Research on Integrated Application System of Internet of Things in Oil Depot

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Abstract: To improve the efficiency of oil support, it is necessary to realize the integrated application of the equipment and systems related to the Internet of Things in oil depots. Based on the service-oriented design idea, this paper puts forward the architecture of the integrated application system of the oil depot Internet of Things, which lays a foundation for the integrated application of the oil depot Internet of Things data and related business systems through the design of business system component, data model standardization and system interface service. At the same time, through the data integration framework and process design of the Internet of Things, the data model design of the Internet of Things integration platform, and the system integration design based on service bus, it provides a key technical way for the development and implementation of the integrated application system of the Internet of Things in oil depots.

1. Introduction

In the military field, with the rapid development and in-depth application of the Internet of Things technology, various intelligent sensing devices have been widely used in oil storage sensing, process operation control, oil depot security and other aspects. How to integrate various Internet of Things technologies and intelligent sensing devices to build a standardized and intelligent oil depot integrated application system provides an important support for solving the compatibility problems among various oil depot information management systems and improving the data-based support capability, which is conducive to adapting to the new requirements of the construction and development of military oil depots in the new period and further improving.

In this paper, the oil depot IOT integrated application system is studied. Firstly, the overall architecture design of the oil depot IOT integrated application system is proposed. Based on the hierarchical, service and standardized design ideas, the architecture realizes the integration of various equipment sensors and business systems, and provides support for the oil depot integrated application. On this basis, aiming at the key technologies in system design, including data integration framework and process design of Internet of Things, data model design of Internet of Things integration platform, system integration design based on service bus. This paper puts forward relevant solutions, which provide a systematic solution for solving the compatibility problems between Internet of Things equipment data integration and various current oil depot application systems, and building an oil depot integrated management application platform.
2. related research
The Internet of Things refers to connecting with the Internet according to the agreed protocol through information sensing devices such as RFID, infrared sensors, global positioning system, laser scanner, etc., exchanging and communicating information, and realizing intelligent identification, positioning, tracking, monitoring and management of articles. The complete Internet of Things is mainly composed of electronic tags, readers and background servers in a narrow sense; Broadly speaking, it mainly includes perception layer, network layer and application layer. Perception layer is equivalent to human skin and facial features, network layer is equivalent to human nerve center and brain, and application layer is equivalent to human social division of labor. The Internet of Things has expanded the ability of people to interact with the real world remotely, and has been widely used in various industries at home and abroad. The application of physical network in the field of oil support makes logistics support more accurate and efficient[1].

In the field of military logistics, the U.S. military has used a large number of Internet of Things technologies represented by RFID technology. In terms of oil support, it has mainly developed general systems such as goods inquiry and tracking and transportation materials monitoring, which have achieved ideal results in the wars in Afghanistan and Iraq. The application of Internet of Things technology has greatly improved the ability of monitoring and controlling the whole process of oil supply guarantee, scientific financing planning and quick response decision-making, and made the US military realize the transformation from "extensive" to "precise" oil management. During the Iraq War, the amount of oil transported by sea, air, battle reserve and strategic reserve mobilization of the US military was greatly reduced compared with the Gulf War.

This paper analyzes the information islands and security problems existing in the informatization construction of oil depots in China, and constructs an oil depot information management and monitoring system with Internet technology as the core. This paper makes a preliminary study on the construction of oil depot information system based on Internet of Things, and puts forward some problems that need to be solved when the related system design and Internet of Things technology are widely used in the construction of oil depot information system. The research on oil depot safety management information system based on Internet of Things is carried out. According to the characteristics of oil depot business and the analysis of the causes of oil depot safety accidents, the latest information technologies such as explosion-proof PDA, 3G communication, RFID and other Internet of Things and mobile computing are introduced, and an oil depot safety management information system is constructed to monitor and track the development process of oil depot related business.

According to the current research literature, the current research on the Internet of Things in oil depot management information system mainly focuses on deepening the application in specific fields. With the deepening of application, the outstanding problems such as inconsistent data standards, inconsistent technical systems, different application functions, and non-sharing of information resources are becoming more and more prominent. It is necessary to build a unified integrated application system of the Internet of Things to realize the fusion and integrated application of all kinds of data.

3. Analysis and Design of Oil Depot Integrated Application System Based on Internet of Things
With the deepening of the application of the Internet of Things, the oil depot has organized and built various information-based business processing application systems according to its own business requirements. These systems have different database structures and adopt different software technologies, and many applications are tightly bound to the database, which not only makes it difficult to maintain and modify the programs themselves, but also makes it difficult to realize the information exchange and interoperability between related businesses and different programs, and it is difficult to meet the comprehensive application requirements such as oil support command and situation control. Therefore, on the basis of various application systems, it is necessary to solve outstanding problems such as inconsistent data standards, inconsistent technical systems, different application functions, and
unshared information resources by combing services, standardizing processes, utilizing platforms and integrating resources. Therefore, it is necessary to build a set of software functional platform and application software interface with flexible structure covering various basic business processing of oil depots with a new architecture for integrating various original application systems, data resources and user interfaces. So that all kinds of business and management systems of the oil depot can be integrated and integrated on this unified business platform interface, and under the support of a unified security system, information intercommunication and interoperability can be realized, so as to avoid the formation of information islands and waste.

Fig. 1 The Overall technical architecture of the integrated application system of IOT in oil depot
Based on the above analysis, this paper puts forward the integrated application system framework of oil depot Internet of Things as shown in Figure 1. From a horizontal perspective, the architecture transforms a series of business information in the process of oil depot management and oil support business into several services, which are connected by a well-defined and open standard interface in a coarse-grained and loosely coupled structure to realize business collaborative work based on smooth information flow; From the vertical point of view, it is divided into several layers from top to bottom.
Starting from business application and business process, the dynamic realization of the system is finally achieved by integrating application layer, service layer, component layer, business system layer and perception layer. The main contents of the architecture include:

1. Integrated application layer
   The application systems with independent functions are loosely integrated at the application level, and all kinds of application systems are integrated into application systems such as oil support decision support, oil support operation monitoring, oil support simulation training, oil depot comprehensive situation, comprehensive information query, oil equipment management, oil facility monitoring, oil depot comprehensive information management, etc. The integrated application layer builds a loosely coupled internal logic structure of the system based on the enterprise service bus, and can call business process services, data services, business services, public services, etc. on different systems and platforms, thus realizing the integrated application of various business systems and underlying data.

2. Service layer
   On the basis of service identification through process management tools, the service system of oil depot Internet of Things integrated application system is constructed. Firstly, from the perspective of comprehensive application of oil depot, the oil support business and oil depot management business are sorted out to form related comprehensive business processes, and then the business processes are decomposed to obtain reusable business function services that match the system components; At the same time, the necessary common component services are extracted based on the system common components, including user and authorization services, identity authentication services, log services, data exchange services and so on.

3. Component layer
   Component mainly provides function realization, cognition or operation for services. Service component layer is mainly composed of a series of fine-grained service components with a specific function, and provides a unified interface of services to the outside world, providing support for the construction of upper-level services. In this layer, it is necessary to transform the existing professional oil depot business management information systems in use at the bottom, encapsulate some necessary functions and information interfaces, and form a series of fine-grained special business service components with different functions to support the operation, management and control of the business management information systems. In addition, it is necessary to develop some necessary general service components or component sets for technical function services and common application services, including data collection, data presentation, data subscription and distribution, general table making, graphic statistics, document management, information retrieval, etc.

4. Business system layer
   The business system layer is mainly composed of various current oil support systems, oil depot management information systems and various basic databases, including the basic databases for global data integration, management and storage. Typical business systems include: oil tank storage sensing system, zero oil filling sensing control system, card self-service refueling system, oil receiving and dispatching sensing control system, oil quality supervision and management system and oil depot safety prevention system, etc.

5. Perception layer
   The sensing layer is mainly composed of various IOT sensors, including measurement and control, security, automatic identification, positioning and tracking, etc. The sensors are read and controlled through industrial Ethernet, 485/232 interface, Gigabit optical fiber, wireless sensor network (WIA), etc. By defining a unified data model, the data is collected and stored, providing data support for the integrated application of the Internet of Things in oil depots.

4. Key technology analysis
   1. Design of data integration framework for oil depot Internet of Things
      Unified collection and centralized control of IOT data is the foundation of the integrated application system of IOT in oil depot. The main challenges faced by IOT data integration mainly come from the
high complexity of data integration caused by the massive data collected, the diversity of data and the accuracy of data collection. In the practice of data integration of Internet of Things, the challenges are often met through clear data integration framework and strategy design of Internet of Things. The hierarchical networking data integration framework and process design proposed in this paper are shown in Figure 2. Various sensing devices in oil depots transmit sensing data to the Internet of Things network layers (1, 2) through the sensing control system; The IOT integrated system forms a reinforced IOT network ring network through the integrated control gateway arranged in the oil depot, and effectively connects the field control networks (3) of various sensing control systems and security monitoring systems; Using the specified data interface protocol, it is converted and put into storage by the IOT integration platform to realize the integration of real-time data and information system of field instruments and equipment (4, 5); The IOT centralized management and control server displays the configuration of the oil depot process flow, and realizes the equipment and link management of the whole IOT subsystem (6).

2. Design of data model of IOT integration platform

Data model and interface specification are the core of the integrated application of the Internet of Things, which can provide a unified data specification for breaking the information islands among different devices, software and hardware platforms, operating systems and network environments, and realize the standardized expression and flow of information, thus providing technical support for the information interaction of heterogeneous entities.

In this paper, a unified data model is defined for different types of data in oil depot Internet of Things. As shown in fig. 3, first set

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Fig. 2 Data Integration Framework of IOT
At the preparation level, a unified data model is defined for all kinds of equipment to be integrated, including oil tanks, valves, pumps, pressure gauges, etc., to realize standardized and unified storage of equipment information of different types and different manufacturers; Then, at the system level, interface specifications are defined for system perception data, business data, security monitoring data, etc., providing model definitions for service transformation of different systems.

3. System service integration design based on service bus

In the design of service-oriented architecture (SOA), various services in data integration are usually decomposed into reusable services, messages between services adopt SOAP protocol, and results generated by service operation are stored in XML documents, thus ensuring stateless and autonomous services and reducing the coupling between services. Then, enterprise service bus ESB technology is applied to realize the integration of various service components. ESB can provide event-driven and document-oriented processing mode, as well as distributed operation management mechanism, support content-based routing and filtering, have the ability to transmit complex data, and can provide a series of standard interfaces[5].

In this paper, the service integration design based on enterprise service bus is shown in Figure 4. The service bus serves all relevant business systems, and the upper integrated business system is no longer directly connected with the integrated system. Instead, it connects the service bus through interface adaptation for data exchange, thus greatly simplifying the system structure, freeing each system from the chaotic data flow like spider web, and simplifying the system interface design, which can connect the business information systems of all links in an orderly manner. As a channel for high-speed transmission, tandem, analysis and distribution of business data in the integrated application system of oil depot integrated Internet of Things, service bus plays an important role in the whole technical system. It connects various business systems at the same level, and makes them provide data services to each other, thus ensuring the operation of each subsystem, which is an effective support for the efficient and smooth operation of the integrated application system of oil depot integrated Internet of Things.
5. Conclusion

In this paper, the integrated application system of oil depot Internet of Things is studied. Based on the in-depth analysis of the current development status of oil depot Internet of Things system, a service-oriented hierarchical overall system architecture design is proposed for the comprehensive application and system integration requirements of oil depot. Based on the overall system architecture, the design of system integration framework, common data model and service integration framework is put forward, which can be used to build a hierarchical, extensible and interoperable integrated application system. The work in this paper can provide an important reference for the comprehensive application research of the Internet of Things in oil depots.

The next step will follow the overall system architecture and key technology design to launch system implementation and optimization research.

References:

[1] Wang Haiyan. Research on Construction of Oil Supervision and Management System Based on Internet of Things Technology[J]. Chemical Enterprise Management, 2015,5:91.

[2] Liu lin. Research Status of Oil Depot Information System Based on Internet of Things[J]. Chemical Enterprise Management, 2019, 6:10-11.

[3] Han lijun, Lan shibin etc. Research on the Construction of Oil Depot Information System Based on Internet of Things Technology[J]. Internet of Things Technology, 2015,1:86-87.

[4] Du zhigao, Wang yubin etc. Research on Safety Management Information System of Oil Depot Based on Internet of Things[J]. Microcomputer&ITS Application, 2012,31(22):7-9.

[5] Zhang bin, Liang hongbo etc. Design of Logistic Integrated Business Processing System Based on Open Source SOA. Application Research of Computer, 2014,31:252-253.