

Recommendation

ITU-T H.626.7 (06/2024)

SERIES H: Audiovisual and multimedia systems

Broadband, triple-play and advanced multimedia services –
Advanced multimedia services and applications

Functional architecture for machine vision systems in smart manufacturing

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Audiovisual and multimedia systems

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Recommendation ITU-T H.626.7

Functional architecture for machine vision systems in smart manufacturing

Summary

Recommendation ITU-T H.626.7 specifies the architecture of machine vision systems for supporting the communication between endpoint, application and machine vision systems in smart manufacturing, so as to help ender users and providers to specify the machine vision tasks and the solutions, enhance confidence in machine vision ecosystem and open new applications for machine vision systems.

History*

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Architecture, machine vision, smart manufacturing, system.

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Recommendation ITU-T H.626.7

Functional architecture for machine vision systems in smart manufacturing

1 Scope

This Recommendation specifies the functional architecture and the reference point of machine vision systems in smart manufacturing, and describes the functional entities, their relationships in the machine vision systems and information flows.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T F.748.16] Recommendation ITU-T F.748.16 (2022), *Requirements for applications and services in smart manufacturing based on machine vision*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 algorithm [b-ISO/IEC 11557]: Set of rules for transforming the logical representation of data.

3.1.2 application [b-ITU-T Y.101]: A structured set of capabilities, which provide value-added functionality supported by one or more services.

3.1.3 endpoint [b-ITU-T H.350]: A logical device that provides video and/or voice media encoding/decoding, and signalling functions.

3.1.4 machine vision [ITU-T F.748.16]: Signal processing to acquire, process and interpret an image or video to support visual analysis for applications, such as automatic inspection, process control and guidance.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AD	Algorithm Domain
ADF	Algorithm Deployment Functional entity
AI	Artificial Intelligence
AMF	Algorithm Management Functional entity
APD	Application Domain

APF	Algorithm training Provider Functional entity
API	Application Interface
ASF	Algorithm Security Functional entity
AVI	Audio Video Interleave
BSMF	Back-Stage Management Functional entity
CDF	Capability Debugging Functional entity
CED	Capability Exposure Domain
CGMF	Capability Gateway Management Functional entity
CSPF	Configure Service Portal Functional entity
DAD	Data Acquisition Domain
DAF	Dataset Acquisition Functional entity
DCMF	Docker Container Management Functional entity
DD	Development Domain
DFF	Data Feedback Functional entity
DMF	Data Management Functional entity
DMMF	platform Daily Monitor Management Functional entity
DSF	Data Security Functional entity
ESF	access Security Functional entity
HTTP	Hypertext Transfer Protocol
IDF	Image Decoding Functional entity
IPF	Interface Presentation Functional entity
MAF	Model Adaptation Functional entity
MCF	Model Compression Functional entity
MD	Manage Domain
MEC	Multi-access Edge Computing
MIF	Model Issuance Functional entity
MTF	Model Training Functional entity
MV	Machine Vision
MVIF	Model Visualization Functional entity
MVS	Machine Vision System
PPF	Pre-Processing Functional entity
PSF	Platform Security Functional entity
RDAF	Runtime Data acquisition Functional entity
ResNet	Residual Network
RQF	Record Query Functional entity
SCD	Security Domain
SDK	Software Development Kit

SPF	Security Functional entity
SSMF	Scenario Solution Management Functional entity
SVD	Service Domain
TMF	Terminal Management Functional entity
VAF	Video Acquisition Functional entity
VCF	Video Control Functional entity
ViT	Vision Transformer
WMA	Windows Media Audio
YOLO	You Only Look Once

5 Conventions

None.

6 Overview of machine vision systems in smart manufacturing

The machine vision system (MVS) will integrate the highest level of machine vision (MV) algorithm, edge computing, cloud-side collaboration, security management and other technologies to provide manufacturing companies with a series of services such as industrial networks, data collection, equipment monitoring, data storage and analysis. The ultimate goal of MVS is building an autonomous and controllable intelligent vision system, realizing the production, introduction, operation, and management of artificial intelligence (AI) abilities, as well as converging self-developed algorithm and third algorithm to form an algorithm repository. Additionally, the system should adapt to the edge computing terminal, and meet the basic requirements of intelligent manufacturing, including coordinated control, management and unified edge resources management.

6.1 System basis

- 1) The MVS supports a cluster structure of multiple servers and adjusts the computing nodes flexibly. It provides horizontal scalability of processing performance and cooperates with load balancing equipment to achieve higher availability.
- 2) The MVS supports independent data storage, business logic, interface presentation, etc.
- 3) The MVS supports a common hardware structure, operating system and database.
- 4) The MVS supports application interface (API) interfaces and the scalability of interfaces that follow the principle of loose coupling.

6.2 Reliability basis

- 1) The application of MVS covers a complete log record function, which can record every user's operation.
- 2) The MVS provides backup and recovery methods
NOTE 1 – A fault-tolerant mechanism is used to avoid the occurrence of a single failure, such as the use of clustering and load balancing.
- 3) The MVS provides reliable operations of business production.
NOTE 2 – Strict authority control or firewalls are adopted between the system and the business support system.

6.3 Maintainability basis

- 1) The MVS has scalability and smooth expansion to meet the increasing scale of applications and business systems in the future.
- 2) The MVS supports the regular backup of important data by a combination of incremental backup and full backup.
- 3) The MVS has partial pressure processing ability by adding hardware/application servers when the system's processing pressure is too heavy.
- 4) The MVS adopts component-based designing ideas and a separate system framework and business logic to meet the requirements of enterprise users.

7 Functional architecture of machine vision systems in smart manufacturing

For supporting the requirements and reference framework for machine vision in smart manufacturing defined in [ITU-T F.748.16], the functional architecture of the MVSs is shown in Figure 7-1. The main functions of the proposed MVS system are divided into four sets based on their functional entities, including application functional entities, operation functional entities, support functional entities and edge functional entities. The application functional entities are responsible for demonstrating and receiving user orders, while the operation functional entities are responsible for encapsulating MV capabilities and system management. The support functional entities are responsible for algorithm production and system maintenance, which the edge functional entities are responsible for algorithm implementation and capturing visual data.

- Image devices

Imaging devices typically consist of a single light source or of multiple light sources and image encoding. These devices are designed to collect and send the image to the edge functional entities. The lighting source is controlled by the lighting controller, and the brightness and angles of lighting on the object will affect the lighting quality of the images passed to the industrial cameras whose field of view is determined by the lenses. The industrial community have mainly adopted the line scan cameras or area scan cameras as industrial cameras. Specifically, the output of a line scan camera is a two-dimensional image with a few pixels in the vertical direction and a long horizontal pixel length, usually up to thousands of pixels. Generally, this kind of camera is used in two situations: a) When the measured field of view is a slender strip, which is mostly used for the detection tasks on the drum. b) When a large field of view, e.g., larger than $10\,000 \times 100$ mm or high image resolution and e.g., $100\text{ }\mu\text{m}$ per pixel is recommended. Also, according to the imaging method, the scan camera can be further divided into grayscale cameras and colour cameras. A scan camera takes a picture of the single rectangle at once, and it utilizes continuous and planar scanning light to realize the functions of detection and identification on the pipeline. Compared with the line scanner, the area scanner can capture intuitive two-dimensional image information, and it can be widely used in some occasions that do not require very high precision, such as the measurement of area, shape, size, position and even temperature. The cost of an area scan camera is relatively low and it can be accepted by most consumers. However, due to the constraints of production technology, it is difficult for a single area scanner to meet the requirements of the field of view and accuracy at the same time, and multiple cameras are normally used in combination.