

Research on Smart Environmental Protection IoT Application Based on Edge Computing

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Abstract. Smart environmental protection is the full use of all kinds of environment-related information technology, integrating the thinking and ideas of cutting-edge technology such as big data and clouds computing and other frontier science and technology with the intelligent software and hardware systems based on the Internet of Things into environmental protection, and realizes the intelligentization of environmental governance. Smart environmental protection is particularly important for the realization of national environmental protection informationization, and it is an important way for the development of national green. As a new Internet of Things technology, edge computing is applied in the field of smart environmental protection, which can effectively deal with all kinds of pollutants at the source and greatly promote the progress of environmental protection. This paper introduces the architecture of intelligent environmental protection Internet of things and the concept of edge computing technology, and proposes a new architecture of intelligent environmental protection Internet of things based on edge computing. On this basis, the overall system design is realized by combining the current smart environmental protection project of the national development and reform commission, and it has been applied to actual environmental monitoring and achieved good results.

Keywords: IoT, smart environmental protection, edge computing.

1. Introduction

Smart environmental protection is the use of sensing technology and intelligent devices to embed various environmental protection devices into various environmental monitoring objects [1], to obtain relevant environmental information in the process of environmental monitoring, and then through the Internet of Things, cloud computing, edge computing and other technologies, real-time processing and intelligent analysis of various environmental data [2], to achieve intelligent monitoring and management of the environment. Smart environmental protection makes full use of advanced technologies, realizes the integration of traditional environmental protection and scientific and technological perception, and helps people realize the wisdom of environmental management and decision-making in a more refined and dynamic way. The construction of IoT-related platforms and technologies based on “smart environmental protection” is an inevitable result of the development of contemporary information technology, and also a new direction for the scientific development of the environment in the new era [3]. Edge computing is an open platform that integrates network, computing, storage and application core capabilities close to mobile devices and data sources. By providing intelligent services nearby, it forms an emerging technology that complements the cloud computing model in traditional IoT technology [4]. Edge computing proposes a new model that allows each edge device of the Internet of Things to have data acquisition, analysis and calculation, communication and intelligent processing capabilities [5]. Edge sensors no longer need to continuously transmit various sensory data to the data center, but can judge various kinds of sensory data by themselves, and only contact the data center when the readings have significant changes, and decide what operation to take[6]. Edge computing provides faster access, lower latency, and increased capacity ratios through cloud-side collaboration to deliver smarter, more secure data services. This

paper analyzes the problems existing in the smart environmental protection IoT application scenario, timely processing the source of pollutants, and secure, efficient and fast transmission of a large number of environmentally-friendly data. The intelligent analysis of the cloud and the rapid response of the terminal environmental protection equipment propose to apply the edge computing technology to smart environmental protection. The system forms a new intelligent and environmentally-friendly IoT architecture system to achieve rapid positioning and timely response to pollution sources; effective integration of environmental data and safe transmission.

2. Key Technical Description

The construction of smart environmental protection Internet of Things involves advanced Internet of Things technology, sensor technology, intelligent GIS technology, cloud computing technology, sky integrated remote sensing monitoring technology, big data analysis and data mining technology, and intelligent environment model simulation technology. Only through the integration of various technologies can we truly build the Internet of Things in the field of environmental protection and realize the transformation from digital environmental protection to smart environmental protection. Edge computing is a new type of Internet of Things technology, which can be applied to the construction of smart environmentally friendly Internet of Things. Promote the intelligent realization of smart environmental protection.

Edge Computing (EC) mainly refers to constructing a new computing mode on the edge of the network near the source of data generated by mobile devices or sensors [7]. This mode combines resources such as network, computing, storage, and application core capabilities. Form an open platform to provide the nearest edge intelligent server to meet the key needs of digitalization in business real-time, business intelligence, data aggregation and interaction, security and privacy protection [8]. The core idea of edge computing is to calculate the source that should be closer to the data. The transmission network with computational function near the head of the data source is more likely to reduce the instability factors such as bandwidth, delay and jitter. The edge computing implements the edge computing device (ECN) in the edge-side device by sending the computing tasks and functions of the core computing node to the edge-side device with processing capability [9], making full use of the processing of the edge-side device. The computing power can perform preliminary processing and analysis on the source data, and even migrate the processing functions originally in the cloud computing server to achieve faster service response. The edge computing node is located between the data acquisition device of the sensing layer and the cloud computing platform of the service layer in the IoT architecture. For the cloud platform, the edge computing node can filter a large amount of redundant data of the terminal node to provide high quality. Data information helps the cloud platform to provide more efficient service capabilities. For IoT terminal devices, edge computing nodes can provide real-time data processing services. Each edge device has data acquisition, analysis and calculation, communication and intelligent processing capabilities. Edge sensors no longer continuously transmit various sensor data. Passed to the data center, you can judge various kinds of sensory data, and only contact the data center when the readings have significant changes, decide what measures to take. Edge computing provides better time response and burst processing capabilities for terminal devices, and better terminal intelligence.

The application of edge computing in the smart environmental protection Internet of Things is mainly to place or embed edge computing in various environmental protection terminals, and to perform calculation services in a local network close to the source of environmental data, which strongly supports the data processing capabilities of various environmental protection devices. Make all kinds of environmental protection terminals more intelligent and interconnected. Edge computing is a kind of perfection and supplement of the traditional Internet of Things + cloud computing model, which can better solve the problem of bandwidth and delay in the platform built by traditional Internet of Things + cloud computing [10]. By integrating edge computing with cloud computing, future 5G networks, narrow-band networks and other new IoT technologies, it can be applied to smart

environmentally friendly IoT architectures, and diversified parallel computing according to different scenarios can greatly alleviate network bandwidth. With data center pressure and enhanced service responsiveness, it can better protect data privacy and improve data security.

3. Architecture Description

The architecture of smart environmental protection IoT based on edge computing is shown in Figure 1: including: perception layer, transport layer, management layer and service layer. The edge computing engine is mainly used in perception layer smart environmental protection edge gateway node to provide data analysis and processing services for various environmental protection monitoring devices on the terminal site. The overall architecture is shown in Fig. 1.

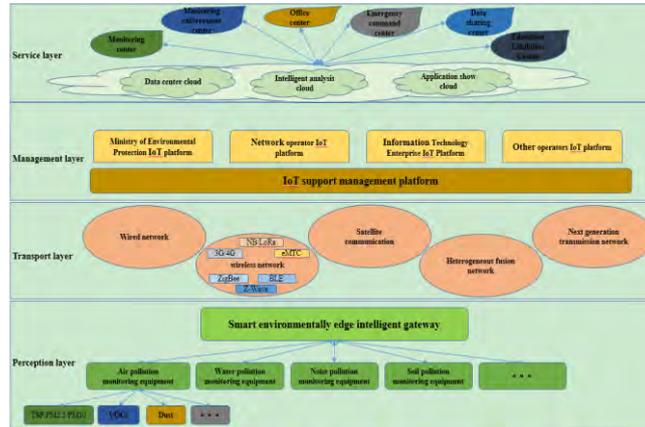


Fig. 1 Smart environmentally IoT architecture

3.1 Perception Layer

The perception layer uses a variety of devices that can sense, measure, capture, and transmit various types of environmental data anytime, anywhere, and achieve a “more thorough perception” of environmental factors such as environmental quality, pollution sources, ecology, and radiation. The environmental protection targets targeted by the perception layer are: air pollution perception (perceptual factors include: VOCs, TSP, PM10, PM2.5, SO2, NO2, O3, etc.), water pollution perception, noise pollution perception, and soil pollution perception. The common types of environmental monitoring equipment in perception layer are air pollution monitoring equipment (including PM2.5 detection equipment, PM10 detection equipment, dust detection equipment, etc.), Sewage Monitoring equipment, noise monitoring equipment, soil monitoring equipment, etc. Sensor devices commonly used in sensing layer usually include temperature sensor, humidity sensor, GPS position sensor, wind direction sensor, wind sensor and so on.

The perception layer uses smart environmental protection edge intelligent gateway and on-site monitoring equipment, sensors, monitoring camera equipment to form a detection system. It obtains all kinds of environmental monitoring data, equipment status data, on-site images, alarm events and other information. It provides basic data for smart environmental protection service layer and realizes integrated perception of the environment.

3.2 Transport Layer

The transport layer utilizes various transport networks to transmit the basic data information acquired by the perception layer to the management layer efficiently, securely, and error-free. The transport layer can select the suitable network for data transmission according to a specific application scenario. The transport layer network mainly includes wired network, wireless network, satellite communication, heterogeneous fusion network, next generation network and other transmission modes.

By using smart environmental protection edge intelligent gateway, the transport layer can detect the diversity of data in the environmental protection field in the actual application scenario, and build a heterogeneous network in which the sensor network is integrated with the mobile communication network and the Internet, which can better realize the acquisition of the sensing layer.

It can better realize all kinds of data acquired by the sensing layer and effectively transmit them to the management layer. In order to meet the needs of low power and wide coverage transmission services, low power wireless WAN can be chosen. The common narrowband Internet of Things includes NB-IoT network, LoRa network, and LTE-based optimized eMTC network and so on. In order to meet the needs of large data and high real-time transmission services, we can use 3G, 4GLTE network, dedicated ethernet, WIFI and other transmission networks with large bandwidth. For some short-distance data transmission business needs, ZigBee, BLE, Z-Wave and other wireless transmission networks can be used. For some short-distance transmission data service requirements, ZigBee, BLE, Z-Wave, etc.

3.3 Management Layer

The management layer mainly implements intelligent management of various environmental awareness devices in the perception layer detection system, and provides persistent storage and visual display of various types of detection data, and provides comprehensive data support for the service layer. The management layer usually builds an IoT device management service platform to support upper and lower services. The IoT device management service platform is a convenient, efficient and secure device management platform built by enterprises or departments related to the Internet of Things industry.

Smart environmental edge intelligent gateway supports fast docking of multiple IoT device management platforms, including the IoT device management platform built by large-scale information technology enterprises: Huawei's OceanConnect IoT ecosystem platform and Amazon's AWS IoT management platform, etc. IoT service management platform constructed by large network operators: China Mobile IoT platform OneNET, China Unicom Internet of Things management platform, China Telecom's IoT acceleration platform, and environmental protection management departments to build environmental protection IoT equipment management platform. The IoT device management platform realizes the functions of fast access, data acquisition and remote configuration of various devices in monitoring field by using intelligent environmental protection edge intelligent gateway, and provides open data interface for service layer application invocation.

3.4 Service Layer

The service layer is to use the environmentally-friendly big data management cloud platform, intelligent analysis cloud platform, application cloud platform and other technologies to achieve comprehensive and accurate analysis and traceability of environmental protection data, and to provide refined services and scientific decision-making basis for environmental protection departments and environmental protection industries. The services provided by the service layer cover the monitoring center, monitoring and enforcement center, office center, emergency command center, data sharing center, education display center and other industries and departments. By using the effective environmental protection data provided by the smart environmental protection edge intelligent gateway, the service layer can provide timely feedback to the application platform for the more serious pollution information in environmental protection monitoring when providing external services, providing an effective basis for tracking the traceability of pollution.

4. Application Case Description

The smart environmental protection IoT architecture based on edge computing can be applied to multiple industries and different scenarios to achieve intelligent management of the environment in the field of smart environmental protection. With the help of IoT equipment management platform, remote management of terminal equipment and intelligent analysis of terminal data can be realized more conveniently. Using environmental protection intelligent analysis platform, real-time monitoring of environmental protection data can be realized, traceability analysis, early warning evaluation and long-term governance can be achieved.

The urban eco-environment operation service system is a smart environmental IoT ecosystem created by iSoftStone and the Huawei OceanConnect platform. The system is the practical application

of the smart environmental protection IoT architecture of edge computing. The smart environmental protection edge intelligent gateway mainly realizes intelligent access to various environmental protection devices, effective processing and safe uploading of environmental protection data, including environmental protection equipment: PM2.5, PM10, dust, noise, etc. The Huawei OceanConnect platform implements remote intelligent configuration and management of smart environmental edge gateways, and provides data persistence storage in service interfaces. The urban ecological environment operation service system makes full use of all kinds of environmental protection data, realizes real-time monitoring, early warning and prediction, analysis and traceability, law enforcement linkage, detection and evaluation of environmental protection data, realizes thorough perception, measurement, ubiquitous access, interconnection, intelligent analysis and sharing of urban environmental protection information, and provides urban environmental protection governance with the help of the collaboration of various application systems. Application and services in various fields such as ecological improvement provide effective support to achieve safe, convenient, healthy and efficient urban ecological management.

5. Conclusion

In this paper, a smart environmental protection Internet of Things architecture based on edge computing is proposed. The intelligent environmental protection edge gateway can respond to and realize the intelligent access of various environmental protection devices in time. It can conduct preliminary analysis and processing of a large number of environmental protection data and pass the results through multiple integration. The network uploads to the management layer for persistent storage and big data analysis, and at the same time, it can securely encrypt environmental protection data, ensure the accurate transmission of environmental protection data to the application layer, and provide a real and effective basis for various services. Through the smart environmental protection Internet of Things architecture based on edge computing proposed in this paper, we can quickly build an effective management mechanism for the environmental protection field, two major operating systems, and three service platforms to realize timely detection of various environmental pollutions, effective early warning, and long Effective management, fully realize the smart of environmental protection.

With the rapid application of Internet of Things technology and edge computing technology, it is of great significance to construct an IoT application architecture based on edge computing to promote the development of intelligent and energy-saving in the field of environmental protection. The research on smart environmental IoT applications based on edge computing helps to promote the early entry of national environmental protection industry into intelligence, help to improve the level of intelligence in social development governance, and improve the accuracy, predictability and efficiency of social governance. At the same time, the application architecture can be extended from the field of environmental protection to intelligent city, smart home, smart forest and other scenarios, and accelerate the pace of national intelligent development in many fields.

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