute of Architectural Design and Research

Participating units: Xingularity Intelligent Technology Group Co., Ltd.

Ningbo Municipal Facilities Center

Yangtze Delta Institute of Urban Infrastructure

Main drafters: GAO Song, ZHANG Hui, XIAO Min, ZHANG Li, CHEN Bin, Bian Wenbin, He Tiantao, Zhang Zhisheng, HUANG Zhen, WU Xin, Wang Chuyang, Zheng Beite, Xu Shuhua, Fang Xiaobo, Wang Zhigang, Song Haoran, Wang Sanxi, ZHOU Feng and Jin Qihang

Main reviewer: YANG Tong, Huang Xiaoyun, Ye Zhongmin, Yang Yuxiang, Chen Qiang and YU Xiang

1 General Rules

1.0.1 In order to promote the construction of digital urban roads, build digital urban roads with accurate perception, accurate analysis, fine management and meticulous service capabilities, and achieve the goals of safe travel, intelligent management and control, effective service and efficient traffic, the technical guide for digital urban road construction in Zhejiang Province is formulated.

1.0.2 This guide is applicable to the design, construction, operation, management and maintenance of newly-built urban expressways, trunk roads and secondary trunk roads in Zhejiang Province, and the reconstruction and expansion roads can be implemented with reference.

2 Terms and Definitions

2.0.1 Urban Road

The urban road referred to in this document refers to the road with certain technical conditions and facilities for vehicles and pedestrians to pass through within the city.

2.0.2 Holographic Perception

The holographic perception in this document refers to obtaining the urban road running status, and dynamic and static information of urban roads, infrastructures and supporting facilities along the line through front-end intelligent perception equipment, such as radar, camera and Internet of Things (IoT) terminal, and fusing them to form structured data.

2.0.3 All-Weather Traffic

All-weather traffic refers to the application of road information monitoring, CVIS, high-precision positioning, lane-level traffic guidance and other technologies and management means to realize the safe passage of vehicles under various weather conditions.

2.0.4 Digital Urban Road

Digital urban roads refer to urban roads with digital and intelligent capabilities, such as holographic perception of road facility status and running status, dynamic and static data fusion analysis, intelligent detection of infrastructure diseases, dynamic control of motor vehicles, non-motor vehicles and pedestrians, and second-level interaction between vehicles and roads.

2.0.5 City Road Intelligent Perception System

City road intelligent perception system refers to software and hardware system to obtain multi-dimensional information, such as urban road running status, running status of urban roads, infrastructures and supporting facilities along the road, and generate structured data through intelligent perception and computing equipment, such as radar, camera, IoT perception and health monitoring installed along urban roads based on artificial intelligence, high-precision positioning, edge computing, graphics and image processing and other technologies.

2.0.6 City Information Modeling

City information modeling: City information modeling integrates urban above-ground and underground, indoor and outdoor, historical, current and future multi-dimensional and multi-scale information modeling data and urban perception data, and constructs an organic complex of city information in three-dimensional digital space based on building information modeling (BIM), geographic information system (GIS), Internet of Things (IoT) and other technologies.

3 Basic Requirements

3.0.1 Digital urban road construction should be based on the present, serve the future, innovate technology, multiplex achievements, enrich scenarios and serve people's livelihood.

3.0.2 Digital urban road construction includes real-time holographic perception of urban roads, fusion computing processing of central platform and overall intelligent governance of urban areas.

1 Real-time holographic perception of urban roads: Obtain, and update the accurate position, speed, direction, size and other data of motor vehicles, non-motor vehicles, pedestrians, throwing objects, traffic signals and road construction signs for all-weather traffic on the road in seconds through the construction of intelligent perception system; obtain data such as the status and diseases of road, bridge and tunnel infrastructures; obtain the status data of road lighting equipment, parking area, platform, manhole cover and other infrastructure along the line, and form the real-time holographic perception capacity of urban roads.

2 Fusion calculation and processing of central platform: Fuse and calculate the real-time holographic perception data of the whole road section, and realize the second-level analysis of road infrastructure and running status to form comprehensive data of urban roads by building a data processing center.

3 Overall intelligent governance capacity of urban areas: Form the overall intelligent governance capacity of urban areas by building a business processing center, combining comprehensive data with road management and maintenance, opening data interfaces with various urban management platforms, providing real-time data and analysis reports, and combining the workflow of various management departments.

4 Intelligent Perception System

4.1 General Provisions

The intelligent perception system should include perception subsystem of urban roads and infrastructures along the line, perception subsystem of urban road running status, and adopt multi-pole, multi-perception and multi-case supporting facilities to realize unified layout. The relevant equipment of intelligent perception system shall meet the safety technical requirements and safety management requirements in relevant national specifications.

4.2 Perception of Urban Roads and Infrastructure along the Line

Intelligent perception equipment, such as IoT perception, radar and camera should be installed on urban roads and along the line. The equipment should have real-time perception and digital processing capacity of the status information of roads, bridges and tunnels, lighting equipment, parking areas, manhole covers, garbage bins, information boards and other facilities, and form the basic data of road sections.

4.2.1 Road, Bridge and Tunnel Status Perception

1 Basic function

IoT perception equipment such as road disease perception and health monitoring shall be laid along urban roads (it shall have the capacity of perceiving cracks, pits, rutting, looseness, subsidence, bump at bridge head (culvert top), water accumulation, etc.), to realize real-time monitoring and digital processing of pavement bridge and tunnel status (including deformation, leakage, settlement, stress, dynamic characteristics and temperature, etc.), and form basic data of road, bridge and tunnel working conditions.

2 Intelligent perception equipment

The perception equipment should use video detection equipment with artificial intelligence algorithm to perceive the road surface status in real time; IoT perception and data acquisition equipment such as deformation, stress, structure, crack and load should be used to monitor the status of bridges and tunnels in real time.

3 Installation requirements

According to the monitoring requirements, the perception equipment should be installed on multi-pole integrated poles or appropriate parts of bridges and tunnels.

4.2.2 Road Lighting Status perception

1 Basic function

Road lighting status perception equipment should be equipped along urban roads, which should have the perception capacity of equipment lighting quality, road lighting quality and running status of lighting equipment itself, and digital processing capacity like single lamp control, and form the basic data of road lighting.

2 Intelligent perception equipment

Road lighting status perception equipment should adopt IoT perception equipment such as illumination and light intensity, combine with intelligent perception equipment like cameras to realize lighting quality detection and monitoring functions; IoT perception equipment such as position, temperature and humidity should be used to realize the detection and monitoring functions of equipment status such as power supply status, communication status, lightning arrester status and temperature and humidity.

3 Installation requirements

The equipment should be installed on the multi-pole integrated rod and in the

case of road lighting equipment.

4.2.3 Infrastructure Perception along the Line

1 Basic function

Infrastructure perception equipment should be equipped along urban roads. Intelligent parking monitoring equipment should be installed in parking areas and non-motor vehicle parking areas along the line. The equipment should have the functions of non-motor vehicle and motor vehicle parking perception, parking service, law enforcement and evidence collection, etc.; a safety monitoring and station reporting system should be set up on the platform, which should have the function of perceiving the flow of people on the platform and providing real-time arrival information, and form the basic data of public travel.

2 Intelligent perception equipment

Intelligent perception equipment such as radar and camera should be adopted for infrastructure perception equipment along the line, and electronic fence should be combined to realize detection and monitoring of target area.

3 Installation requirements

Intelligent perception equipment, such as radar and camera, should be combined with multi-pole integration and installed in roadside parking areas, non-motor vehicle parking areas and bus stops.

4.3 Perception of Urban Road Running Status

4.3.1 Basic Function

The perception subsystem of urban road running status should have the function of perceiving urban road running status, including real-time holographic information of motor vehicles, non-motor vehicles and pedestrians, and information of traffic signal lamp status information, road construction signs, throwing objects, etc.

1 Real-time holographic information of motor vehicles, non-motor vehicles and pedestrians should include type information, spatio-temporal information (time, coordinates, lane, etc.), motion information (motion direction, motion speed and acceleration, etc.) and other static information (mark, color, size, type, etc.) of motor vehicles, non-motor vehicles and pedestrians.

2 Traffic signal lamp status information should include signal color (red, green and yellow) information, timing information, direction lamp indication information (straight, left turn, right turn, etc.) and signal lamp position information.

3 Other road information should include road construction signs such as cone bucket and triangular cone and real-time information of road surface throwing objects (coordinates and lane information, etc.).

4.3.2 Intelligent Perception Equipment

Intelligent perception equipment should adopt radar, camera, radar video vehicle detector, intelligent computing and other equipment, which should meet the requirements of normal operation under all-weather conditions in urban roads, complex intersections, ramps, bridges and tunnels. Intelligent perception

equipment should accurately locate, detect and identify motor vehicles, non-motor vehicles, pedestrians, signal lights, pavement construction signs and thrown objects by perceiving targets.

4.3.3 Installation Requirements

Perception equipment should be mounted on multi-pole integrated poles, fusion computing equipment and other hardware should be installed in equipment cases, and equipment cases should be mounted by poles or installed on the ground. The installation of perception equipment shall meet the following requirements:

1 One set of perception equipment for holographic road section should be installed every 150m, and each set of equipment should be composed of at least one telephoto camera, one medium focus camera, one radar and other equipment with equivalent functions.

2 One set of perception equipment at holographic intersection should be installed in each direction of the intersection, and each set of equipment should be composed of at least one telephoto camera, one medium focus camera, one radar and other equipment with equivalent functions. The installation position should not be more than 100m away from traffic lights and 50m away from zebra crossings.

3 One set of perception equipment for holographic bridges and tunnels should be installed every 100m, and each set of equipment should be composed of at least one medium focus camera, one radar and other equipment with equivalent functions.

4 If the equipment is installed on a multi-pole integrated pole, it shall meet the requirements of Zhejiang Provincial Project Construction Standard *Technical Standard for Smart Lighting Pole* (DB 33/T 1238).

4.4 Supporting Facilities

Supporting facilities shall include poles, perception equipment and case. On the premise of meeting the structural and functional requirements, industry standards and information security, all kinds of poles, perception equipment and equipment case on urban roads should be integrated to realize multi-pole integration, multi-perception integration and multi-case integration.

4.4.1 Basic Function

Digital urban road supporting facilities should create good installation conditions for each subsystem in the intelligent perception system, and realize the co-construction, sharing and co-governance of infrastructure.

4.4.2 Multi-pole Integration

Multi-pole integrated poles should be continuously and evenly laid on the road, which can be used as the main carrier for the integration of various equipment, and can be used to integrate traffic facilities, public security facilities and urban management facilities with a distance less than 10m around the poles. A certain load should be reserved reasonably for the multi-pole integrated pole to meet the needs of future expansion.

4.4.3 Multi-perception Integration

Cameras, radars, IoT perception and other equipment shall be integrated when the above conditions of 4.4 are met. All kinds of equipment should have data formats and unified interface modes in line with relevant national standards, and open data and interface protocols externally.

4.4.4 Multi-case Integration

When the equipment case meets the above conditions of 4.4, multiple cases shall be merged and concentrated to form a unified case frame, or all kinds of cases shall be arranged centrally. Power supply, network, case position, interface and pipe hole should be reserved for multi-case integrated case to meet the needs of future expansion.

5 Central Platform

5.1 General Provisions

The central platform includes two parts: data processing center and business processing center.

5.2 Data Processing Center

5.2.1 Basic Function

The data processing center should have the capabilities of data access and storage, data processing and data processing.

1 Data access and storage

The existing network should be used to access the perception subsystem of urban roads and infrastructures along the line and the perception subsystem of urban road running status, support the perception data reported by various equipment in the facilities, and store the data in the storage cluster of the data processing center.

2 Data processing

Data extraction, data cleaning, data association and data statistics should be carried out on the accessed perception data, and the processed results should be stored.

1) Data extraction: According to the data definition, the target format data is extracted from the accessed multidimensional perception data as the basic data for data cleaning and data association.

2) Data cleaning: Filtering, duplication eliminating and format cleaning of accessed data.

3) Data association: According to association rules and algorithms, the accessed multidimensional perception data are associated, and the associated information is output.

4) Data statistics: According to the defined statistical indicators, the data are statistically analyzed, and the statistical analysis results are stored in the distributed storage cluster to provide services for the business processing center.

3 Data processing

The data should be further processed, including data fusion, trajectory tracking, event analysis and facility status analysis, and reported to the business processing center.

1) Data fusion: Intelligent fusion algorithm is used to fuse the perception data of accessed multi-equipment and multi-systems.

2) Trajectory tracking: Through intelligent algorithms such as target features, trajectory fitting and trajectory prediction, the moving target is tracked to ensure that its tracking marks in the whole road section are consistent.

3) Event analysis: Traffic events are analyzed and identified with the fused data, in combination with traffic management rules and basic data of traffic roads..

4) Facility status analysis: Intelligent algorithm is used to analyze and judge the status of infrastructure and possible hidden dangers, and report them to the business processing center for processing.

5.2.2 Data Processing Center Equipment

Data processing center should adopt general server cluster to decouple data access and data processing

1 The data access cluster should adopt distributed architecture and general data interface, which can quickly access the perceived data of different manufacturers.

2 The data processing cluster should adopt distributed architecture with data processing and data processing functions, and the processing results should be reported to the business processing center.

5.2.3 Installation Requirements

The data processing center should be deployed in the regional computer room, and redundant technology should be adopted for hardware and network design. Information security design should meet the requirement of no lower than the second level of security physical environment, communication network and calculation according to *Information Security Technology-Baseline for Classified Protection of Cybersecurity* (GB/T 22239).

5.3 Business Processing Center

5.3.1 Basic Function

Business processing center utilizes the data assets of data processing center to provide business services and data services externally.

1 Business service

The data analysis of the data processing center should be used to form business service capabilities such as maintenance management, information service, operation management and CVIS.

1) Maintenance management: According to the monitoring and analysis of municipal facilities and their running status by the data processing center, the disease diagnosis of road facilities is made, and the maintenance suggestions

for infrastructures are offered.

2) Information service: According to the data analysis results of the data processing center, road infrastructure information, service facility status information, traffic running status information, traffic event information, road construction and maintenance information, meteorological environment information and other information are provided externally.

3) Operation management: Data assets of central platform are operated and managed.

4) CVIS: Real-time information, such as traffic accident warning, surrounding traffic status information and traffic light information, is provided for motor vehicles, non-motor vehicles and pedestrians through the existing network.

2 Data service

Data service should be provided for various management departments through standardized data interfaces, including authorization management of access to data assets, query and acquisition of data directory, mining and analysis of open data, query and subscription of data assets in data processing centers, etc.

5.3.2 Business Processing Center Equipment

Business processing center should adopt cloud architecture design.

5.3.3 Installation Requirements

Business processing center should be installed on government cloud, public cloud or private cloud.

5.4 Management Platform Docking

5.4.1 Basic Function

The central platform should have the capacity of opening data interface, which can dock with CIM and other urban management platforms.

5.4.2 Docking Requirements

Standardized data formats and external interface protocols should be defined, and the capacity of providing real-time data such as urban road and infrastructure status and traffic conditions and special analysis reports such as road network safety, efficiency and management should be possessed.

6 Construction

6.0.1 The construction organization shall prepare the construction scheme according to the design documents, which can be implemented only after being approved. The construction shall be carried out according to the approved design drawings, and the construction process shall be supervised by a third party meeting the requirements.

6.0.2 The construction organization should have a perfect construction quality assurance system, and the construction personnel should have

corresponding abilities.

6.0.3 During construction, relevant national and local safety production standards should be implemented and perfect safety measures should be taken.

6.0.4 Full investigation should be conducted before construction, complete records should be made during construction, and commissioning and trial operation should be completed after construction.

6.0.5 Construction shall comply with the provisions of the current relevant national construction standards, and equipment and materials shall comply with the relevant national product safety regulations and design requirements.

7 Operation, Management and Maintenance

7.0.1 The objects of operation, management and maintenance include intelligent perception system, central platform, multi-pole integrated pole and infrastructure.

7.0.2 The contents of operation, management and maintenance include real-time online monitoring, fault early warning and comprehensive analysis of the running status of intelligent perception system and central platform by using special software and hardware, and countermeasures and methods to solve the safety problems and hidden dangers found should be put forward.

7.0.3 The security policy of operation, management and maintenance should realize the isolation of functions, data and operations to ensure the security of data and network.

8 Others

8.0.1 In order to explore the digital urban road construction in the whole province and accumulate experience, digital urban road management measures are issued in different places according to local conditions, and operation and maintenance management departments are specified to promote the formation of technical specifications, project specifications and management specifications of digital urban roads in Zhejiang Province.

8.0.2 Housing and urban-rural departments at all levels should integrate the construction achievements with relevant management platforms, create more application scenarios for urban intellectual governance and serving the people (refer to the annex), and boost the digital management and maintenance of urban roads.

Annex: Schedule of Digital Urban Road Application Scenarios

S/N	Application scenarios	Brief description	Expected effect
Management class			
1	Traffic safety warning	Monitor and analyze traffic events (traffic accidents, non-motor vehicles entering motor vehicle lanes, road throwing objects, etc.), abnormal weather (agglomerate fog, water accumulation, snow cover, icing, etc.), abnormal road conditions (temporary road closure, road construction, traffic control, etc.) and abnormal vehicles (low-speed driving, illegal parking, occupation of emergency lanes, occupation of non-motor vehicle lanes, retrograde, etc.) in real time, generate early warning information, report it to the management platform, and send it to the information board, call out system and vehicle terminal (intelligent vehicle terminal, mobile phone terminal, navigation) to realize safe and efficient passage	Reduce accidents, reduce the impact of accidents, standardize driving behavior and improve traffic efficiency
2	Supervision of driving behaviors of key vehicles	Monitor and analyze the running track of key vehicles in real time, such as abnormal driving behaviors such as three emergencies and one high speed and serpentine driving, generate early warning information, report it to the management platform, and send it to the on-board terminal of abnormal driving vehicles to inform the owner to resume safe driving as soon as possible	Safe driving of vehicles and accurate supervision of platforms
3	Automatic timing control of signal lamp	Signal lamp timing is combined with holographic perception data of the whole road section, automatic timing control is carried out according to real-time traffic flow, and the green light interval is reduced to realize the global green wave passage	Fine management of intersections
4	Congestion management in hot spots	In areas prone to blocking points such as subway entrances, interchanges, ramps, hospitals, schools, etc., the comprehensive traffic flow conditions of various sections in multiple directions are identified and analyzed in real time, and tailor-made management and control strategies are formulated according to the analysis results, which are linked with traffic signals of various sections to realize rapid relief of blocking points and reduce congestion	Improve traffic efficiency and safety and purify road space

5	Digital forensics	For minor traffic accidents, the data processing center analyzes the lane, track, speed and other data of vehicles, forms an evidence chain by means of pictures and videos, completes the digital forensics, and sends the information to the traffic management department to judge the accidents online. The management department sends the judgment result and warning information to the vehicle through the platform, and	Quick identification, quick judgment, quick processing and quick evacuation of accidents online
		remind the owners of leaving quickly to avoid congestion. At the same time, the management department sends the judgment result to the insurance company to form the basis of insurance claims, and the insurance company registers online claims	
	……		
Service class			
1	Accompanying travel service	Based on the holographic perception data of the whole road section, the traffic congestion information, traffic event information and the optimal driving path are sent to the vehicle terminals (intelligent vehicle terminals, mobile phone terminals and navigation) through the mobile communication network to provide accompanying travel services for travelers	Improve travel experience and improve traffic efficiency
2	Passage guarantee of special vehicles	In sections where special vehicles (such as fire engines, emergency vehicles, ambulances and road rescue vehicles, etc.) need to pass urgently, the management department sends information such as lanes and time to be guaranteed to ordinary vehicles through the central platform, and requires these vehicles to avoid in advance	Ensure the rapid passage of special vehicles
3	Flexible lane multiplexing	Set up special passages in specific road sections (large-flow commuter roads, roads near major events or emergencies) during specific periods (such as large-scale events, major emergencies, etc.) to ensure the priority passage of specific vehicles; during the non-occupied time of the restricted lanes, the management department can issue the flexible multiplexing license information of the restricted lanes to social vehicles (vehicle terminals, intelligent vehicle machines or mobile phones) through the central platform to guide the vehicles to pass through the restricted lanes quickly and orderly	Improve road utilization rate and improve flexibility

4	Smart information release	Multiplex multi-pole integrated facilities, add network broadcasting, mobile phone charging, one-click help and other equipment, and use multi-functional pole LED screens, road guidance screens and mobile terminals to release information through multiple channels; create an interactive and experiential bus stop to realize the real-time release of bus arrival information, weather conditions, public welfare publicity and other information	Release travel information and provide convenience services
	……		
Facility class			
1	Digital road maintenance and management	According to the road total factor perception data such as pavement diseases, bridge and tunnel structure conditions, road lighting conditions and the data analysis formed by the data processing center, the maintenance requirements of municipal facilities are generated, and scientific maintenance management decisions are made.	Improve management efficiency and reduce maintenance cost
2	Intelligent parking management	An integrated management of parking on and off the road is provided based on full video; parking services, shared services, law enforcement forensics, etc. are integrated; the parking management of non-motor vehicles is standardized in combination with "Electronic Fence"	Optimize parking order to facilitate citizens' travel
3	Sidewalk purification	The safety of sidewalk facilities and hidden hazards are timely checked and eliminated through intelligent inspection. Combined with "multi-pole integration, multi-case integration and multi-perception integration", various poles and cases are cleaned and integrated, and isolation facilities are scientifically and rationally set up	Purify sidewalk space and create a high-quality green travel environment
	……		