Big Data Technology in Intelligent Management and Control System of Drainage Pipe Network

Su Hu1*, Wanhui Zhang2

1School of Information, Guangdong University of Finance and Economics, Guangzhou, China, 510000
2Guangdong Academy of Building Sciences Group Co., Ltd, Guangzhou, China, 510000

*Corresponding author e-mail: husu@gdufe.edu.cn

Abstract. With the rapid development of urban construction, smart city has become an important trend in the future, which is inseparable from the intellectualization of drainage pipe network. At the same time, with the increasing frequency of urban flood disasters, the old drainage pipe network system will cause significant economic losses, which requires modern cities to establish intelligent management and control of drainage pipe network. However, the situation of drainage facilities in most cities in China is complex, which requires strengthening modern means such as monitoring, operation management and planning services. Therefore, the research on intelligent management and control system of drainage pipe network based on big data technology is of great significance. Firstly, this paper analyzes the importance of intelligent management and control system. Then, this paper puts forward the main algorithms for big data processing. Finally, this paper constructs the intelligent management and control system of drainage pipe network.

Keywords: Big Data Technology, Drainage Pipe Network, Intelligent Management and Control System

1. Introduction
With the rapid development of modern science and technology, the monitoring of drainage pipe network system has been difficult to meet the needs of the information age, which needs to study the requirements of big data in the intelligent management and control of drainage pipe network [1]. Through the real-time wireless automatic monitoring system, the intelligent city can improve the monitoring capacity of drainage network management, pump stations, valves and other facilities and equipment, which will realize the functions of intelligent discharge and pump gate linkage [2-3]. Therefore, big data technology can provide scientific basis for flood prevention command [4]. In recent years, sudden rainstorms have occurred in many cities in China, which has caused major problems of waterlogging and water environment pollution. Urban waterlogging has exposed many problems existing in the management of urban drainage pipe network, such as unclear drainage facilities, unclear operation status of facilities, low efficiency of manual management, slow response
to accident treatment, etc., which needs to strengthen the management means of drainage system [5]. Through intelligent management and control, we can improve the drainage capacity of the city, which will improve the current situation of urban drainage problems [6].

2. Necessity of intelligent management and control system for drainage network

2.1. Requirements for smart city construction
Smart water is an important part of smart city construction, which is an important support and guarantee to ensure people's livelihood and public services. Smart water is an important part of smart city construction, which needs to be built with the development and practice of new technologies as the core. Therefore, modern cities need to establish intelligent drainage pipe network system, which is an essential part of urban modernization. Water conservancy modernization is an important link for China to realize national modernization [7]. The intelligent management and control system of drainage pipe network is an efficient and low consumption operation management system, which has highly shared data information and systematic problem solutions. Therefore, the drainage pipe network system can better meet the requirements of modern water conservancy information construction, which is the inevitable choice of water conservancy modernization [8].

2.2. Strong guarantee for water resources management
At present, there are many problems in urban water resources, such as huge rigid demand, serious waste of water resources, serious water pollution exceeding the standard, etc. It is urgent to establish an intelligent, integrated and automatic monitoring equipment [9]. Through the intelligent management and control system, we can monitor and supervise water affairs, which can ensure a more comprehensive perception index. Chinese cities must better protect national resources, which can implement the strictest water resources management system by quantitative means [10].

2.3. An important starting point for the construction of ecological civilization
Water quality and quantity are the key to the success of the construction of ecological civilization. At the same time, the construction of ecological civilization is not a leap, which dynamically forms multiple departments into a large comprehensive system. Through interdepartmental communication, cooperation and operation, we can promote the construction of ecological civilization in all directions, all fields and the whole society [11].

2.4. Adaptive needs of information technology development
After entering twenty-first Century, the information age is coming, including Internet plus, Internet of things, BIM, etc. Among them, China's State Grid and transportation network have been upgraded with the help of information means. Therefore, as an important part of urban infrastructure, urban drainage system urgently needs to build a system suitable for information technology [12]. Through the intelligent management and control system of drainage pipe network, modern cities can build an intelligent management and control system, which will improve the overall service capacity of the city and promote the construction of urban informatization [13].

3. Research on related algorithms

3.1. Reliability Analysis
Reliability is the abbreviation of reliability, which mainly reflects the internal stability and consistency. There are many methods for reliability analysis. At present, the most commonly used is Cronbach $\alpha$ reliability coefficient. The formula of Cronbach $\alpha$ reliability coefficient method is shown in Formula 1.
\[ \alpha = \frac{k}{k-1} \left(1 - \frac{\sum_{i=1}^{k} S_i^2}{S_T^2}\right) \]  

(1)

Among them, \( k \) is the total number of evaluation items in the scale; \( S_i^2 \) is the variance of the score of the \( i \) item; \( S_T^2 \) is the variance of the total score.

3.2. Correlation analysis

Correlation analysis is an analysis method that reflects the attachment relationship between random variables. Pearson correlation coefficient method is commonly used, as shown in formula 2.

\[ r = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2 \sum_{j=1}^{n} (y_j - \bar{y})^2}} \]  

(2)

Maturity composite index

The comprehensive index formula of intelligent management and control system construction maturity is shown in Formula 3.

\[ C_iM_i = f(P_i, E_i, S_i, D_i) = \alpha CP_i \oplus \alpha CE_i \oplus \alpha CS_i \oplus \alpha CD_i \]  
\[ C_iP_i = \sum_{j=1}^{m} P_i \sum_{j=1}^{n} P_j f(P_j) \]  
\[ C_iE_i = \sum_{i=1}^{m} E_i \sum_{j=1}^{n} e_j f(P_j) \]  
\[ C_iS_i = \sum_{i=1}^{m} S_i \sum_{j=1}^{n} s_j f(S_j) \]  
\[ C_iD_i = \sum_{i=1}^{m} D_i \sum_{j=1}^{n} d_j f(D_j) \]  

(3)

Among them, \( C_iP_i, C_iE_i, C_iS_i, C_iD_i \) are infrastructure construction index, security system development index, operation system construction index and service construction index respectively.

4. Construction of intelligent management and control system for drainage pipe network

4.1. System function construction

Through accurate early warning and forecasting, we can effectively deal with the rainstorm problem, which will reduce economic losses. However, some managers are difficult to grasp the accurate operation of drainage facilities in time, which will be difficult to make accurate judgment and scientific dispatching. Through the intelligent management and control system of drainage pipe network, we can provide real-time online monitoring capability of drainage and waterlogging prevention. Through video, optical fiber broadband and Internet of things technologies, the system can monitor the working conditions of sluice, pump station, pipe network and other facilities in real time,
which will realize the management of urban waterlogging prone points. By deploying liquid level meter, liquid level gauge and HD camera, the system can focus on monitoring the ponding at urban waterlogging prone points, which will further realize the functions of intelligent discharge and pump gate linkage. Through big data analysis, the system can better detect and control. This paper constructs the functions of the system, as shown in Figure 1.

![Figure 1. Function construction of intelligent management and control system](image)

4.2. Overall architecture design
The core data of drainage pipe network system is the attribute data of drainage pipe network facility space and business expansion. The main functions of the intelligent management and control system of drainage pipe network are dynamic update of drainage pipe network data, query and statistics of pipe network facilities, application analysis, drawing and printing, etc. Based on the data characteristics of drainage network, the system can be implemented with C / S structure, which can greatly reduce the calculation pressure of the server. Based on the characteristics of system data management, we can get the system logic structure diagram, as shown in Figure 2.

![Figure 2. System logic structure diagram](image)
5. Conclusion
Through intelligent management and control, cities can use traditional artificial drainage pipe network management methods, which will improve the digital and information management ability of urban drainage facilities. Through big data technology, computer technology, GIS technology, GPS technology and sensor communication, modern cities can establish grid and fine management means, which will improve the scientific and effective inspection mechanism of drainage facilities. Through the intelligent management and control system, modern cities can make real-time early warning and prediction, which can realize the real-time monitoring and control of the operation status of drainage facilities.

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