Recommendation

ITU-T M.3367 (04/2023)

SERIES M: Telecommunication management, including TMN and network maintenance

Telecommunications management network

Requirements for robot-based on-site smart patrol of telecommunication networks

ITU-T M-SERIES RECOMMENDATIONS

Telecommunication management, including TMN and network maintenance

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T M.3367

Requirements for robot-based on-site smart patrol of telecommunication networks

Summary

Recommendation ITU-T M.3367 introduces requirements for intelligent maintenance robots (IMRs) based on-site smart patrol of telecommunication networks, includes the network elements to be patrolled, requirements for management function of IMR-based patrol and related management interfaces.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Requirements for robot-based on-site smart patrol of telecommunication networks

1 Scope

This Recommendation proposes requirements for on-site smart patrol of telecommunication networks based on intelligent maintenance robots (IMRs), principally including the network elements to be patrolled, requirements for the management function of IMR-based patrols and related management interface technology to develop the IMR itself.

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 M.3040]   Recommendation ITU-T M.3040 (2019), *Principles for on-site telecommunication smart maintenance*.

[ITU-T M.3364]   Recommendation ITU-T M.3364 (2020), *Requirements for on-site telecommunication smart maintenance management function*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 robot [b-ISO 8373]: Programmed actuated mechanism with a degree of autonomy to perform locomotion, manipulation or positioning.

3.1.2 telecommunication smart maintenance [ITU-T M.3040]: The maintenance carried out with advanced technology-based (IoT, AR, wearable technology, etc.) toolkit and system, which can provide strong human-computer interaction capabilities and online guidance to personnel, to achieve higher efficiency and precision of actions.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 intelligent maintenance robot: A kind of smart wearable maintenance assistant toolkit, a smart information collection device that integrates infrared, visual, sound and other multi-functional sensors, uses the autonomous navigation and positioning function to follow the patrol route, and uses visible image analysis, infrared temperature measurement and other technologies to carry out on-site patrol, information collection and dispatch of reports to a telecommunication smart maintenance system.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AR   Augmented Reality

GIS   Geographic Information System

IMR   Intelligent Maintenance Robot

IoT   Internet of Things

TSMS   Telecommunication Smart Maintenance System

5 Conventions

In this Recommendation:

The phrase "is required" indicates a requirement that must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The phrase "is recommended" indicates a requirement that is not absolutely required. Thus, this requirement need not be present to claim conformance.

The phrase "can optionally" indicates an optional requirement that is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator or service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 Overview

The telecommunications smart maintenance system shall realize intelligent support and monitoring of the maintenance site, support the general flow of intelligent maintenance of communication networks, and improve the operation level of on-site maintenance personnel and the management level of on-site maintenance operations as described in [ITU-T M.3040].

[ITU-T M.3364] focuses on requirements for on-site telecommunication smart maintenance management function, which includes on-site patrol, on-site overhaul, on-site troubleshooting, maintenance work evaluation, management of a maintenance knowledge base and service activation. [ITU-T M.3364] describes the complete set of maintenance management functions. This Recommendation focuses only on the on-site smart patrol part with the aid of a intelligent maintenance robot.

This Recommendation presents requirements for IMR-based on-site smart patrol of telecommunication networks. This Recommendation describes the network elements to be patrolled, requirements for the management function of IMR-based patrol and related management interface technology. The purpose is to apply IMR-based smart patrol technology, which is a combination of Internet of things (IoT) and artificial intelligence technology, in the maintenance of communication network equipment and lines, in order to enhance the level of smart network maintenance.

The overall architecture for the IMR-based on-site smart patrol part of telecommunication networks consists of a telecommunication smart maintenance system (TSMS), IMR-based smart patrol systems and patrol objects. As shown in Figure 1, with reference to [ITU-T M.3040], the TSMS implements some of the functions related to on-site smart patrol in the TSMS function. The IMR-based smart patrol systems are one specific scenario of the smart maintenance assistant toolkit function in the functional architecture of on-site telecommunication smart maintenance [ITU-T M.3040].
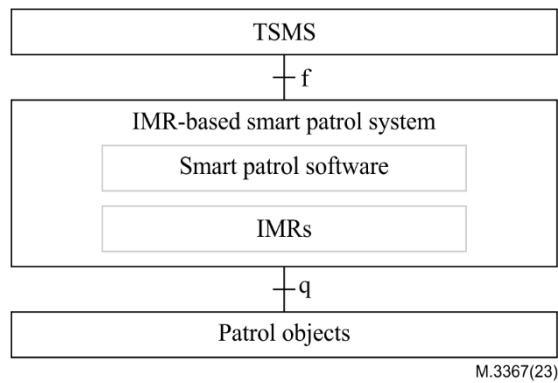
**Figure 1 – Architecture for IMR-based on-site smart patrol
of telecommunication networks**

7 Requirements for IMR-based on-site smart patrol of telecommunication networks

7.1 Framework of management function

The framework of a management function for IMR-based on-site smart patrol of telecommunication networks is shown in Figure 2.
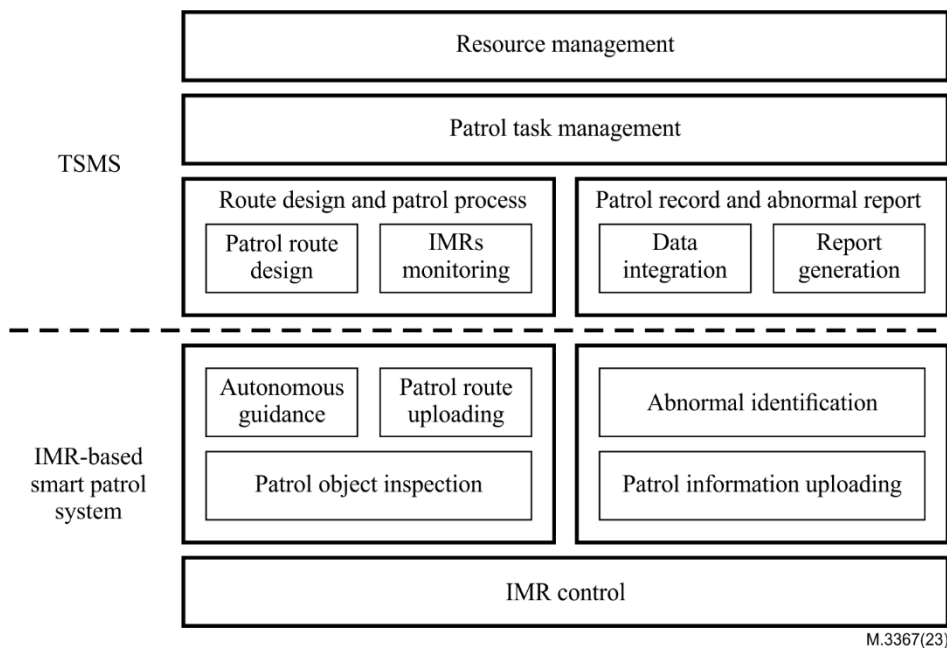

Figure 2 – Framework of management function

7.2 Network elements to be patrolled

The objects of IMR-based on-site smart patrol include resources that can be patrolled by aid of intelligent means in various types of communication networks, such as communication devices, power devices and conditions. Some examples of patrol objects and tasks are listed in Table 1.

Table 1 – Examples of patrol objects and tasks

Patrol object	Patrol task
Equipment rack	Rack temperature
Cable	Equipment power line, optical cable
Network management and maintenance terminal	Equipment status and performance, current alarm, historical alarm
Communication power supply equipment	Power supply, battery pack
Communication line	Whether the identification is clear, whether the optical cable is well protected

7.3 Requirements for IMR-based on-site smart patrol

On-site patrol means that on-site patrol personnel or IMR who go to the job site, perform maintenance management functions, identify problems and solve problems in a timely manner. IMR-based on-site smart patrol of telecommunication networks is recommended to provide the subfunctions specified in clauses 7.3.1 to 7.3.5.

7.3.1 Requirements for resource management

The TSMS should support resource management functions, mainly to complete the registration and viewing functions of IMRs and other facilities. There are requirements for the TSMS of resource management, which are as follows:

1)   the TSMS is required to provide addition, deletion, modification and checking of information in IMR-based smart patrol systems;

2)   the TSMS is recommended to support the query and view of the current patrol tasks of the IMR-based smart patrol system;

3)   the TSMS is recommended to view the name, logo, model and description of the IMRs and patrol objects during the patrol process.

7.3.2 Requirements for patrol task management

A TSMS is recommended to support the addition, deletion, modification, investigation and graphic presentation of combined spatial coordinate information. With patrol task management, a TSMS is supposed to achieve the closed-loop accompaniment with feedback of rapid data collection, real-time information transmission, intelligent analysis and emergency decision-making.

There are requirements for a TSMS for patrol task management, which are as follows.

1)   A TSMS is recommended to support centralized control and real-time visualization of all patrol points in the system. The TSMS can provide efficient information processing capabilities because of powerful computing resources. According to centralized control, the system is able to analyse and coordinate feedback data from distributed patrol points.

2)   A TSMS is recommended to support the addition, deletion, modification and query of patrol tasks, as well as a graphic presentation combined with a geographic information system (GIS) and space. The information related to IMR-based patrol tasks can be retrieved through the resource list. The patrol tasks of the current day in the current system can be displayed in chronological and reverse order, as well as the detailed information of these tasks, including real-time status and patrol results. Through the GIS system, the information about the IMR-based patrol task in the selected geographical range can be retrieved. Relevant patrol tasks can be filtered and queried according to real-time status and early warning information.

7.3.3 Requirements for route design and patrol process

There are requirements for the IMR-based smart patrol system of route design and patrol process, which are as follows.

1) The IMR-based smart patrol system is required to provide the functions of autonomous guidance of patrol routes and obstacle detection. The IMR-based smart patrol system is recommended to have the mechanism of emergency stop to prevent accidents happening.

2) The patrol route of IMR is composed of a series of patrol points connected in series. The IMR-based smart patrol system is recommended to upload patrol routes to the TSMS after the inspection is completed.

3) The IMR-based smart patrol system is recommended to identify patrol objects according to patrol tasks, and shoot pictures or videos around patrol objects through various sensors and multiple angles.

There are requirements for the TSMS of route design and patrol process, which are as follows:

1) the TSMS can optionally support real-time monitoring of the performance of the IMRs during the patrol process;

2) the TSMS is recommended to design patrol routes for the IMRs according to the location of the patrol points.

7.3.4 Requirements for patrol record and abnormal report

There are requirements for the IMR-based smart patrol system of patrol record and abnormal report, which are as follows:

1) the IMR-based smart patrol system is recommended to recognize the remainder of the machine fault, which include warning light or alarm whistle;

2) the IMR-based smart patrol system is required to support the return function of patrol position information, patrol status information, on-site image and video data, and support on-site abnormal situations and machine fault reporting to TSMS.

There are requirements for the TSMS of patrol record and abnormal report, which are as follows.

1) The TSMS is recommended to produce the patrol record and abnormal report automatically. By checking the abnormal report, maintenance can be conducted on time.

2) The TSMS can optionally integrate the data from every patrol point in the system for comprehensive data processing to ensure the feedback data of every patrol point refer to each other.

7.3.5 Requirements for IMR control

There are requirements for IMR-based smart patrol system of IMR control, which are as follows.

1) The IMR-based smart patrol system is recommended to communicate with mobile communication networks to obtain IMR sensor data, the IMR image and the IMR basic information through wireless fidelity, fourth generation, fifth generation, Bluetooth and other methods.

2) The IMR-based smart patrol system is recommended to support self-check, and the detection content includes various sensors in the IMR, global positioning system sensors, motor status, battery status, communication module, storage system, etc. If any abnormality is found in the self-check, the IMR will automatically return for maintenance. If no abnormality is found in the self-check, the IMR continues the patrol task.

7.4 Requirements for management interface of IMR-based patrol

7.4.1 The interface between IMR-based smart patrol system and TSMS

A TSMS achieves the information collection of IMR resources through the interface with the smart patrol function of an IMR. At the same time, the interface completes the message interaction between the TSMS and IMR-based smart patrol system.

As shown in Figure 3, in the field inspection function, an IMR-based smart patrol system obtains and downloads inspection tasks and intelligent identification data of inspection objects from an TSMS, and sends inspection record report messages to the TSMS.
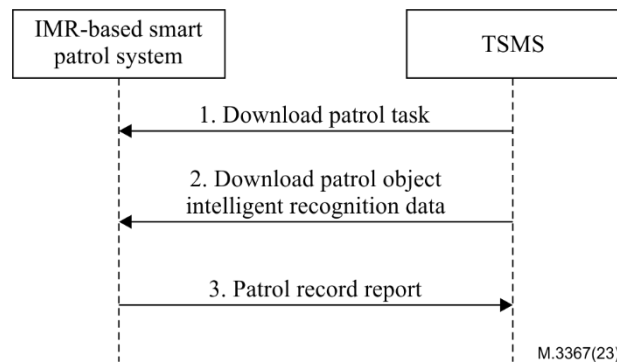

**Figure 3 – Interaction diagram between an IMR-based
smart patrol system and TSMS**

7.4.2 The interface between IMR-based smart patrol system and patrol object

As shown in Figure 4, the interface between an IMR-based smart patrol system and the patrol object can realize the information interaction between the IMR-based smart patrol system and the patrol object, and the communication methods include but are not limited to the near-field communication means. The physical interface of an IMR-based smart patrol system can include Bluetooth, wireless local area network, near field communication, universal serial bus and wireless charging. An IMR-based smart patrol system can connect with the inspection object through Bluetooth to obtain the inspection object number. The IMR-based smart patrol system can also obtain basic information about the inspection object by, for example, scanning code, taking photos, video recording and sensor collection. A TSMS can process and analyse the relevant state information of the inspection object.
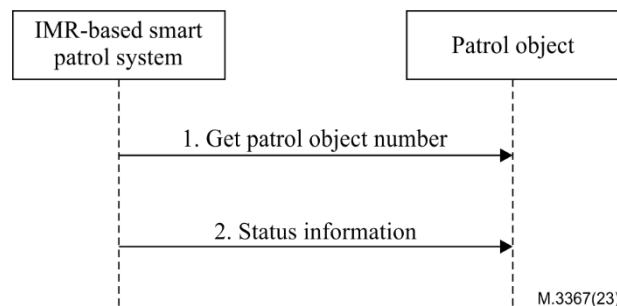

**Figure 4 – Interaction diagram between IMR-based
smart patrol system and patrol object**

Bibliography

[b-ISO 8373]   ISO 8373:2021, *Robotics – Vocabulary*.

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