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SERIES M: TELECOMMUNICATION MANAGEMENT, INCLUDING TMN AND NETWORK MAINTENANCE

Telecommunications management network

Requirements for work order processing in telecom management with artificial intelligence

Recommendation ITU-T M.3382

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Recommendation ITU-T M.3382

Requirements for work order processing in telecom management with artificial intelligence

Summary

Recommendation ITU-T M.3382 provides the requirements for work order processing in telecom management with artificial intelligence (AI). Based on AI models and features extraction, work orders will be collected, analysed, forwarded and archived.

This Recommendation describes the framework and functional requirements for work order processing in telecom management with AI, and the requirements of these work orders. It also describes the process of text and image feature extraction.

History

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Keywords

Artificial intelligence, telecom management, work order processing.

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Recommendation ITU-T M.3382

Requirements for work order processing in telecom management with artificial intelligence

1 Scope

This Recommendation describes the requirements for work order processing in telecom management with AI. Based on AI models and features extraction, work orders will be collected, analysed, forwarded and archived.

This Recommendation covers the following:

1) Framework for work order processing in telecom management with AI;
2) Functional requirements for work order processing in telecom management with AI;
3) Requirements of work orders;
4) The feature extraction process of sample work orders.

2 Reference

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 M.3010] Recommendation ITU-T M.3010 (2000), *Principles for a telecommunications management network*.

[ITU-T M.3041] Recommendation ITU-T M.3041 (2020), *Framework of smart operation, management and maintenance*.

[ITU-T M.3080] Recommendation ITU-T M.3080 (2021), *Framework of artificial intelligence enhanced telecom operation and management (AITOM)*.

[ITU-T M.3400] Recommendation ITU-T M.3400 (2000), *TMN management functions*.

[ITU-T Q.9] Recommendation ITU-T Q.9 (1988), *Vocabulary of switching and signalling terms*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 functional block (in SDL) [ITU-T Q.9]: A functional block is an object of manageable size and relevant internal relationship, containing one or more processes.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 work order: A ticket through which the superior department assigns a network management, operation and maintenance task to the subordinate department.

4 Acronyms and abbreviations

This Recommendation uses the following abbreviations and acronyms:

AI Artificial Intelligence

AITOM Artificial Intelligence enhanced Telecom Operation and Management

API Application Programming Interface

BSS Business Support System

EMS Element Management System

E-OSF Element management layer – Operations Systems Function

NFV Network Function Virtualization

NLP Natural Language Processing

NMS Network Management System

N-OSF Network management layer – Operations Systems Function

OCR Optical Character Recognition

OSS Operation Support Systems

SDN Software Defined Network

SOMM Smart Operation Maintenance and Management

S-OSF Service management layer – Operations Systems Function

SPO Subject-Predicate-Object

5 Conventions

None.

6 Overview of work order processing in telecom management with AI

This Recommendation proposes the requirements for work order processing in telecom management with AI. With the rapid development of network scale, the operation and maintenance management has become more complicated. The number of network elements has increased sharply, and the type of network management work orders has also increased in the same manner. In order to process various work orders, more people are needed to work on duplicate work with traditional management methods, which lead to an increase in labour costs and processing time. Therefore, it is necessary to use new technology AI to realize intelligent and automatic processing of network management work orders.

The work order processing in telecom management with AI is a typical scenario application based on the artificial intelligence enhanced telecom operation and management (AITOM) (see [ITU-T M.3080]. The work orders available in this Recommendation are classified into the following areas:

- Network management
- Service management

The network management work orders include performance management, fault management, configuration management, accounting management and security management as listed in [ITU-T M.3010]. The service management work orders include service provision, service orchestration and service quality assurance based on the software defined network (SDN) / network function virtualization (NFV) architecture.

This Recommendation proposes the requirements for work order processing in telecom management with AI. The main AI technologies used in work order processing include the natural language processing (NLP) and image recognition. Based on AI models and features extraction, work orders will be collected, analysed, forwarded and archived.

The main characteristics of processing work orders in telecom management with AI can be described as follows:

– **Intelligent**: Based on big data, AI algorithms and smart devices, the network management work orders can be processed without humans in a more precise and easier way and can even give accurate classification and recommendation of different work orders.

– **Automatic**: The processing of network management work orders is a closed loop. From generation to completion, work orders transfer in different links automatically.

7 Framework for work order processing in telecom management with AI

7.1 Functional block diagram of work order processing in telecom management with AI

The functional block diagram of network management work order processing is shown in Figure 7-1. The dotted frames represent the functional blocks in work order processing with AI.

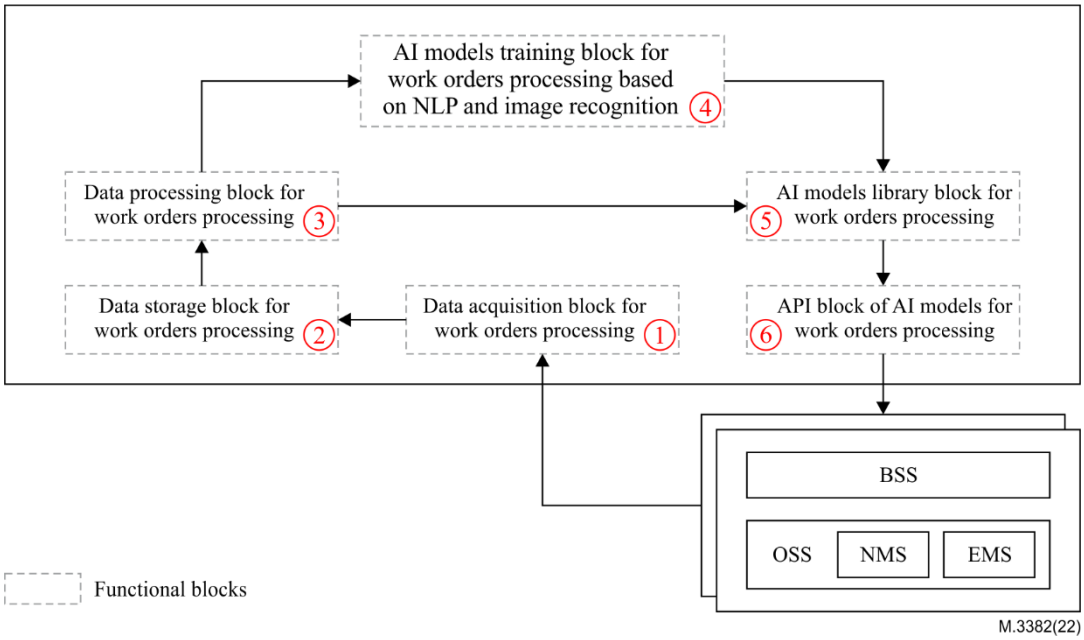

Figure 7-1 – Functional block diagram for work order processing in telecom management with AI

There are five functional blocks in this framework, including:

1) Data acquisition block for work order processing: To make machines understand the content of work orders, many types of work orders should be used to train the AI model. This block can get work orders from the related interface of a business support system (BSS) / operation support systems (OSS) and offline collection. The work orders from the offline collection are paper documents, therefore it is necessary to convert them to digital documents with AI methods instead of manual input. This block mainly uses text recognition technology, such as an optical character recognition (OCR) to extract information from paperwork orders. Functions of this block can refer to clause 8.3.3.2 of [ITU-T M.3041].

2) Data storage block for work order processing: Functions of this block can refer to clause 8.3.3.2 of [ITU-T M.3041].

3) Data processing block for work order processing: Functions of this block can refer to clause 8.3.3.2 of [ITU-T M.3041]. First, according to the administrator experience, tagging work orders based on different scenarios. Then using NLP and other AI technology to realize an intelligent auxiliary tag.

4) AI models training block of work order processing based on NLP and image recognition: This block mainly uses NLP and image recognition to train work order models, such as intelligent interaction scenarios, classification scenarios and so on.

5) AI models library block of work order processing: The AI model library of work order processing mainly stores and manages different AI models, such as the classification model, OCR model, text information model and so on.

6) Application programming interface (API) block of AI models for work order processing: The main function of the API block is to provide an interface of the AI model library for the application of telecom management systems. The AI model after training can be applied in the BSS / OSS through the API block.

7.2 Mapping relationship between the framework for work order processing in telecom management with AI and AITOM framework

Work order processing in telecom management with AI is an application scenario for the AITOM framework. The functional block diagram for work order processing in telecom management with AI references the functional framework of AITOM. The mapping relationship between them is shown in Figure 7-1 and Figure 7-2 by the symbols of a red circle with a number.

– Data acquisition block, data storage block and data processing block for the work order processing is based on the "Data convergence and management layer" designed in smart operation maintenance and management (SOMM), and it is extended to support AI methods in AITOM.

– AI models training block of work order processing, correspond to the computing engine framework management, common AI model repository management and AI sandbox training of AI engine in the AITOM framework.

– AI models library block of work order processing, correspond to the AI capability orchestration and the AI capabilities management of AI engine, and service management of the management service layer in AITOM framework.

– API block can correspond to a traditional service management layer – operations systems function (S-OSFs), network management layer – operations systems function (N-OSFs) and element management layer – operations systems function (E-OSFs) of the management service layer in the AITOM framework.

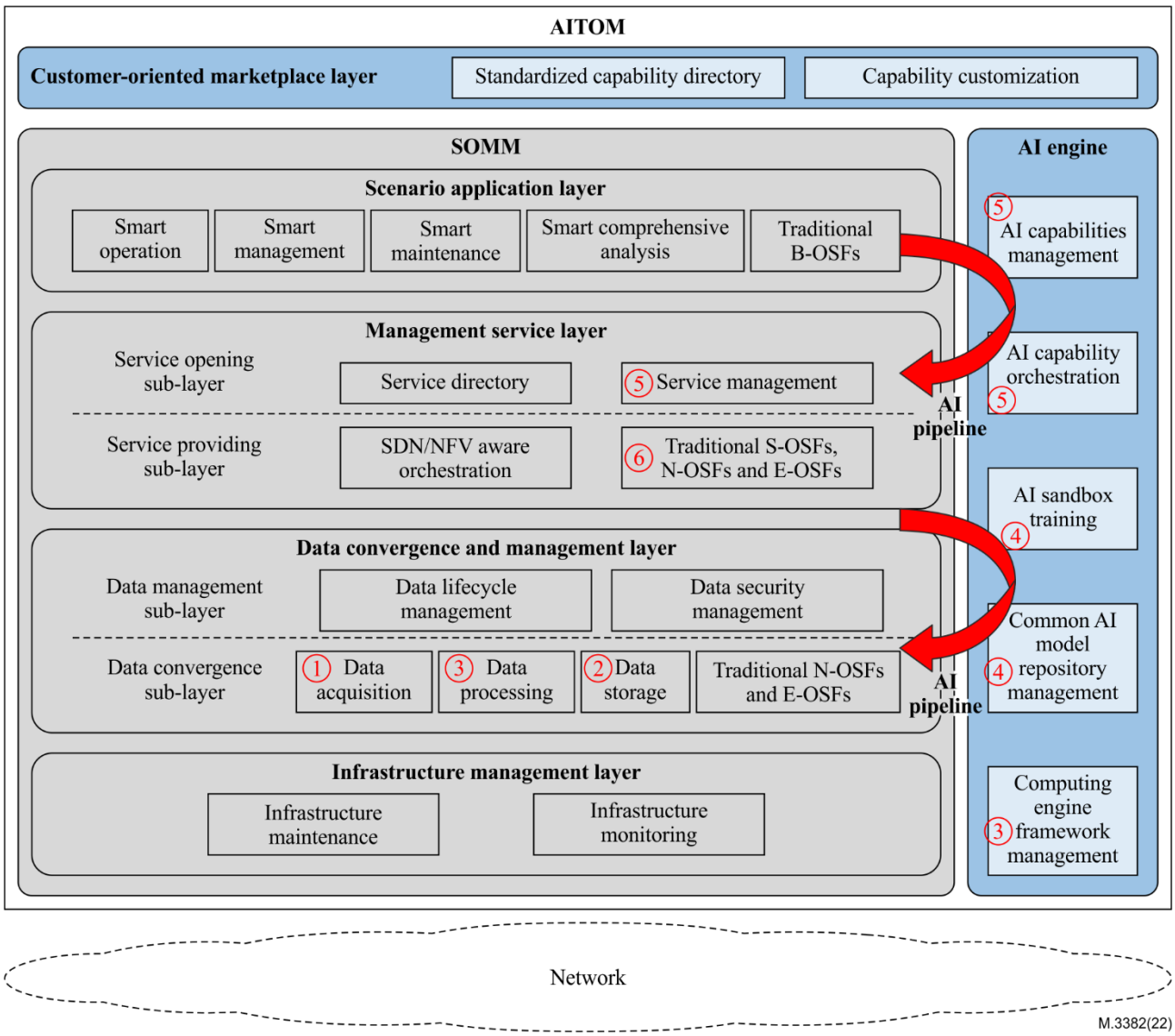

Figure 7-2 – Functional framework of AITOM with a red circle number

This Recommendation introduces the functional requirements of each functional block for work order processing in telecom management with AI in clause 8.

8 Functional requirements for work order processing in telecom management with AI

8.1 Functional requirements of data acquisition block for work order processing

There are two types of work orders that need to acquire electronic work orders and paperwork orders. For electronic work orders, the following requirements should be followed in this block:

– Openness of the network management system (NMS) interface: The interfaces of telecom management systems should be ensured to be open so that work orders can be collected. The telecom management systems include OSS and BSS.

– Openness of work order fields interface: The interfaces of work order fields should be ensured to be open so that the work order can be analysed directly.

For paperwork orders, the following requirements should be followed in this block:

– Legible handwriting: The handwriting should be legible enough so that the content in work orders can be recognized by the OCR technology.

– Completeness of paper: The paperwork orders should be stored intact so that the information in it can be converted into digital completely.

NOTE – Following fields of work orders need to be collected but is not limited:

– Basic information: including initiator, location, next handler and other basic information.

– Processing time: including arrival time and submit time of work orders.

– Content: including a description of network failure phenomenon, business activation application and other requirements.

8.2 Functional requirements of data storage block for work order processing

The work order data need to be stored in the data storage block. And the following requirements should be followed in this block:

– Data integrity: Two different work orders may contain some same content, like a device number. These work orders should be stored completely, although some content is duplicated.

– Access control: Work orders may contain company business secrets, which cannot be leaked. The data storage block should set up an access control to allow the data processing block access only.

8.3 Functional requirements of data processing block for work order processing

First, it is necessary to tag work orders by humans, after the quantity of tagged sample work orders is enough, an intelligent assistant tagging function can be added to the work order processing.

The tagging of work orders should have the following requirements:

– Scenarios are distinguished clearly. The sample work orders should be tagged in different scenarios accurately.

– Scenarios feedback professionally. It is necessary to set AI feedback in a professional way.

Figure 8-1 describes the process of smart work order tagging with a tag platform.

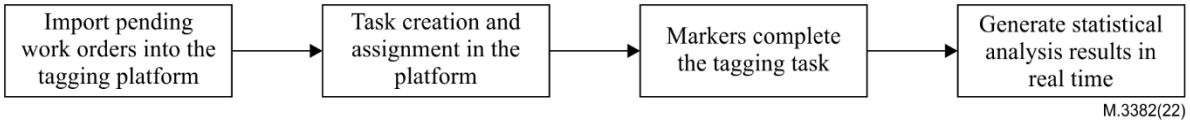

Figure 8-1 – The process of smart work order tagging

1) Import pending work orders

   Import pending work orders from the data storage block into the tagging platform. It is required to ensure the accuracy and completeness of the data during the import process.

2) Task creation and assignment

   Users who have the "task management" permission can create tasks. There are three functional requirements in the task creation and assignment process.

   – Configuring information. Including set classification information and import work orders and training models. The training models are generated by tagged work orders to assist the staff to complete the automatic tagging.

   – Assigning tasks. According to the number of imported work orders, the platform assists users to distribute the tasks. There are two distribution plans: manual assignment and equal assignment.

   – Tagging guideline. Users can upload the task description and introduction of the classification settings for the marking staff to reference.

3) Tagging task

There are three functional requirements in the tagging task process.

- Intelligent auxiliary tag. The platform will complete the pre-marking through the training model provided when the task is created.
- Batch tag. Batch tagging by searching designated work orders.
- Progress control. View tagging progress, including the total number of work orders, tagged work orders and untagged work orders.

4) Data statistics and analysis

There are three functional requirements in the data statistic and analysis process.

- Ambiguity rate statistics. One work order will be assigned to three people at least, if all tagging results are not the same, this work order will be marked ambiguous. The tag platform assigns the statistics to the ambiguity rate, then analyses reasons, and then optimizes the training models.
- Ambiguity result confirmation. An expert can view ambiguous work orders and confirm their tag.
- Marker evaluation. Statistics the total number of work orders, tagged, untagged, pass verification and failed verification work orders of each marker.

The data pre-processing of work orders can refer to step 2 in Annex A.1 and Annex A.2.

8.4 Functional requirements of AI models training block for work order processing

This function block includes the basic AI functions that work order processing with AI must have. These AI functions can be managed by the AI engine in the AITOM architecture. AI's basic function of work order processing includes the following requirements:

1) OCR – This function is one technology of image recognition. It provides the ability to obtain text and layout information from the image files. Since the traditional work orders are in paper, it is necessary to convert them to digital that machines can process. Some work orders may include an image file of the routing table, it is necessary to convert the routing table into digital for processing. This can be used in the data acquisition phase and data processing phase.
2) NLP – This function provides the ability to analyse the language on work orders to realize intelligent and automated processing. This ability can make the machine understand the intent of the work orders, then automatically process these orders without manual operation.

The feature extraction for AI model training can refer to step 3 in Annex A.1 and Annex A.2.

8.5 Functional requirements of AI models library for work order processing block

This function block includes two parts: Intelligent function and automatic function.

8.5.1 Intelligent function

Intelligent function includes the following requirements:

1) Human-computer interaction – This function provides various methods and interfaces for communication between the system and users.
2) Intelligent classification – This function provides the classification ability of various work order types without manual operation. Based on enough sample work orders and AI abilities, after AI model training, the classification of network management work orders can be realized automatically.
3) Intelligent recommendation – This function provides the recommendation ability of similar completed work orders for unskilled administrators.

8.5.2 Automatic function

Automatic function includes the following requirements:

1) Task timer – This function provides various clock mechanisms applied on different tasks, including start up, termination, interruption and so on.
2) Automated process management – This management function provides different ways to formulate the processing flow of network management work orders. According to the specified process, the work orders can circulate automatically.
3) Automated monitoring – This function provides the ability to gather the alarm, performance and condition of a processing procedure of network management work orders in an automated way.

8.6 Functional requirements of API block of AI models for work order processing

Through the API block, the AI models of work order processing can be used on the telecom management system.

9 Requirements for work orders

9.1 Requirements for work orders description

The description of work orders should have the following requirements:

– Professional. The content of work orders should be described professionally with specialized vocabulary. Colloquial description cannot be used.
– Comprehensive. The work orders should be described comprehensively, otherwise, the NLP model cannot analyse content in the right way.
– Accurate. The work orders should be described accurately, in order to improve the accuracy of the AI model recognition.

9.2 Requirements for work order models

After describing the work orders accurately, the AI model of work orders can be trained. The AI model of work orders could be classified into three types. They are classification model, text processing model and image processing model.

9.2.1 Requirements for classification model

First, classify the work orders based on the different network types, like transmission network, data network, wireless network and so on. Then, classify the work orders based on the different services, like network failure, service opening and so on. Last, classify the work orders based on the different processing scenarios. There are two requirements for a classification model:

– Intelligent interaction. According to classification results, the management system makes corresponding operations automatically. The management system can process, forward, or archive a work order based on analysing its content.
– Normative verification for the reply of work orders. According to the classification, determine whether the work order is a reply. If a work order is a reply, the management system can analyse the reply based on the specification, then verify its normative. If the reply meets the specification, then archive it automatically. Otherwise, it goes back to the corresponding personnel for modification.

9.2.2 Requirements for text processing model

Analyse the content of work orders and extract the key information. Based on the classification model, build the text processing model according to NLP technology. There are two requirements for the text processing model.

– Intelligent recommendation. Analyse the text information of historical work orders and perform unsupervised text learning expression on the content. After processing the information of work orders, the management system can assist the network manager to process the work orders by recommending similar ones.

– Intelligent summary. Analyse and comprehend the content of work orders based on AI technology, refine and summarize the main ideas and generate a work order processing summary. The management system can assist the network manager to process the work orders based on the summary.

9.2.3 Requirements for image processing model

Through image recognition technology, like OCR, recognize text information from paper work orders and image files in the electronic work orders. Import the information into data storage to analyse work order content. There is one requirement for the image processing model.

– Misroute analysis and location. Some work orders include an image file of trace route information. The management system recognizes the routing text information on the image, then analyse the reasons of the routing information failure.

Annex A

The feature extraction processes of sample work orders

(This annex forms an integral part of this Recommendation.)

A.1 The text feature extraction process

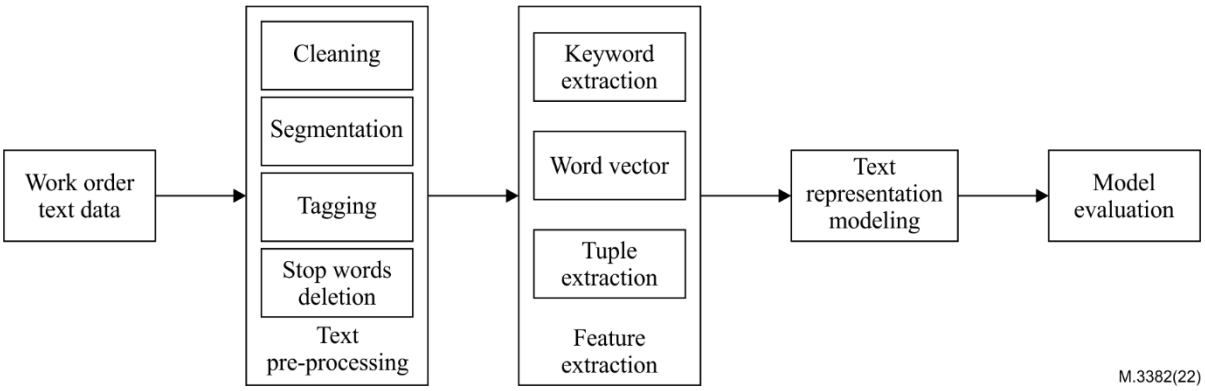

Figure A.1 – The process of text feature extraction

Text feature extraction of sample work orders is a key step for AI model building. Through text feature extraction and analysis, the AI model can be trained in an effective way. The text feature extraction includes the following four steps as shown in Figure A.1:

1) Before text feature extraction process, the text needs to be pre-processed. The text pre-processing mainly includes cleaning, segmentation, tagging and stop words deletion.
   - Cleaning: Cleaning is the process to select the data needed in the training and delete the information which is not necessary. Cleaning is required in the selection includes extraction of title, main body and other useful information from the linguistic data.
   - Segmentation: In text feature extraction process, words are required. In this condition, sentences are necessary to be segmented into words.
   - Tagging: For different application purposes, adding labels to tag the part of speech is optional in some scenarios, like sentiment analysis, knowledge reasoning and requirements analysis.
   - Stop words deletion: Set up the dictionary of the stop words, which include some adverbs, adjectives and conjunctions. The stop words dictionary is just like the process of feature extraction, which removes the useless features.
2) In text feature extraction process, keyword extraction, word embedding, and tuple extraction should be considered.
   - Keyword extraction: Keyword is the phrase that expresses the central content of a document. The keyword of work orders should be extracted to train the AI model, and then analyse and classify work orders automatically. To satisfy this requirement, unsupervised keyword extraction methods, semi-supervised keyword extraction methods and supervised keyword extraction methods should be supported.
   - Word vector: A universal technique to compute semantic similarity based on the distribution attributes of the language. There are two different methods that should be supported. One is taking the word as a vector of co-occurring words, like one-hot representation. The other one is taking the word as a vector of the language context in which the word appears, like distributed representation. The former one can be used to

indicate the frequency of words, the latter one can be used to express the correlation between words.

– Tuple extraction: Extract two entities in a sentence and the relationship between these two entities to form a subject-predicate-object (SPO) triple. Multiple triples can form a knowledge graph. Bag of word and word2vec are general models which can be used to extract tuple.

3) Text representation modelling: Based on text features, using some algorithms to build a text representation model to classify work orders based on different scenarios.

4) Model evaluation: Evaluate the accuracy of the model of work order processing. If the accuracy cannot satisfy the requirement, the model should be trained again.

A.2 The image feature extraction process

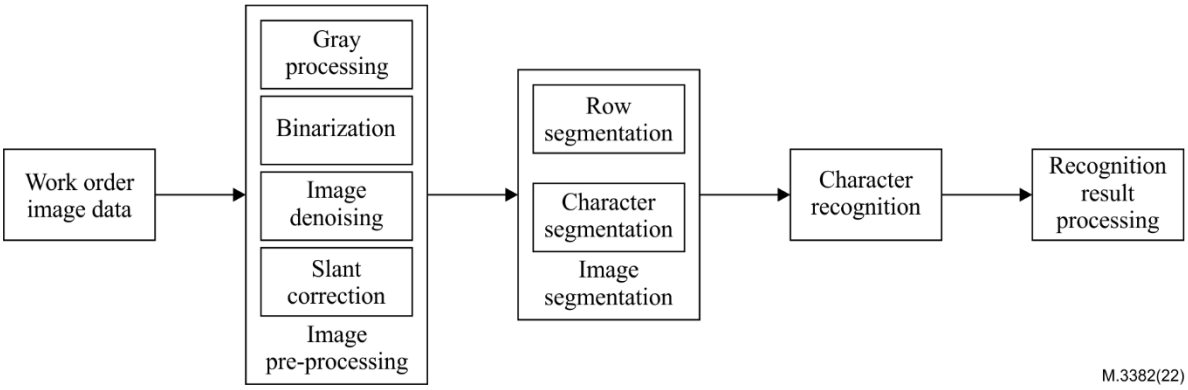

Figure A.2 – The process of image feature extraction

Image text recognition is an important step for work order processing. Some work orders may include image information of the routing table. It is necessary to recognize the routing information from the image through the OCR technology. The OCR process consists of the following four steps as shown in Figure A.2:

1) Image pre-processing: Pre-processing mainly includes gray processing, binarization, image denoising, slant correction and other technologies. Image pre-processing can help subsequent feature extraction and learning.

2) Image segmentation: After pre-processing, the image should be segmented by row and character.

3) Character recognition: Done through some algorithms to recognize the character on an image, like template matching, artificial neural network character recognition algorithm and so on.

4) Recognition result processing: After text recognition, it is necessary to post-processing error correction on results.

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