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**The classification and reference architecture of cloud platform
for service robot**

服务机器人云平台分类及参考体系结构

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1 Scope

This document gives the service content, the classification method and the reference architecture (infrastructure layer, platform layer, application layer, security management, operation and maintenance management, and evaluation and assessment) of cloud platforms for service robots.

This document applies to the building and use of service robot cloud platforms by service robot cloud platform developers and by service robot application developers, manufacturers, integrators and users.

2 Normative references

The contents of the following documents constitute indispensable provisions of this document through the normative references made to them in the text. For dated references, only the edition corresponding to that date applies to this document; for undated references, the latest edition (including all amendments) applies to this document.

GB/T 12643-2013 Robots and robotic devices - Vocabulary

GB/T 32400-2015 Information technology - Cloud computing - Overview and vocabulary

GB/T 38834.1-2020 Robotics - Performance criteria and related test methods for service robots - Part 1: Locomotion for wheeled robots

3 Terms and definitions

The terms and definitions given in GB/T 12643-2013, GB/T 32400-2015 and GB/T 38834.1-2020 and the following apply to this document.

3.1 service robot: A robot that performs useful tasks for humans or equipment, excluding industrial automation applications. [SOURCE: GB/T 12643-2013, 2.10]

3.2 cloud platform: A collection of software and hardware that provides one or more capabilities through the defined interfaces of cloud computing.

3.3 architecture: The organisational structure of a system or a component. [SOURCE: GB/T 11457-2006, 2.73]

3.4 cloud computing: A paradigm in which a scalable and elastic pool of shared physical and virtual resources is provided and managed in an on-demand self-service manner. Note: the resources include servers, operating systems, networks, software, applications and storage devices. [SOURCE: GB/T 32400-2015, 3.2.5]

4 Abbreviations

The following abbreviations apply to this document.

API: Application Programming Interface.

IaaS: Infrastructure as a Service.

PaaS: Platform as a Service.

SaaS: Software as a Service.

5 Services provided by a service robot cloud platform

A service robot cloud platform mainly provides the following services.

- a) Computing and storage services: they provide the computing and storage resources a service robot needs so that it can carry out various tasks on the cloud platform, such as speech recognition, natural language processing and data analysis.
- b) Security services: they provide the security measures that protect the data of the service robot at every stage of the whole data life cycle, such as data encryption and identity authentication.
- c) Interface services: they provide open and extensible interfaces, including secondary

development of software interfaces and data transmission protocols.

d) Collaboration services: they rapidly assemble the various system services according to what the user needs and provide a collaborative solution.

e) Sharing services: they allow outside parties, once they have obtained permission, to call the services of the platform.

f) Other services: services other than those listed above are supported.

6.1 Classification by the users the cloud platform is aimed at

6.1.1 Cloud platform aimed at service robot developers. It is aimed at the people who develop service robots and provides the various tools and general service components that service robot development calls for, including service robot software development tools, software development kits and APIs, a virtual simulation environment for service robots, and cloud training services for service robot models.

6.1.2 Cloud platform aimed at business users of service robots. It provides users with platform services for the deployment, management, operation and maintenance of service robots, and supports continuous integration, security, deployment of computing resources and management of cluster service pools, so that users can quickly build a service robot system, manage the computing resources and the data of the service robots, and make the service robots intelligent, for example by achieving visualisation and automated data management through data analysis.

6.2 Classification by the way the cloud is connected

6.2.1 Cloud-device centralised cloud platform. Each service robot sets up a communication link directly with the cloud platform, transmits its operating data and calls the services on the cloud platform, as shown in Figure 1.

6.2.2 Cloud-edge-device distributed cloud platform. Each service robot sets up a communication link with an edge server; the edge server is responsible for the preliminary filtering, analysis and storage of local data and then uploads the data to the cloud, and the cloud platform is responsible for the analysis and storage of the data, as shown in Figure 2.

Users, cloud service platform developers and robot developers choose the deployment method of the cloud service according to factors such as the scale of the cloud service, its real-time behaviour, its security and the way the services are called. In a cloud-edge-device distributed cloud platform, the computing and storage services are generally placed both in the cloud and at the edge, the security services are placed at the edge, and the interface services, collaboration services and sharing services are placed in the cloud.

7.1 Overview

The reference architecture of a service robot cloud platform includes the infrastructure layer, the platform layer, the application layer, security management, operation and maintenance management, and evaluation and assessment, as shown in Figure 3. The architecture defines a complete device abstraction capability, a general service extension capability and a flexible capability for aggregating solutions. The different classes of cloud service platform described in Clause 6 can be built on this architecture, forming different user interfaces by the way the function list is organised, and the function list can be adjusted as use requires.

The infrastructure layer is mainly the layer that provides the basic physical resources for the service robot, and it includes computing infrastructure, storage infrastructure and network infrastructure. The provider of the cloud computing infrastructure integrates large numbers of servers, network devices and storage devices into available basic resources by means of distributed technology, virtualisation technology and the like, and abstracts them outwards as standardised cloud infrastructure. The user of cloud computing only has to apply for the kind of resource it needs and can then obtain the required resource allocation from the infrastructure service in the cloud. A service robot, or an application, can obtain these resources on demand while running, and the cloud platform can deliver the lowest-level devices and resources to the user over the internet.

The platform layer includes modules for service robot and device management, data communication, resource management, data storage, perception, cognition, decision, control and collaborative computing. It performs the modelling and access management of service robots and devices and the unified management and scheduling of computing resources, provides the service robots connected to the platform with intelligent algorithm services for perception, cognition and autonomous decision, and controls the service robot on the basis of the decision results. Relying on the collaborative computing module, the platform layer schedules cloud, edge and device heterogeneous computing units together, and deploys and runs each computing task in a distributed way according to the current resource load of the system and the demand for computing resources, producing a reliable output.

The application layer abstracts and encapsulates the resources of the two layers below into application services or complete solutions, and provides pre-integrated products and combinations of capabilities for particular industries, meeting the needs of different scenarios for moving to the cloud.

Security management of the cloud platform includes infrastructure security, IaaS security, PaaS security, SaaS security, cloud security management, cloud security supervision, and the process security between the service robot and the cloud platform, so that the secure operation of the platform is managed and monitored.