

Application of Internet of Things in Urban Waterlogging Prevention Management System

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Abstract

This paper aims to realize the extensive application of Internet of things technology in urban waterlogging prevention management system, and has analyzed the security requirement and security architecture of Internet of things technology, and discussed the demand of urban waterlogging prevention management system in combination with the key technology of Internet of things technology, to do the overall design and functional design well during designing of urban waterlogging prevention management system. Finally, the application process of the Internet of things technology in Chongqing waterlogging prevention management system is summarized. The application result shows that the flood control and drainage function of Chongqing is gradually improved with smooth drainage facilities; the inspection and maintenance management is gradually standardized; operation monitoring and early warning management is fully strengthened. There is visual management for emergency command and dispatch, and at the same time, the drainage pipe network assessment management can be conducted correctly.

Keywords

Internet of Things, Urban Waterlogging Prevention, Management System, System Design, Application Analysis

1. Introduction

Urban waterlogging is a phenomenon of water disaster in urban caused by rainstorm or continuous rainfall which exceeds the urban's drainage capacity. In recent years, urbanization process changes the situation of urban earth surface coverage. The increasing waterproof ground makes most of the rain water as rivers flowing on urban ground, which caused serious urban waterlogging in

many cities. Besides, rainstorm also makes urban waterlogging more and more serious, which adds the task of urban flood prevention and control, causes traffic tie-up, property loss, personnel casualties and other disasters that affect citizen's work and life and restrict city's development [1].

As present, the monitoring and warning on urban's waterlogging rely much on weather information. Waterlogging monitoring reduces to means of people check, people on vehicles check or camera check, which has the defects of slow speed, little data, poor continuity and time lag. When the rainstorm comes, that means it could not provide the waterlog information to related apartments exactly and quickly, and thus the related apartments are not able to take corresponding measures and make warnings. As to the hot topic of urban waterlog, many developed countries conduct researches in different extent, using computer aided way to monitor, forewarn and make analogue simulations. A lot of countries have built the urban monitoring and forewarning system based on their own environmental simulation model and geographic information system. Japan, a country with frequent disasters, pays much attention to urban waterlogging, and also formulates relevant laws on forewarning about disasters. It requires that governments of all levels should report on current disasters' forecast evaluation. This paper studies the application of Internet of things in urban waterlogging management system.

2. Overview of Internet of Things

2.1. Security Requirement of Internet of Things

Based on the application of Internet of Things technology, there are strong security requirements, having not only the highlight information in terms of integrity, but also the more secure information management, to achieve the management application of scale network service, avoiding bringing more serious security problems in the information management process [2]. Internet of Things technology has a strong nature of secrecy, paying attention to protect information's security, avoid bringing direct damage to the institute, and promote the integrity analysis of information from the Internet of Things during the process of information security expression, at the same time, guarantee the securing application of Internet with security [3]. Conduct the effective perception of information based the requirement of Internet of Things, to analyze the system's diversified functional requirements as much as possible, and process the data of network scale, reflecting the decision-making function [4].

2.2. Security Architecture of Internet of Things

Security architecture of Internet of Things is shown in **Figure 1**.

The basic organizational process of Internet of Things is mainly to collect information, thus to provide effective guarantee for information analysis [5]. Design the model using sensor technology based on information collection, to achieve the safeguard application of information security, and also conduct the infrastructure management analysis. As for information transmission and secu-

rity processing links, achieve the effective scale management of data network layer in combination with the effective safeguard function of data, and improve the security of firewall. As for information security processing link, the effective application of information content shall be promoted, and conduct the strategic analysis and protection [6]. For the security link of information application, pay attention to information security of the system, to achieve information authentication as well as the control and management of security [7].

2.3. Key Technologies of Internet of Things Security

Conduct the comprehensive protection of mobile communication network well as much as possible based on application of key technologies of Internet of Things security, combining effective application and analysis of multiple networks, as shown in Figure 2.

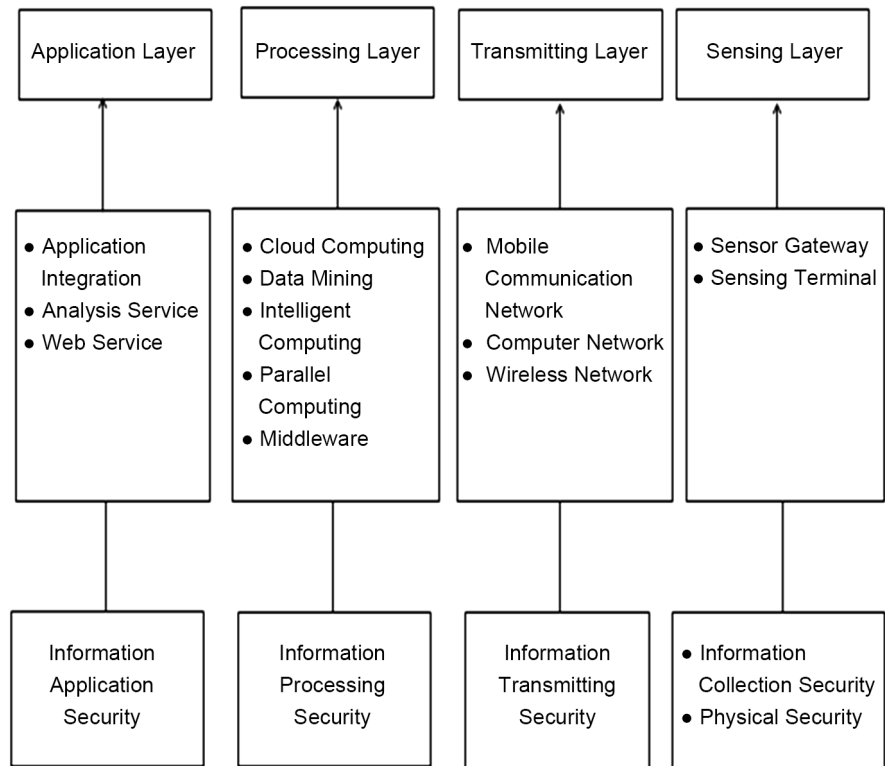


Figure 1. Security architecture of Internet of things.

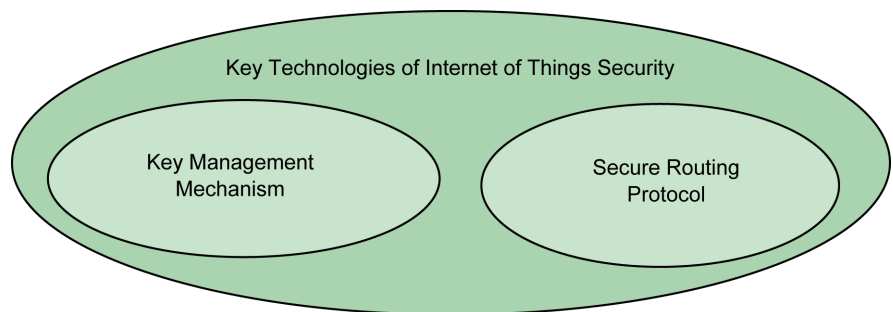


Figure 2. Key technologies of Internet of things security.

3. Urban Waterlogging Prevention Management System Requirement

Urban waterlogging management system should conduct the three-dimensional perception of drainage and waterlogging prevention information and effective monitoring, at the same time, the effective monitoring on drainage and waterlogging prevention information shall also be conducted. On the information management platform, the safe and reliable external perceptual information is available, but the information feedback processing shall be conducted well, to detect urban drainage and waterlogging prevention information in an all-around way as much as possible on the basis of three-dimensional perception [8]. The comprehensive monitoring on hydraulic engineering need to be achieved based on spatial blocks and analysis of rain characteristics [9].

While constructing the system, use the data reasonably on the management and control platform, and apply the data fusion technology as well as the wireless remote intelligent monitoring technology well to realize the effective synergistic application of heaven and earth sensor. Make an effective integration of multi-source spatial data on the system platform, to realize the effective integration management of multi-source data. Conduct analysis of data integration, and determine the effective integration analysis of the intelligent multi-source data.

Therefore, the application of Internet of Things-based technology in urban flood control management system is to promote the gradual improvement of flood control and drainage function, so that drainage facilities are extremely smooth, inspection and maintenance management is gradually standardized, operation monitoring and early warning management is comprehensively strengthened, and there is visual management for emergency command and dispatch.

4. Internet of Things-Based Urban Waterlogging Prevention Management System Design

4.1. Overall Design of System

As for the system, there are five layers as shown in **Table 1**.

While designing the system, not only the good design management of user layer and comprehensive application layer shall be made, but the application of data layer and network layer shall also be conducted, to determine the system design of perception layer.

4.2. System Function Design

1) Drainage facilities management system

An import analysis is needed based on the design of systematic drainage management system, meanwhile, realize the facility enquiry in combination with the map operation and data editing, to conduct special analysis management, determine statistical analysis function, thus to perform unified management analysis of general survey data, achieve effective control of quality, and determine

Table 1. Urban waterlogging prevention management system requirement.

Urban Waterlogging Prevention Management System Requirement	User Layer	<ul style="list-style-type: none"> • Government Department • Enterprise and Public Institution • Social Public • Other Groups
	Comprehensive Application Layer	<ul style="list-style-type: none"> • Drainage Facilities Management Subsystem • Operation Monitoring Early Warning Subsystem • Drainage Network Evaluation Subsystem • Inspection Maintenance Management Subsystem • Emergency Command and Dispatch Subsystem
	Data Layer	<ul style="list-style-type: none"> • Drainage Waterlogging Prevention Perception Database • Drainage Waterlogging Prevention Geographical Database • Drainage Waterlogging Prevention Emergency Database • Drainage Waterlogging Prevention Model Database
	Network Layer	<ul style="list-style-type: none"> • Government Affairs Network • Internet • Mobile Communication Network • Software Facilities • Hardware Facilities
	Perception Layer	<ul style="list-style-type: none"> • RFID • Zigbee • Sensor • Video Monitoring • GNSS

the specific figure of drainage and waterlogging prevention [10]. The functional structure of drainage facilities management system is as shown in **Figure 3**.

2) Inspection and maintenance management system

As for the realization of inspection and maintenance management system, the main work is to manage pipe network facilities, maintain and manage the branch companies, formulate the inspection plan and query the inspection and maintenance information in a timely manner, display inspection and maintenance information, take down the spot check condition, as well as perform well the recording and feedback management of inspection and maintenance by virtue of mobile equipment.

3) Operation monitoring early warning system

Conduct well the online monitoring management of drainage facilities based on the analysis of operation monitoring early warning system, determine the operation status management of drainage facilities, and realize the effective collection management of system data. At the same time, the visible display shall be reflected, realized the online supervision and effective query statistics, thus to achieve the analysis function of early warning.

4) Emergency command and dispatch system

The emergency command and dispatching system is mainly designed in combination with the online flood situation, conduct well the analysis and management of operational data, feedback and release flood information timely, and analyze the operation and dispatching situation of drainage facilities, realize the

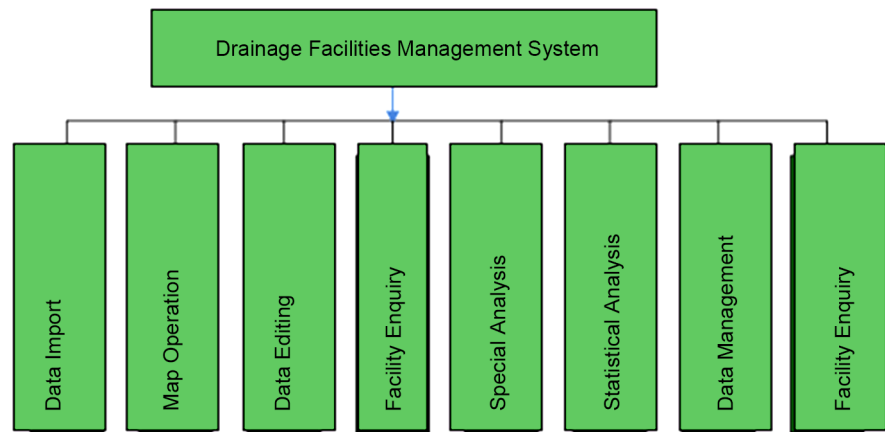


Figure 3. Design of drainage facilities management system.

functional analysis of consultation and coordination, develop the flood prevention plan, and determine the functional analysis supporting contingency plans, so as to realize the effective data collection management for mobile devices.

5) Drainage pipe network assessment system

The design of drainage pipe network assessment system is conducted in combination with the drainage network performance obtained from hydrodynamic model diagnosis. In the system drainage process, achieve the deep processing of data and the effective detection and analysis of data, to further improve the dynamic model characteristics of urban drainage pipe network, achieve effective planning and application of the drainage network, so as to further promote the scientific management of urban drainage.

5. Internet of Things-Based Application of Urban Waterlogging Prevention Management System

5.1. Project Overview

Chongqing urban flood control tunnel is 4100 meters long in total, which is dug and excavated from the both ends simultaneously. The tunnel section is designed to be $4.8 \times 5 \times 8$ meters. The constructor has made many visits prior to tunnel commencement; finally two 80-type extension jib machines are booked in Hubei Xiangyang Zhongliang Mucking Loader Factory. Up to now, the tunnel has been dug more than 600 meters. In the good rock structure condition, there are three rows of guns basically each day, tunneling 6 meters, and there are two self-dumping agricultural vehicles with capacity of 5 square meters for the slag, the carriage is 2.2 meters high and 3.5 meters long. Apply the urban waterlogging prevention management system in an all round way based on the flood control process in Chongqing by virtue of the Internet of Things technology. Design the system well and attach great importance to optimization application urban flood control system.

5.2. System Application

Obtain the flood control timely and drainage information, conduct well the in-

formation command and dispatch management and realize the dynamic intelligent management based on the application process of urban flood control system, the application of Internet of Things technology, the management process of drainage facilities, and by virtue of the integrated application of Internet of Things and geographic information technology, thus to perform effective control and application of urban drainage and waterlogging prevention command. The current management system of urban drainage and waterlogging prevention is shown in **Figure 4**. Based on information transmission application link, the data information not only has a strong confidentiality, at the same time, with technical guarantee, achieve guarantee application of data integrity, and fully protect the functional transmission application of the Internet of Things, thus to use the system effectively based on the comprehensive guarantee of wireless network.

Three-dimensional perception process of drainage and waterlogging prevention information, with its drainage and waterlogging prevention information three-dimensional perception and monitoring process is shown in **Figure 5**.

As for the processing procedure of the system, first of all, acquire the geographic information data and perceive the intelligent sensing data, eliminate the error, complete data pretreatment, data first-level processing process, realize the

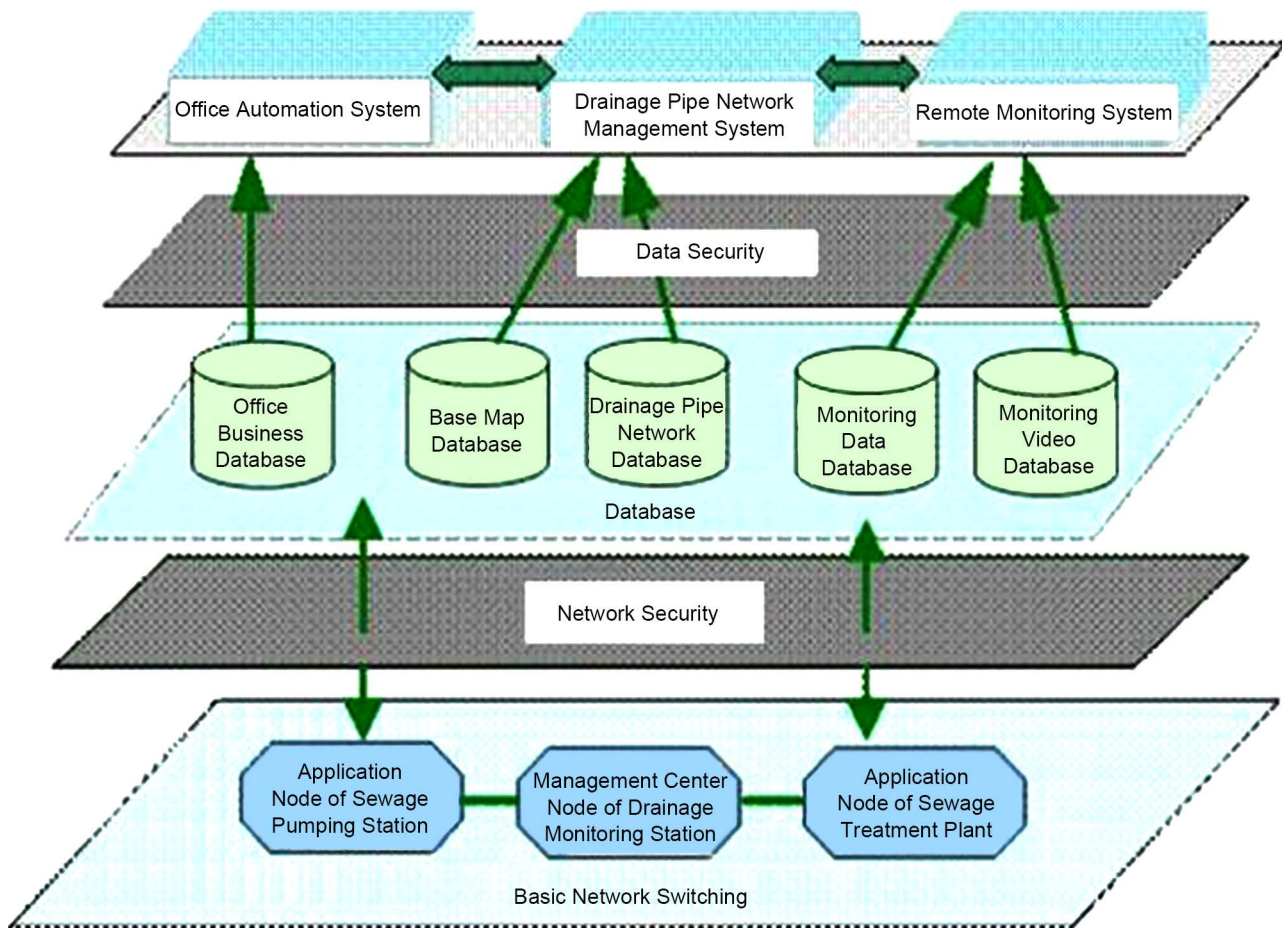


Figure 4. Drainage and waterlogging prevention management system of Chongqing.

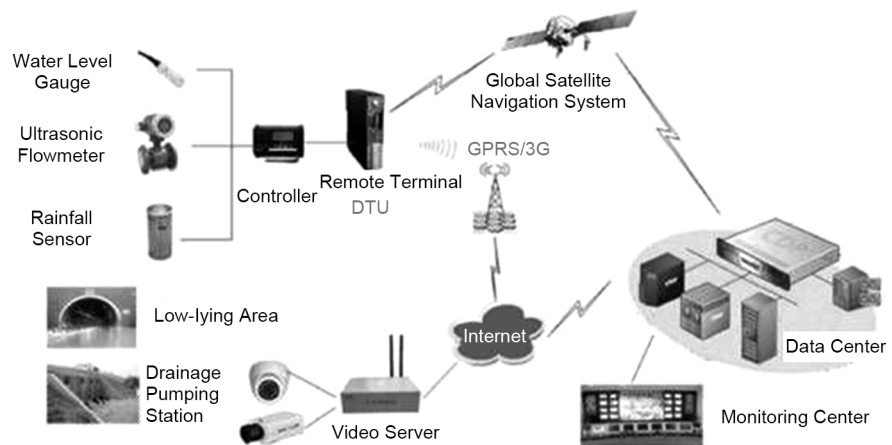


Figure 5. Drainage and waterlogging prevention information three-dimensional perception and monitoring process.

analysis and identification regarding data proofreading correlation, determine the geographical position, and conduct the second-level processing, assess the target correctly, realized data management subsystem, thus to conduct effective support for database.

The auxiliary decision making application phase under the Internet of Things technology has achieved the resources' data integration application. And complete the effective integration of multi-source special data in the data integration process of the Internet of Things, and realize the effective integration of intelligent sensing data in combination with the analysis of geographic information data [11].

5.3. Application Effect

The flood control and waterlogging prevention function of Chongqing is gradually improved after application of the system. The drainage facilities are smooth extremely, inspection and maintenance management is gradually normalized, the operation monitoring and early warning management is strengthened in an all round way, and there is visual management for emergency command and dispatch. Moreover, the drainage pipe network assessment and management can also be conducted correctly.

6. Conclusion

All in all, the application of urban flood control management system based on Internet of things technology pays more attention to the comprehensive monitoring and management of urban drainage and waterlogging prevention, provides operational services, conducts the monitoring and early warning management, and realizes the comprehensive supervision management and investigation management, which has not only improved the city's decision-making capacity regarding flood control and drainage, but the city's flood control capacity is significantly improved, which is contribute to the city's security and harmonious construction and development.

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