Research on Knowledge Intelligent Learning Method in Network Operation and Maintenance

Lu Wang\textsuperscript{a}, Yu Zhao\textsuperscript{b} and Zhikun Chen\textsuperscript{c}

Naval Academy of Armament, Beijing 100161, China

\textsuperscript{a}jichenzhe@126.com, \textsuperscript{b}yfzy1221@163.com, \textsuperscript{c}zkchen@nudt.edu.cn

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Abstract. Network operator confronts diverse challenges in the procedure of network operation and maintenance with massive applications emerging, in this paper, we design a framework to achieve the objective of Knowledge Intelligent Learning in Network operations. Our framework focuses on augmented reality technology, knowledge mapping technology, man-machine conversation assisted operation and maintenance technology, on-site fault diagnosis, etc. Our work also builds a channel between network operation knowledge and entities, which dramatically promotes the ability of network operators.

1. Introduction

With the arrival of the Internet and Big Data era, the network has become the most important data carrier and information source\textsuperscript{1}, and its importance in the organization has become increasingly prominent. With the rapid growth of the number and scale of the network services and devices, and the introduction of new technologies, higher requirements for network operators have been put forward. At the same time, the number of network operations, the knowledge and ability are all limited. A large number of operation and maintenance tasks will be completed in a short period of time, which will inevitably face enormous challenges. The traditional method with centralized training learning model costs large time and lacks pertinence, and can’t meet the requirements of fine network management and rapid response at the present stage.

Facing the problems of network operation and maintenance personnel knowledge learning, the research of network operation and maintenance of knowledge in the field of intelligent learning method, through the application of new technology of augmented reality and knowledge map, man-machine dialogue, open up the channels between the network operation knowledge and network operation entities of information, explore the first-line maintenance personnel intelligent learning method.

2. Challenges faced by network operators

2.1 The number of network access devices and systems has increased sharply

The hardware of Network access contains not only various types of routers, switches, servers, firewalls and other standard equipment, but also many wireless access controls, data processing and other special non-standard equipment, different configuration and use method of equipment. The network carries all kinds of business systems, and the information transfer relationship between the system, the internal, the upper and lower levels is complex, and the end-to-end service support is more difficult.

With the new technology of cloud computing, big data and extensive application of network operation, to the development of traditional infrastructure and cloud IT infrastructure operation and maintenance mode duplex direction. In this mode, the traditional physical devices, virtual devices, and a wide range of carrier services, operating characteristics vary, the network physics, logic, virtual organization structure, facing the task may changes. Hybrid network routing topology and various organization structures, the existence of a large number of invisible and unknown aspects of risks, on the other hand, the increase of network monitoring, accident diagnosis and emergency disposal of the difficulty, bring new challenges to the network operation and maintenance work.
2.2 Frequent changes in personnel and experience inheritance difficult

With the increase of network demand and the constant number of personnel, the knowledge of operation and maintenance and the amount of work required by the staff are increasing constantly. Different organizations, network security departments, security personnel business level is uneven. Some small scale nodes are located in a remote place, scattered, lack of professional network maintenance forces, and even unattended.

Network security personnel changes frequently, many skilled operation skills personnel face rotation and leaving flow. Operation and maintenance personnel flow will bring losses to the operation and maintenance, and may lose valuable experience and methods accumulated over the years. The new receiver is also difficult to understand the network operating environment and incident handling methods in a short time. The management, economy and time cost of traditional centralized training are high, which are out of line with the actual work and lack of pertinence.

2.3 Inconvenient checking network operation and maintenance knowledge

After years of construction, network management and operation system has accumulated a large number of operations and maintenance data, convenient access can effectively improve people's ability to analyze problems and solve problems. Because of the restriction of query means, people can’t transfer the attention data to the scene of the computer room and so on. It is difficult for the operators to establish effective contact with the actual field environment, which affects the efficiency of learning. Need to provide a convenient channel for maintenance operation and maintenance personnel to show the real state, fault diagnosis and resolution information, and the use of voice, gestures and other interactive way acquisition and maintenance of knowledge, teaching, guidance as experts around the virtual operation whenever and wherever possible.

3. Network operation and maintenance domain knowledge intelligent learning system design

Network operation and maintenance domain of knowledge, a wide range of new operation and maintenance knowledge constantly emerging, so you need to design intelligent learning system to help operators quickly grasp the main points, improve ability and quality. The system is divided into 4 levels, which are basic data source, data storage, intelligent analysis and user interaction, according to the function orientation, as shown in Fig. 1.

![Diagram](image_url)

Figure 1. Domain knowledge intelligent learning system architecture diagram.

Data source layer is responsible for resource management system, asset data network management system monitoring data, network operation and maintenance system for operation and maintenance of data access and management, transformation of the service to the system data interface is also
responsible for the acquisition and maintenance of knowledge; from the search engine, Wikipedia, Technology Forum etc. The data storage layer stores the basic data in file, relational database, NoSQL database and graph database, which facilitates the retrieval, analysis and calculation of the intelligent analysis layer. On the one hand, the intelligent analysis of communication network operation and maintenance of ontology construction, knowledge extraction, fusion analysis, problem solving knowledge oriented automated calculation model; on the other hand, the analysis of voice, image and video interaction layer to obtain the input signal. The user interaction layer realizes the interactive information acquirement of scene operation, maintenance and voice, image, video and other output signals of AR terminals such as smart phones, PAD, glasses and mobile phones.

4. Network operation and maintenance domain knowledge intelligent learning key technology

4.1 Learning interaction based on AR technology

Augmented reality (AR) is a technique to realize augmented reality by adding virtual objects, scenes or system hints to a real scene. AR technology will be the real and virtual world information seamless integration in the real world, the scope of a certain time and space is difficult to experience the entity information through the mobile phone, glasses, helmets and other equipment, simulation after superposition, the application of the virtual information into the real world, is perceived by the human senses, so as to achieve transcendence the reality of the sensory experience.

![Figure 2. Schematic diagram of knowledge learning interaction technology based on AR.](image)

The AR terminal captures the image frames, speech streams, video streams that the learner can sense, and identifies the real world entities, as shown in Fig. 2. Through the recognition of image frames, tags, objects, human faces, environment positions, text, learner's gestures and so on, are identified, and the tracking of the target is carried out. Tag and object identification, determine the object identification code and the network operation and maintenance system records the object of other physical information. Face recognition identifies people, people, skills, responsibilities, and past experience. The environment position determines where the learner is, and guides the learner to the device or field location that is relevant to the learning content. Gesture recognition captures the gestures of learners and performs operations on AR terminals. Through speech recognition, AR intelligent analysis can convert the learner's voice into text, and analyze whether the learner's intention is to operate the AR terminal, or to retrieve or answer questions about operation.

AR device can also transfer the captured video to a remote expert terminal, and the expert guides the operation and maintenance personnel by voice or text prompts to realize remote teaching.

4.2 Intelligent organization technology based on Knowledge Mapping

The knowledge map is used to model the relationship between knowledge and knowledge, and to display the knowledge, the core structure and the whole knowledge architecture in the visual way. Graph nodes represent concepts or entities of knowledge, concept graph edge or entity relationship...
between many nodes and edges can be carried out a complete and clear description of knowledge. At present, knowledge mapping is mainly used in two aspects of knowledge retrieval and question answering. It provides knowledge services for users through analyzing the knowledge entities contained in encyclopedia knowledge or knowledge base. Knowledge mapping is a knowledge engine in the era of big data, and acquiring structured knowledge from the latest information sources is the basis of intelligent question and answer.

After years of network operation and maintenance work, a large amount of information has been accumulated, and the operators need to check it regularly. The original network operation and maintenance data is dispersed and stored, and there is no effective correlation analysis of network operation and maintenance knowledge. Through the knowledge map, we can sort out the concepts, entities, attributes and relationships of the operation and maintenance field, and provide a panoramic field knowledge learning framework and convenient knowledge inquiry channels for the operation and maintenance personnel.

![Figure 3. Basic knowledge of computer network.](image)

In order to quickly form a knowledge map, the first comprehensive operation area DBpedia[5], YAGO[6] and other open source of knowledge in the ontology, combined with the existing cyber source system, network management system resources and knowledge base data form operation domain ontology. Based on the domain ontology library, it can automatically generate a knowledge map for concepts, equipment types, fault diagnosis methods and other topics, so as to facilitate the operation and maintenance personnel to master the overall knowledge structure. For example, a knowledge atlas of the fundamentals of computer networks is shown in Fig. 3.

You can also select a number of network equipment, operation manuals, operation and maintenance, technical articles, etc., through the word frequency analysis and other methods to form a text cloud chart, to help operators understand the focus of knowledge. Each node of the atlas can be linked to the description of nodes, concepts, entities, attributes, and other knowledge domains.

4.3 Knowledge answering technology based on Chatbot

Chatbot is a revolution of artificial intelligence in the field of human-computer interaction[7], and it is a platform of multi technology integration. The essential components includes NLU (Natural Language Understanding) and NLG (Natural Language Generation), which combine machine learning, depth learning and other technologies. Based on man-machine dialogue network operation and maintenance knowledge quiz, so that operators can through voice quiz way to obtain operation and maintenance knowledge, realize 7*24 hours intelligent expert consultation.
The AR terminal receives the user's voice, speech recognition, speech into text, and natural language understanding, first determine whether the current AR operating instructions, if not judgment is retrieval dialogue or quiz dialogue, then matching or retrieval model, the formation of solution results from the knowledge map, feedback to the operation and maintenance personnel through the superposition of information display and voice output method.

There are two main algorithms for Chatbot implementation: retrieval model and generative model. The retrieval model is similar to the search engine in the algorithm flow and structure. The first template defined network operation question base and knowledge base or answer, and then through the NLP technology to user questions were analyzed by keyword extraction, inverted index, matching and sorting method definition document repository, and returns to the user. In the operation and maintenance knowledge base, you can also embed knowledge discovery and reasoning mechanism to improve the quality of dialogue.

The generated model usually does not depend on the specific event handling answer database based on learning from a large corpus but according to the "language ability" to dialogue, see this process closer to human thinking and language production. The language ability in the field of network operation and maintenance involves the knowledge representation of basic language elements in this domain. It can be based on the knowledge map of network domain.

5. Scenario application

5.1 Basic theory study

In the network operation basic theory study, by combing knowledge mapping technology of network operation system structure, knowledge and related knowledge points, also can enhance understanding and memory network maintenance knowledge through interactive 3D books.

The theory in the textbook Abstract difficult knowledge using augmented reality technology to deal with, when the special identification of AR terminal to scan the textbook, above that will show related knowledge of 3D animation image or video, the textbook is no longer dull and abstract, make learners focus, let learners unconsciously accept all kinds of knowledge or improve skills.

5.2 Practical learning

In the network operation and maintenance, practical operation, learning, operation and maintenance personnel need to master all kinds of network equipment operating procedures, as well as a variety of related procedures, operations, command configuration or maintenance processes. Operation and maintenance personnel can also according to the actual work of the typical mode of operation, methods and steps, and the need to configure or maintenance of AR equipment in the practical environment, the need for training or operation instrument panel for real-time interaction. Compare the operation record of the learner with the set process, evaluate the level of operation skills.
automatically, point out the mistakes of the learners in the course of operation, and give some suggestions for improvement.

![Figure 5. Equipment actual operation view.](image)

The advantage of augmented reality is that it can provide learners with the same feelings as real devices, and improve the effectiveness of virtual operation training. It also has the advantages of zero risk and low cost. The use of augmented reality technology to change the existing teaching model, improve the practice environment, solve the shortage of teaching resources, optimize the process.

5.3 Environment learning

New operators and maintenance personnel not only need to learn network basic theory and practical operation, but also need to be familiar with the computer room, office and other on-site work environment of the equipment location, use, connection, etc.

![Figure 6. Environment learning view of computer room.](image)

AR equipment can identify the location of the personnel through the cabinet, equipment, line labels which obtain the information like operation status, operation manuals and so on. Operation and maintenance personnel can also obtain other environmental information about the scene through Chatbot.

6. Conclusion

Network operation and maintenance is becoming more and more important in the process of modern efficient organization development. It can reduce the operation cost and improve the service response efficiency by continuously improving the ability and quality of maintenance personnel. With the continuous development and improvement of AR technology, knowledge mapping technology, Chatbot technology, the diversified application and development of knowledge learning will certainly be an intelligent assistant for network operation and maintenance personnel work. The exploration of this thesis also provides technical path exploration and application method practice for knowledge intelligent learning in other fields.
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