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Supplement

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SERIES H: Audiovisual and multimedia systems

Practice for intelligent traffic sensing device deployment on the roadside

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Supplement 20 to ITU-T H-series Recommendations

Practice for intelligent traffic sensing device deployment on the roadside

Summary

To support an ITS in order to obtain a comprehensive and effective perception data, this Supplement 20 to ITU-T H-series gives the practice references for roadside sensing devices' deployment in the ITS. The detection and analysis of traffic elements based on roadside sensing devices is an important foundation for intelligent transportation. Sensing devices used on the roadside to build an intelligent transport system (ITS) generally include cameras, light detection and ranging (lidars), millimetre wave radio detection and ranging (radars), etc. The requirements for sensing devices, such as the deployment and the function characteristics will affect the quality of data for intelligent transportation systems. Supplement 20 to ITU-T H-series Recommendations applies to ITU-T H.550-H.599 series: Vehicular gateways and intelligent transportation systems (ITS).

History

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Intelligent transportation system, sensing devices, traffic scenarios.

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FOREWORD

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Introduction

Intelligent transport system is a new generation of intelligent, networked and shared transport systems based on the International Mobile Telecommunication-2020 (IMT-2020) network, big data, artificial intelligence and other emerging technologies. The intelligent transport system will:

1) Ease traffic congestion and improve traffic efficiency;

2) Minimize traffic accidents caused by human and unforeseen factors;

3) Effectively coordinate the use of vehicles, roads and fuel, and promote energy conservation, emission reduction and pollution prevention;

4) Improve the efficiency of traffic management and transportation management.

Roadside sensing devices are an important part of the intelligent transportation systems. Commonly used intelligent traffic sensing devices include a camera, lidar, millimetre wave radar, etc. The requirements for these sensing devices, such as quantities, combination, deployment mode, data collecting ability, and transmission interface will affect the quality of data for intelligent transportation systems. And this Supplement gives the practice references for intelligent traffic sensing devices' deployment on the roadside.

Supplement 20 to ITU-T H-series Recommendations

Practice for intelligent traffic sensing device deployment on the roadside

1 Scope

This Supplement gives the practice references for intelligent traffic sensing devices' use on the roadside.

This Supplement covers the following:

1) Deployment of sensing devices;
2) Sensing devices' function, data collecting capability and transmission interface;
3) Use cases of sensing devices working in different traffic scenarios.

2 References

None.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following term defined elsewhere:

3.1.1 device [b-ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.2 Terms defined in this Supplement

This Supplement defines the following term:

3.2.1 traffic scenario: A road traffic condition, including the characteristics of the road, traffic flow and the traffic participants.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

GNSS	Global Navigation Satellite System
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IMT-2020	International Mobile Telecommunication-2020
ITS	Intelligent Transport System
Lidar	Light Detection and Ranging
MQTT	Message Queuing Telemetry Transport
NTP	Network Time Protocol
PTP	Precision Time Protocol
Radar	Radio Detection and Ranging
RTCP	Real-time Transport Control Protocol

RTP Real-time Transport Protocol

RTSP Real-time Streaming Protocol

5 Conventions

None.

6 Overview

The detection and analysis of traffic elements based on roadside sensing devices is an important foundation for intelligent transportation. Sensing devices used on roadsides to build an intelligent transport system (ITS) include cameras, light detection and ranging (lidars), millimetre wave radio detection and ranging (radars), etc. The application for sensing devices, such as quantities, combination, deployment mode, data collecting ability, and transmission interface will affect the quality of data obtained by the intelligent transport systems through them. To support the ITS to obtain a comprehensive and effective perception data, this Supplement gives the practice references of sensing devices' deployment on the roadside.

First, the deployment mode suggestions of sensing devices which are are provided include the combination and the quantities of multi devices. Then the recommended functions, data collecting abilities and transmission interfaces are listed. And use cases of sensing devices working in typical traffic scenarios are given in the Appendix.

7 Sensing devices' deployment mode

a) Combination of multi devices:

- At least one camera and one millimetre wave radar should be used in each deployment site. The combination can meet the basic data acquisition requirements of an intelligent transportation system in most instances.
- When the data accuracy requires the shape, position, distance, and speed, and other characteristics of traffic participants are higher, lidar should be added.
- Patch devices could be added as needed to cover detection blind areas in practice.

b) Deployment site:

- Sensing devices should be deployed on one side of the road when the road is narrow (e.g., the number of lanes is 1 ~ 4) and there is no isolation belt in the middle of the road. Otherwise, bilateral deployment should be considered.
- The deployment interval is determined according to the demand for road intelligence level. When building high level intelligent roads to provide automatic driving control and decision-making information for vehicles, sensing devices should cover all the roads, and the interval is recommended to be about 200 m - 400 m (according to the sensing devices' detection distance). When building low intelligent roads to provide safety tips and road planning information for vehicles, sensing devices should cover only key sections of roads, and the interval can be longer.

c) Installation:

- The installation poles are recommended to share traffic signal light poles or monitoring poles. If there is no pole to be shared, new poles should be built.
- The installation height is recommended to be 4 m - 6 m above the ground, it is necessary to consider the actual road conditions, like shelter from trees, buildings, and so on.
- The distribution and installation angle of the devices on the pole should enable the target area to be effectively covered and detected.

8 Sensing devices' function

Camera:

– Support basic functions such as image capture and video streaming output.

– AI calculation functions are optional according to the needs, which is the AI algorithm processing of images and videos, and outputting the characteristics and measurement data of traffic elements such as vehicles, licence plates, traffic signs, motorcycles, bicycles, pedestrians, etc.

– Support the transmission of raw and processed data to a roadside computing facility and cloud system connected to it.

– Support retransmission function after disconnection.

Lidar:

– Support visual rendering and preservation, and playback of raw point cloud data.

– Support outputting the speed, position, direction, attitude, and shape of the target being detected.

– Support the transfer of data to a roadside computing facility and to a cloud system connected to it.

Radar:

– Support detecting the object's position and speed.

– Support detecting the lane traffic, occupancy and queue length.

– Support event detecting functions such as abnormal stopping, retrograde, pedestrian in the driveway, objects dropped on the road and congestion.

9 Sensing devices' data collecting capability

The data collecting capability of sensing devices is determined according to the demand for road intelligence level and the construction cost. For a camera, it is recommended to support HD photos and videos ($\geq$ 720p). And for Lidar and Radar, it is recommended to be high resolution and long distance.

10 Sensing devices' transmission interface

Camera:

– Physical interface: RJ45 ethernet port and RS485 serial port are commonly used, and RJ45 ethernet port is recommended.

– Time synchronization: It should support the global navigation satellite system (GNSS) satellite timing or network interface timing, and the network interface timing should support the network time protocol (NTP) or the precision time protocol (PTP).

– Data transfer protocol: The transport layer should support transmission control protocol (TCP) / user datagram protocol (UDP). For the application layer, real-time streaming protocol (RTSP), real-time transport protocol (RTP) / real-time transport control protocol (RTCP), Hypertext transfer protocol (HTTP) / Hypertext transfer protocol secure (HTTPS), and other protocols can be selected according to needs.

Lidar:

– Physical interface: RJ45 ethernet port or RS485 serial port are commonly used, RJ45 ethernet port is recommended.

– Time synchronization: It should support GNSS satellite timing or network interface timing, and the network interface timing should support NTP or PTP.

– Data transfer protocol: The transport layer should support TCP / UDP. For the application layer HTTP / HTTPS, message queuing telemetry transport (MQTT), and other protocols can be selected according to needs.

Radar:

– Physical interface: RJ45 ethernet port or RS485 serial port or CAN port are commonly used, RJ45 ethernet port is recommended.

– Time synchronization: It should be either GNSS satellite timing or network interface timing, and the network interface timing should support NTP or PTP.

– Data transfer protocol: The transport layer should support TCP / UDP, and the HTTP / HTTPS, MQTT and other protocols can be selected in the application layer according to needs.

Appendix I

Use cases

I.1 Traffic scenarios 1: Straight section of urban roads

In urban straight roads, traffic participants include motor vehicles, non-motor vehicles, pedestrians, and so on. Vehicles' driving states are complex and there are many situations such as lane change, overtaking, emergency deceleration, etc. Moreover, there are buildings, trees, and other objects in the city which are easy in creating perceptual blind areas for vehicle drivers or autonomous vehicles, that may lead to accidents and reduce traffic efficiency.

In the intelligent transportation system, by setting up roadside sensing devices, the motion status of all traffic participants can be obtained in real-time. The roadside sensing system can analyse the driving intentions of vehicles, such as lane change, deceleration, avoidance, etc., and send them to the relevant vehicles to help them choose the appropriate driving strategy and realize safe and efficient driving.

Roadside sensing device sites can be deployed at intervals, it is recommended to install at least a lidar, a camera, and a millimetre wave radar equipment on each site.

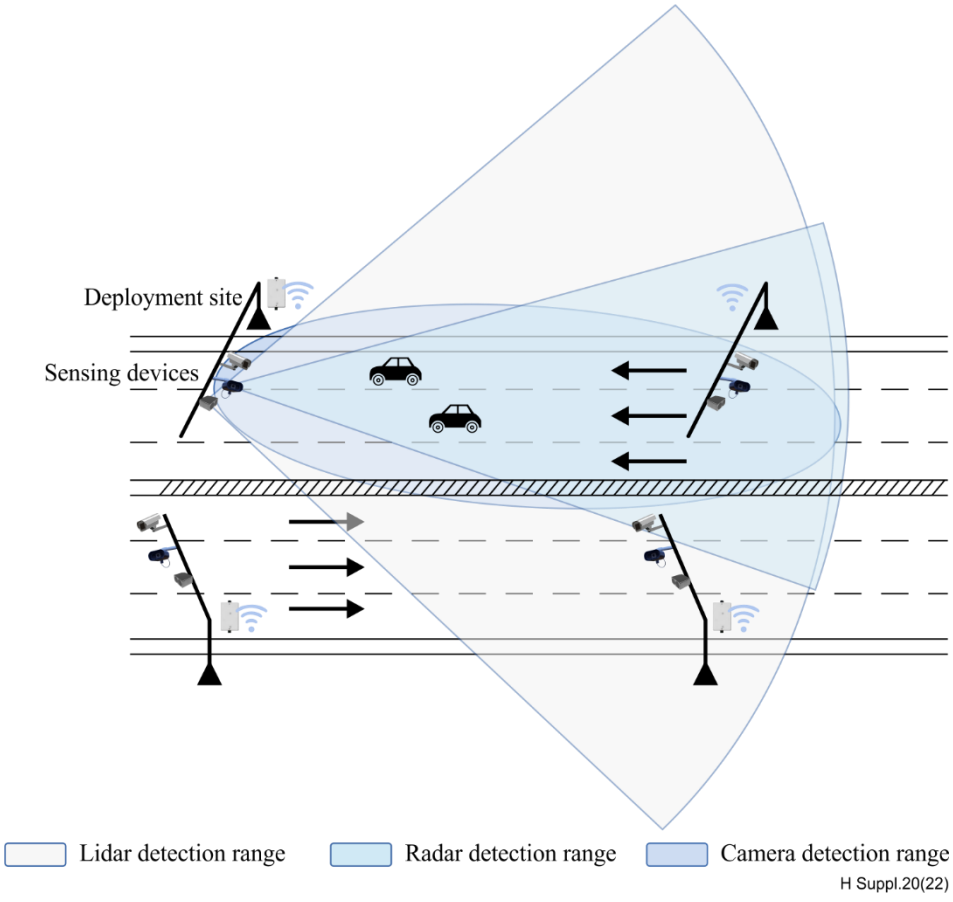

Figure I.1 – Sketch map of sensing devices in a straight road

I.2 Traffic scenarios 2: Intersection of urban roads

At urban intersections, there are many concentrated traffic participants. Vehicles and people are prone to collision, and the traffic efficiency of intersections often affects the traffic efficiency of local areas. The roadside sensing system will:

– Help vehicles identify the traffic participants at the intersection and avoid collision.

– Count the intersection traffic flow and configure the dynamic traffic time in cooperation with the signal control system.

– When vehicles approach the intersection, the signal light status is sent in advance to help the vehicle driver or the autonomous vehicle to reasonably plan the speed.

To realize the functions above, a global perception of the intersection is needed. It means to perceive and monitor the lanes in every direction. At the intersection of each direction, facing the incoming vehicle, deploy the sensing device group:

– At a simple intersection with lanes of less than four (narrow roads), small traffic flow and no obvious objects to block the field of view of sensing devices, a lidar can be deployed in just one direction, and a set of camera and millimetre wave radar is recommended to be deployed every direction.

– At the large intersection with lanes of more than four (wide roads), large traffic flow and obvious objects to block the field of view of sensing devices, a set of lidar, camera and millimetre wave radar are recommended to be deployed in every direction.

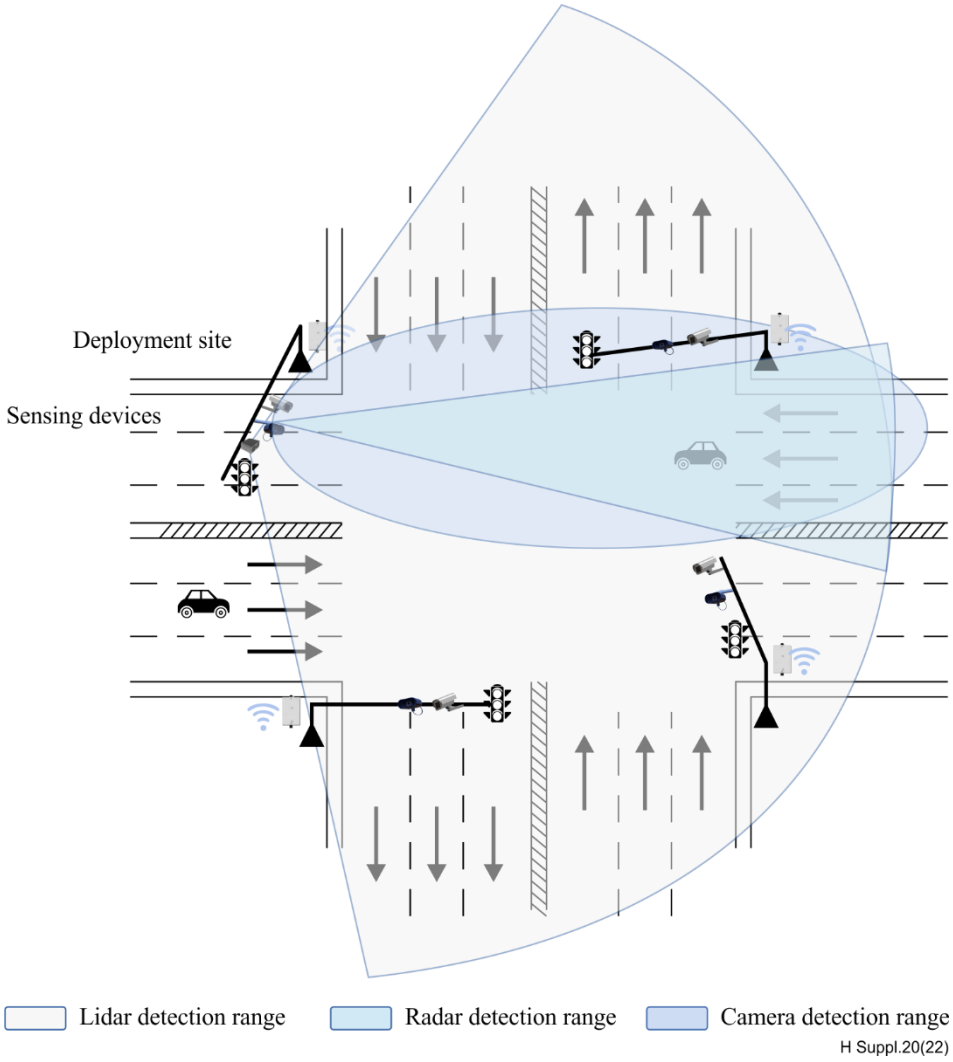

Figure I.2 – Sketch map of sensing devices at the intersection

I.3 Traffic scenarios 3: Straight section of highways

High speed straight roads generally have a long distance and a fast driving speed. The roadside sensing system can detect traffic events (such as traffic accidents), obstacles (such as falling stones, left goods, etc.), road conditions (such as ponding, icing, etc.), and sends the information to the

vehicles that may be affected. Vehicles get traffic conditions beyond the sight distance in advance, which can improve driving safety and plan the optimal driving path.

Roadside sensing device sites can be deployed at intervals, it is recommended to install at least a camera and a millimetre wave radar on each site.

Highway roads are generally closed, with only vehicles and no traffic participants such as pedestrians and non-motor vehicles. Hence, lidar is an optional equipment and can be installed only in particular sections, such as entrances, exits and accident-prone sections.

I.4 Traffic scenarios 4: Bend section of highways

At the bend section of the highway with a large corner, there is a blind area in front of the vehicle. An extra deployment site for sensing devices is needed.

– At one-way road bends, a set of sensing devices can be deployed. At two-way road bends, it is recommended to deploy two sets of sensing devices facing two driving directions respectively.

– The deployment site is set near the place with the largest curve radian, and the devices are installed towards the driving direction to cover the blind area.

Bibliography

[b-ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things.*

[b-ITU-T Y.4471] Recommendation ITU-T Y.4471 (2021), *Functional architecture of network-based driving assistance for autonomous vehicles.*

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