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The Construction of Smart City Information System Based on the Internet of Things and Cloud Computing

Dingfu Jiang*

College of Business, Jiaxing University, Jiaxing, 314000, Zhejiang, China

**Corresponding author (Email: dingfujx@126.com)*

Abstract

With the rapid development and deep application and cooperation of new concepts and technologies brought by the Internet of Things and cloud computing all over the world, all walks of life have gradually moved towards a "smart" modern society. These technologies have gradually penetrated into the field of smart cities. The traditional urban system, the system that has been handed down since ancient times, has a very inefficient and cumbersome mode of operation, and the information between the systems has not been effectively shared and interconnected. In order to solve this series of problems, this study first studies the development of the Internet of Things, cloud computing-related technologies and smart cities, and then focuses on the key technologies of the Internet of Things and cloud computing in the field of structure and application. Under the support of these two technologies, proposed a smart city system based on Internet and cloud computing. System architecture, application system design, application support platform, various transmission networks and typical sensors are studied in detail and on different levels. In smart city systems based on the Internet of Things, sensor networks are often placed in unreliable communication environments, and this usually causes the transmission of information to fail. Whether the sensor chooses to transmit again after the information transmission fails is an optimized problem. This research study proposes a data aggregation algorithm based on Markov chain to solve the problem of transmitting such data again. The experimental results show that the system can realize information sharing, exchange and fusion between various sensing subsystems, solve the previous information island phenomenon and meet the actual needs of smart cities.

Keywords: Cloud Computing, Internet of Things, Smart City, Information Isolated Island

1. Introduction

The emergence of cities is a symbol of the high-level form of human society entering the civilized era and human social life. The urbanization process has been accelerating, the urban population has increased sharply, the city has expanded rapidly, and the status of cities as regional economic and

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political centers has increased [1]. The increase in human productivity has also contributed to the evolution of urban form and function. The process of the rapid development of the city is also emerging social problems: traffic congestion system, inefficient urban management, environmental monitoring systems are imperfect, uneven educational resources, emergency response system is not satisfactory and[2-5]. After years of development, China's urbanization process has been accelerating, and the urban population has grown at a rate of 15 million per year. Fifteen years later, the urban population will reach two-thirds of the country's population, and the total urban population ranks first in the world. In the process of urbanization, people's living standards have continuously improved. The concept of smart city construction centered on next-generation technologies such as the Internet of Things and cloud computing has become a new model for future urban development [6-7]. Smart cities are the inevitable result of the development of urban models. The construction of smart cities can significantly solve the dilemma related to urban development, improve the level of urban information management, and promote the development of high-end industries nationwide [8].

The new smart city can be used as an essential means to solve urban development problems. It can collect information comprehensively and transparently, transmit information widely and safely, and process information intelligently and efficiently. It can not only improve urban management and operational efficiency, improve urban service levels, but also promote sustainable urban development. In this way, in order to build a new form of urban development, the city can automatically sense and effective self- decision making, so that the public can feel the wisdom of the city provided by intelligence services and applications [9-10]. Against the background of rapid urbanization and human civilization, major cities in the world are generally facing development problems such as energy shortage, environmental pollution and traffic congestion. Urban computing is a new concept based on IoT perception, with related data technology, big data mining and analysis technology as the core [11-13]. The implication of urban computing is that each sensor, device, person, vehicle, building, and road in an urban space can be considered a unit of perceived urban dynamics [14]. Work together to complete city-level computing and serve citizens and cities. Urban computing aims to intelligently improve the lives of citizens and urban environments through urban perception, data mining, intelligent extraction and improved cyclical processes [15-17].

Domestic and foreign scholars in the wisdom of urban areas has been achieved many research results. In 2015, Bonino and other scholars introduced the Joint Smart City Platform (SCP) developed in the context of the ALMANAC FP7 EU project , and discussed the experience of the platform's first experiment applied to medium-sized European urban smart waste management solutions. The platform is designed to integrate the Internet of Things (Internet of Things) and metro access networks to provide intelligent services to citizens, enabling smart city processes [18] . In this article, we explore the concept of sensing as a service and how it matches the Internet of Things. In their research, Perer introduced the importance of the Internet of Things to smart cities and envisioned connecting billions of sensors to the Internet and hoping to use them in smart cities for efficient resource management. They also explored the concept of sensing as a service and how it matches the Internet of Things. They study the concept of sensing as a service model in a technical, economic, and social perspective and address key challenges and issues [19]. Researchers such as Kitchin highlighted the ubiquitous computing and sensors in smart cities and detailed how cities can use digital devices and “big data” infrastructure. Finally, proposed some problems creatively in the smart city [20]. Jiong Jin proposed a framework for realizing smart cities through the Internet of Things (Internet of Things). The framework covers a complete urban information system, cloud-based services from the sensory level and network support structure to data management systems, and describes how to transform from existing physical network systems [21].

The characteristics of present study are as follows: (1) Based on the basic framework of Internet of Things and cloud computing, comprehensively consider the information that needs to be shared and exchanged in each sensing subsystem , and make reasonable use, (2) proposed based on Markov Chain aggregate data algorithm solves the unreliable communication environment sensor easily lead to failure of information transmission problems, (3) using the connectivity of the Internet to effectively realize the smooth transmission and interaction of the perceptual data collected by each subsystem. In order to realize the exchange and sharing of information within the city, the goal of information fusion of smart cities was finally realized , and the phenomenon of information islands was broken.

2. Proposed Method

2.1. Related Concepts and Technologies

As an emerging discipline, we must first understand the wisdom of the city itself, the rationale behind this concept is to understand the starting point for the city of wisdom, the use of "smart city" concept is a direct translation of the English word "Smart", but in English. " Smart ", is a word whose meaning changes. As shown in Figure 1, the word " Smart " was first used as an adjective in English to describe people or things with high intelligence in different fields. When " Smart " when used to describe the context of urban form, more was to represent the city itself is the use of advanced science and technology, can achieve healthy and sustainable development of self-management, performance is the life of urban residents levels can be significantly raise liter. When " Smart " directly to " Smart City ", it can be understood to mean that the use of large data emerging technology, networking and other cities to improve operational efficiency, drive innovation cities and intelligence of means.

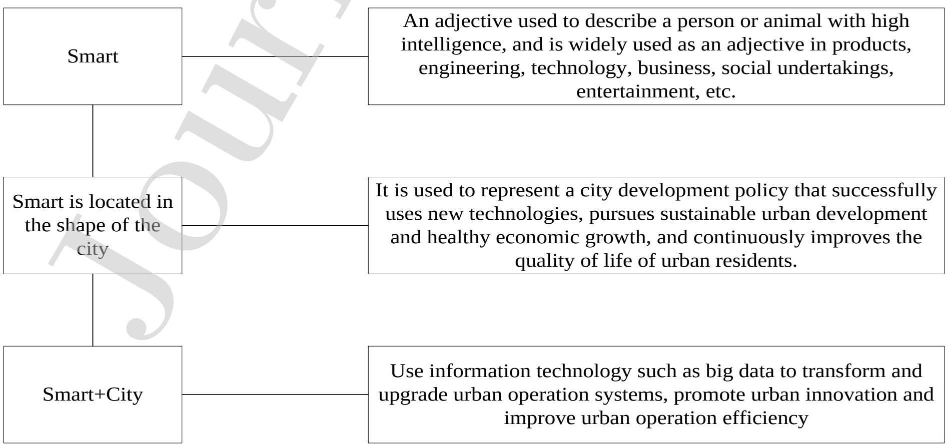

Figure 1. The origin of " Smart City "

As a new development idea and urban form through various application of various information technology, the generalized smart city expresses human beings' imagination of the future city life state and expresses some intelligent, harmonious and sustainable production. Lifestyle, as a managed whole, is destined to its free and open development path and become the shape of the future city.

Narrow smart city is based on a variety of web-based, in-depth development, make full use of various information resources, form a network, intelligent high-end new city, intelligence management, service, industrial, medical and other part is focused On the construction, in order to promote A new model of urban construction and vigorous development.

(2) The supporting role of the Internet of Things and big data on smart cities

The goal of building a smart city is accompanied by the popularity and application of the Internet. The technologies that are widely accepted and closely related to the construction of smart cities include: Internet, big data, cloud computing and Internet of Things technologies.

Internet technology has been developed for decades, and many technologies have been developed. The latter three can be said to be the product of the deep development of the Internet in a broad sense. Among them, the main role of the Internet of Things technology in the construction of smart cities is to perceive massive data with diverse sources. The sum of these massive data can be approximated as big data. The cloud computing model is responsible for the big data information through the widely distributed computing resources in the cloud. At the construction of smart cities, is equivalent to collecting, analyzing and storing the data related to IT. With at the development of mobile internet devices, such as at the popularity of personal terminals such as smart phone, Smart Tablets, Smart Watches, and more ubiquitous Internet, different technology systems are closely linked, among which big data, cloud computing and the Internet of Things are Representatives of these, as shown in Figure 2 , play a key supporting role in the construction of smart cities .

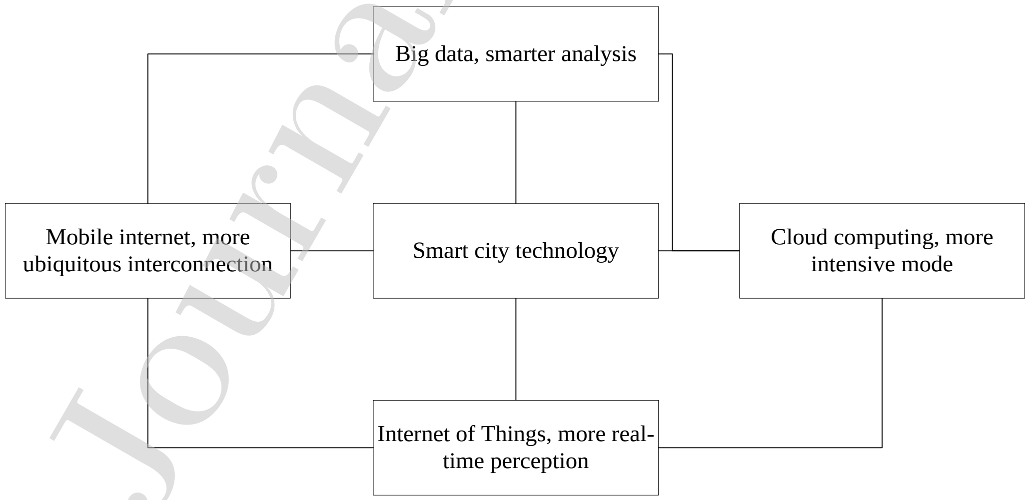

Figure 2. Smart City Technical Support Diagram

2.2. Smart City Information System Design

In the system architecture aspect, information system needs to have : application (including

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application support systems) , network transmission system, the system acquisition terminal (Sensing System c) portion.

(1) Smart City Information System Architecture

The urban information system architecture is based on the ITU (International Telecommunications Union) architecture. The system architecture is based on a three-tier architecture of awareness, networking and applications. By deploying and setting up multiple types of sensors, information in the city is collected quickly and multiple direction and transmitted to the system through each file application transport network. The after the relevant information generated, relevant information displayed by each file application and processed system . Its system architecture is shown in Fig. 3.

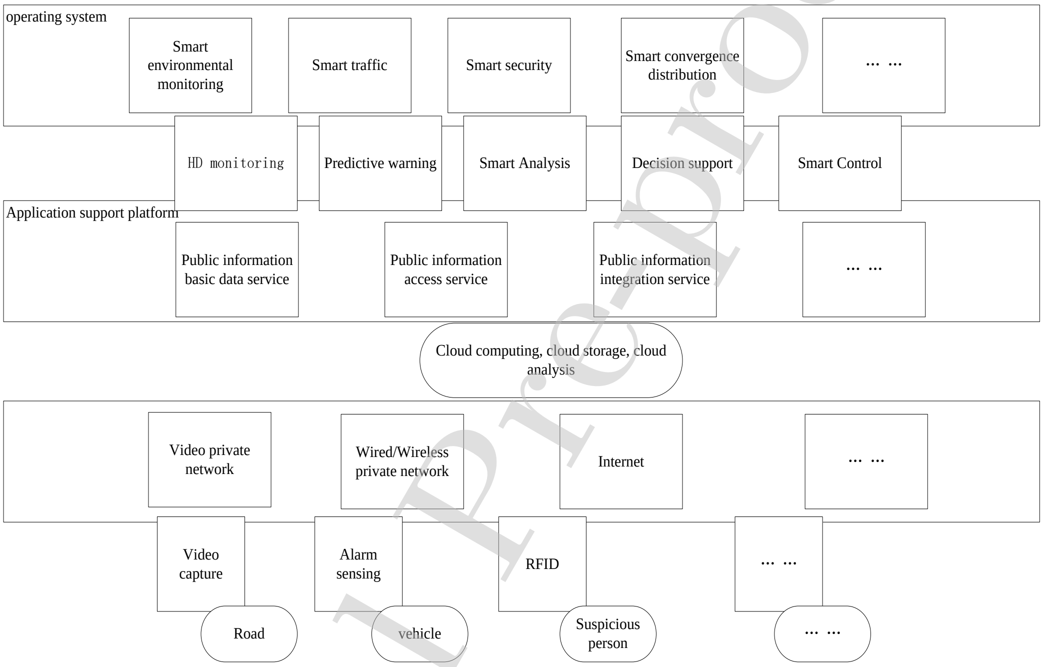

Figure 3. Smart City Information System Architecture

Perception; "Sense" is the basic data acquisition layer for building a secure city. The high-definition video surveillance camera is used as the main base layer image acquisition unit to monitor the front-end monitoring scene in real time. The video recognition and behavior analysis technology is used to the collect road vehicle the traffic and illegal information . Extensive English grammar in use of the RFID technology and the GPS/ Beidou technology to the collect real-time location and other relevant information of vehicles, people and items; other social Security information collection . This is the most part of the safe city construction effort.

Network: The network transmission layer uses advanced wireless broadband technology, optical fiber communication, 3G wireless communication technology and other data coverage. Need to meet the bandwidth needs.

Applications: "Use" is an important part of system functionality, using cloud computing, cloud storage and cloud analysis to integrate monitoring resources within the city. Digging deep into "massive data" and providing comprehensive data support for related applications is a successful embodiment of urban informational construction. The comprehensive management platform based on GIS provides a humanized and intelligent application interface for urban units and regional personnel. Provide data sharing services for urban safety management, traffic management, emergency response processing and command and dispatch.

(2) Application system design

1) Intelligent environment monitoring design

Real-time monitoring of urban real-time environmental information (temperature, humidity and harmful gas content) in the city is monitored by environmental monitoring units and modules (smoke, noxious gases) installed in the city. And aggregated to the application support platform through the transport network.

Environmental monitoring systems include: environmental data collection and environmental related data reception processing. The environmental data collection part includes two parts: The wireless transmission of the sensor and data reception processing section includes wireless data reception processing. After collecting the environmental data, the transmission system transmission is the sensor-to-environment data processing part of each node arranged in the city. In the environmental data processing section, after the data processing and analysis, if the environmental data exceeds the safe range, the related operations are automatically triggered. The transmission system sends alert information to the relevant managers and systems. The corresponding camera is called for video viewing through the previously entered association.

Multiple monitoring nodes are deployed to collect environmental data and send the collected data to the aggregation node via wireless Zigbee technology. The INTO processing system is then collected over a wired or wireless network for data analysis, processing and storage. The analysis results are used in conjunction with the video network to send the analysis results to the urban management personnel to improve monitoring efficiency and personnel response speed.

2) Intelligent traffic design

Real-time monitoring of vehicle locations in the city by integrating GPS/ Beidou modules and RFID modules on urban vehicles. The real-time situation of each part of the city is generated by the transmission network statistics and summarized into the application support platform. After The certification, the city personnel can dial the real-time road section information, and then select the most suitable route or site for vehicle-related operations. Vehicles certified in the city can use RFID technology to directly enter and leave the city without parking.

By integrating the GPS/ Beidou module on urban vehicles , real-time monitoring of urban vehicles can be achieved . Combined with the use of video networks, when traffic jams occur in cities , digital clusters and integrated communication platforms are used to transmit congestion information to City managers in a timely manner. Such urban congestion will be effective in the treatment.

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3) Intelligent security design

Smart Security is a video monitor in the surrounding areas and key areas of the city that monitors all parts of the city, buildings and factories in real time. By visually displaying the distribution of all video resources on the GIS map, the operator can quickly open The video information using a mouse operation, thus quickly implementing video control. System based on a number of video behavior analysis, can improve the system 's efficiency and reliability.

The intelligent security in this paper is based on video control, taking advantage of the massive data and cloud analysis power of the cloud storage platform, comprehensively utilizing video resources, intelligent analysis of urban personnel intensive alarms, warnings of illegal stays at city borders, and Specific areas. The schematic diagram is shown in Figure 4:

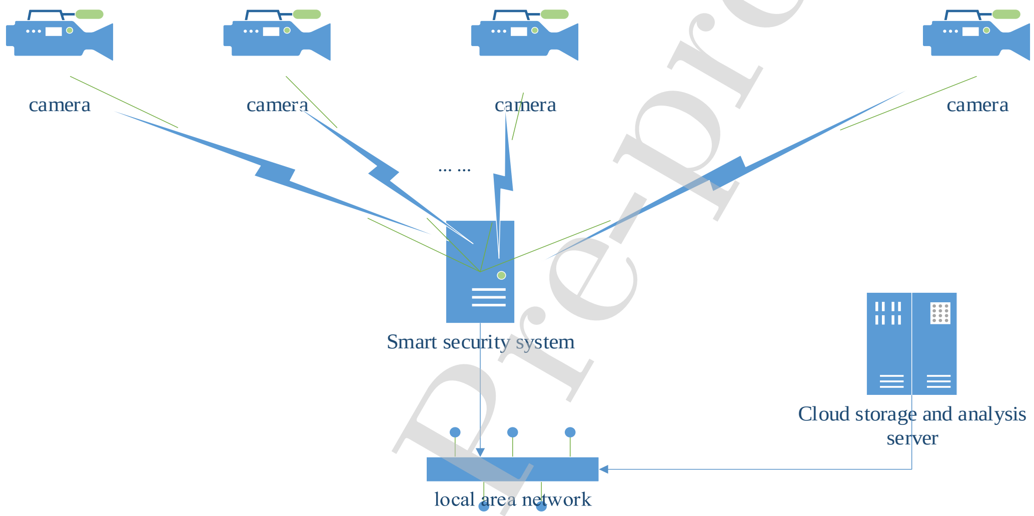

Figure 4. Intelligent Security System Architecture

(3) Application support platform

The application support platform adopts the methods of cloud computing, cloud storage and cloud analysis. Provide public basic data information services, public information wireless, wired access services, public integrated information services, and public information exchange services. High-definition monitoring, forecasting and early warning, intelligent analysis, decision making and intelligent control.

1) Public information basic data service

Public information basic data includes urban geographic information and basic business information (unit name, legal person, main business, region, department composition and contact telephone number, etc.), vehicle information, city personnel information, various sensor basic information (video collection, Alarm sensing, RFID , GPS/Beidou terminal). It provides timely and relevant underlying data services for each application.

2) Public information access service

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IT CAN the Provide Public Information Access Services for Urban Security Systems, Urban Personnel and social Personnel ACCORDING to Different Authorities. Public Information CAN BE accessed through at The Internet and at The City Intranet to the Achieve Public Information Access Services, Including Urban Geographic Information Inquiry, inbound Enterprise Information Inquiry, and so on.

3) Public information integration services

Public information that is reported at the same location or simultaneous for different units and applications can be integrated as needed to generate complete, comprehensive public information feedback for each application.

4) Public information exchange service

For public information reported by different application systems at the same place or at the same time, information exchange in different forms and formats may be performed as needed.

(4) Smart City Transmission Network

1) Video private network

Video Control Takes Place in Different Areas of at The City, ON Different Buildings Zip and ON Different Floors to the Create A Video-specific Network. The Realize Urban Video Surveillance around at The Clock, the Provide Video Services for Urban Security Systems, and the Achieve Intelligent Security. By You CAN View Videos in different locations, different buildings and different floors, and you can retrieve historical data. When a theft or security incident occurs, the relevant video material can be used as an important basis.

2) Wired / Wireless private network

Established a wired/ wireless private network for information systems to realize the interconnection and intercommunication between urban enterprises and application systems, and realize the broadcasting and information exchange of urban public information. A wireless private network can be established by relying on cluster communication as a dedicated Mobile wireless network for urban security.

3) Internet

Establish a city website that accesses urban information systems via the Internet. The company's key star products and main business information will be released to the website to effectively enhance the strength of urban enterprises and enterprises. Establish urban personnel authority management, and access the corresponding content of the city information system according to different permissions.

(5) the wisdom of the city spread a sense of choice

Because of the wide variety of sensors, this article selects video capture, alarm prediction, RFID , GPS / Beidou to introduce .

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1) Video data monitoring and collection

Video Surveillance and Acquisition IS A Very Important Part of at The Video Surveillance Field, and Applies to All Aspects of Our Daily Lives. From social Production's to people's Daily Lives, Video Surveillance and Collection are in use and in Operation. ESPECIALLY in at The Field, of Urban Security, video surveillance and collection are deployed in transportation sites, production plants, hospitals, banks, and key cities. Achieve comprehensive, all-weather monitoring of major urban areas. Now, with the development of wireless communication technology, video surveillance is toward wireless in the direction of development. With the increase of cloud computing, video surveillance is also moving towards intelligent direction.

2) Alarm prediction

Effective monitoring and early warning of hazard sources can be achieved by deploying environmental monitoring equipment and toxic gas sensors in pollution sources, personnel work areas and susceptible areas. When the relevant parameters change abnormally, various collected data information will be collected into the central processing system. At this point, the file application layer program responds and responds further by implementing a learning custom security plan. If the sudden pollution source is accidentally leaked, the intelligent city information system will promptly contact relevant environmental protection related units to deal with the accident in a timely manner by implementing the established strategy.

Currently, two sensors for environmental monitoring using the in COMMUNASITIONS frequency are: The TWO sensor's smoke sensor and temperature sensor have a simple interface, high measurement accuracy, stable operation and high reliability. With the easy-to-expand functionality, the need to monitor according to specific environments can be extended in the corresponding sensors.

The smoke sensor has the characteristics of fast, high reliability and stability, long service life, simple device principle and low cost. The corresponding smoke sensor can be configured according to the specific conditions of the city. Natural gas, liquefied gas, and other temperature The sensors have the following characteristics: The device has simple principle, simple layout, single connection, convenient communication, low power consumption, and can realize multiple site distributed application.

3) RFID

RFID is a technique for identifying and determining the identity characteristics and related data of a target itself within a relatively close range and distance by identifying and transmitting a radio signal. At present, the technology is mature and widely used. Mainly because of its cost- Effective low-cost, multiple application object recognition in the Internet of Things. It can be said that this technology allows an object to "talk" to introduce its identity. It is a non-contact automatic identification technology. It can automatically identify the identification work can work in various harsh environments without manual intervention. Since it has the following characteristics: the technology is small in size, large in capacity, non-contact, multi-purpose. And has been widely used in many occasions and fields such as industrial automation processing, intelligent traffic control and management. It is a fast, efficient, accurate, real-time data acquisition and processing technology with broad application prospects. It is a non-contact mode of operation, and automatic identification does not require manual intervention, it is widely used to identify a variety of harsh environments.

4) GPS / Beidou

At present, my country's most popular satellite positioning system are: the US GPS system and China's Compass system.

After using GPS, China's Beidou satellite has the following two technical advantages: First, satellites are deployed on the oblique orbit to enable the Beidou satellite navigation system to intercept under complex terrain conditions. Get a stronger surface positioning signal to achieve higher accuracy (such as high-rise areas in the city); second, GPS is just a pure receiving satellite navigation system, which can only relay signals and achieve positioning through user reception. China's Beidou satellite navigation system is two-way, with positioning and communication functions. The configuration of the short message transmission information function CAN can be received not only on the Beidou positioning signal ON of the terminal device, but also actively transmitting relevant information from the terminal device and REACH at the real-time information. The real-time terminal is controlled by satellite arrival. This paper considers the use of Beidou/GPS terminal equipment to realize the two signals of SIM, namely the superior reception of Beidou and GPS, so as to improve the accuracy of positioning information.

By installing a GPS/ Beidou module on a city vehicle , the real-time location information of the vehicle is obtained, and a real-time urban traffic condition map is generated by statistics.

2.3. Data Aggregation Algorithm Based on Markov Chain

In smart city systems based on the Internet of Things, sensor networks are often placed in unreliable communication environments. Unreliable communication links will cause data transmission failures. To do this, you need to transmit the data again that failed to transmit. However, transmitting data again will not only take time but also consume energy. The time spent to transmit it again will affect the quality of data aggregation under time constraints, and the energy consumed by transmitted again will affects the life cycle of the network. However, if the failed data is not transmitted again after the data transmission fails, the data aggregation quality under the time constraint is reduced because the data transmission fails. Therefore, in time and energy constraints in an unreliable environment, whether the node chooses to transmit it again after the data transmission fails is an optimization problem. The following is a study of data aggregation methods that maximize the quality of aggregates under time and energy constraints in an unreliable environment.

By applying the Markov chain, the optimal solution can be obtained approximately. Markov chains in recent years have been used to solve some combinatorial optimization problems. Therefore, in order to solve these problems, using Markov chain approach framework design distributed algorithms. In this distributed algorithm, the Markov approximation method first constructs the target steady-state distribution, and then designs a Markov chain structure suitable for distributed implementation. Based

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on the Markov chain, the system performs random walks in different data aggregation trees, so that trees with high aggregation quality can have greater access probability, so that the aggregation tree converges to the optimal tree to achieve maximum aggregate quality data.

The Markov chain is a stochastic process with Markov properties and is characterized by no memory. No memory means that the state of the system at the next t+1 time is only related to the state at the current t time, and has nothing to do with the state before t. The specific expression is as shown in the formula:

$$P\{x_{t+1} = b_{t+1} | x_t = b_t, x_{t-1} = b_{t-1}, \dots, x_0 = b_0\} \tag{1}$$

The memory loss of the Markov chain allows the system to predict the next state of the random variable based on the current state.

A network consists of a user set R and a network configuration set F. A network configuration consists of each user using a separate local configuration. Under a network configuration f, each user r can get a benefit $x_r(f)$. Maximizing the benefits of the system by choosing the optimal configuration is a combined optimization problem, as shown in the formula.

$$MWC\colon max_{f \in F} \sum_{r \epsilon R} x_r(f) \tag{2}$$

In the data aggregation tree that creates the maximum quality, one aggregation tree corresponds to one configuration f, and the generated tree set $T_r(G)$ corresponds to the configuration set F. definition

$$x_\psi = \sum_{r \epsilon R} x_r(\psi) = max_{f \in F} \sum_{\overline{r\psi}、\overline{W\psi}、} \sum_{i \epsilon V} w_s^\psi(i) \tag{3}$$

Then formula (2) can be redefined as

$$MWC\colon max_{\psi \in T_r(G)} x_\psi \tag{4}$$

Equation (4) has the same optimal value as the problem described in the following formula:

$$MWC - EQ\colon max_{p \geq 0} \sum_{\psi \in T_r(G)} p_\psi x_\psi \tag{5}$$

$$st \sum_{\psi \in T_r(G)} p_\psi = 1 \tag{6}$$

Where p_ψ is the probability that the aggregation tree ψ will be used. According to the log-sum-exp approximation function, we can deduce that the function is an approximate solution to the MWC problem:

$$g_\beta(x) = \frac{1}{\beta} \log\left(\sum_{\psi \in T_r(G)} \exp(\beta x_\psi)\right) \tag{7}$$

Where β is a normal amount. By calculating the conjugate function of $g_\beta(x)$ conjugate function

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$g_\beta^*(x)$ and conjugate function $g_\beta^*(x)$, it is derived that $g_\beta(x)$ has the same optimal value as the problem described by the following formula. .

$$max_{p\geq 0} \sum_{\psi \in T_r(G)} p_\psi x_\psi - \frac{1}{\beta} \sum_{\psi \in T_r(G)} p_\psi \log(p_\psi) \tag{8}$$

$$st \sum_{\psi \in T_r(G)} p_\psi = 1 \tag{9}$$

Using the above formula as an approximation function for MWC and MWC-EQ will introduce an information entropy:

$$1 - \frac{1}{\beta} \sum_{\psi \in T_r(G)} p_\psi \log\left(p_\psi\right) = st \sum_{\psi \in T_r(G)} p_\psi \tag{10}$$

Where β controls the approximation accuracy. Since equation (8) is a convex function and is closed, its optimal solution p_ψ^* can be obtained by solving the Karush-Kuhn-Tucker condition.

$$p_\psi^* = \frac{\exp(\beta x_\psi)}{\sum_{\psi \in T_r(G)} \exp(\beta x_\psi)} \tag{11}$$

The upper bound of the approximation difference between the approximation and the optimal value obtained by substituting the optimal solution is:

$$= -\frac{1}{\beta} \sum_{\psi \in T_r(G)} p_\psi \log\left(p_\psi\right) \tag{12}$$

When β is infinite, the approximate difference is zero. However, due to the constraints of the actual conditions and the cost, it is unrealistic to use a large β value. In addition, the large β value causes the Markov chain to converge too fast and fall into local optimum. In summary, the MWC and MWC-EQ problems are solved approximately by using the value of p_ψ^* to give different configurations with different probabilities.

By utilizing the Markov chain, the system accesses the data aggregation tree in the state space $T_r(G)$ in a probability p_ψ^*. It can be seen from equation (11) that the performance of the data aggregation tree is larger as the probability of being accessed. When the Markov chain converges to the steady-state distribution, the performance of the system also tends to be a stable value from the optimal solution: (1/β)log|F|. To design a time-reversible Markov chain for the state space $T_r(G)$, state mobility needs to be designed. A time reversible Markov chain must satisfy the following two conditions:

1) Markov chain is irreducible, that is, any two states can reach each other;

2) Meet the detailed balance equation.

3. Experiments

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3.1. Experimental Environment and Data Sources

Select a cloud-based video server to effectively monitor anomalous behavior within the city. The outdoor base station is derived from the ACRO Tetra digital trunk single carrier base station SB421. The experimental data comes from self-made.

The selected cypress SRH3800 integrates the world's leading GPS module, making it faster and easier to locate than a typical GPS receiver, even between buildings. The positioning sensitivity is -152 dbm and the tracking sensitivity is -155 dbm. Pass the ETS300019Drop Vibration drop and vibration test. Waterproof and dust-proof to a high standard, storage temperature range of -40 ° C to +85 ° C, ambient temperature of -20 ° C to +60 ° C, it can meet the storage conditions and conditions of use in the low temperature region of the north.

Some parameter specifications of the SB421 base station are shown in Table 1:

Table 1. Technical Parameters of the Single Carrier Base Station SB421

Receiving Sensitivity	Using Diversity -121dBm , No Diversity - 118 dbm
Static receiving sensitivity	-118dBm
Dynamic receiving sensitivity	-113dBm
Backup	The base station controller supports redundant; can be automatically converted to the backup failure hot parts of the controller
Filter	Double direction
Positioning	Internal integrated GPS receiver; a new generation of GPS and the processing technology

The selected ARCO Unite U7200 is a new type of communication system. It can realize wired and wireless network access, even IP network access, and integrate them together to become an overall network, enabling interconnection between networks.

Some functions of the AcroUniteU7200 are shown in Table 2:

Table 2. Part of the AcroUniteU7200 features

Features	Description
Multiple System Integrated Access	Providing 800M , 350M clusters, often radio, short wave, E1 , the VoIP and other access port , wireless communication, the TDM private network, public telephone networks (including PSTN and the GSM , the CDMA network) and IP network access.
Multiple System Cross -Linki	The wireless and private networks and the public telephone network

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ng Interworking	are connected to each other .
Unified Dispatching command	The different communication systems interconnected together , to do its function calls all terminals by a network control center, it is possible to achieve integration of the overall schedule.

The experimental network includes a LAN environment, access to the video cloud storage and analysis server, and an analog fabric control point (clothing point 1). Four computers are equipped with intelligent environment monitoring system software, intelligent transportation system software, intelligent security system software and intelligent fusion system.

3.2 Experimental Content

(1) Cluster terminal positioning display

The three terminals mentioned above are named A, B, and C respectively. The city map is configured in the background management of the intelligent security system, and the location information sent by A, B, and C is collected.

(2) Personnel gathering alarm and fusion processing distribution

Set the monitoring area and set the maximum number density to 10. When the number of control points exceeds 10, the smart security system will issue an alert. Obtain the traffic information and environmental information of the control point, and then generate comprehensive information after the fusion process, and distribute it to the terminal held by the relevant personnel.

(3) PSTN and terminal interconnection

The PSTN and the terminals A, B, and C communicate with each other through system management. Cluster D and terminals A, B, and C are connected to each other. The cluster D implementation is interoperable with the mobile phone E.

4. Discussion

4.1. Analysis of Intelligent Security Experiment Results

(1) Terminal positioning display

In the background management of the intelligent security system, the location information of the terminals A, B, C, and D is received, and then displayed on the map.

(2) PSTO and terminal interconnection to achieve scheduling

The PSTN and the terminals A, B, and C are connected to each other by the management system, and the call is clear. The cluster D and the terminals A, B, and C are connected to each other by the management system, and the call is still clear. Cluster D and mobile phone E are connected to each

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otherand the call is clear. Therefore, in the event of an emergency, timely communication can be handled.

4.2. Intelligent Transportation Route Planning

The GSM module is integrated on the city bus, which can continuously send the location information of the vehicle to the intelligent traffic information system, so that the system can compare the position information and provide the route planning for the user after the operation.

The front end of the intelligent traffic information system uses a goddess weaver and uses the HTML language. The smart city management login interface is shown in Figure 5 and Figure 6:

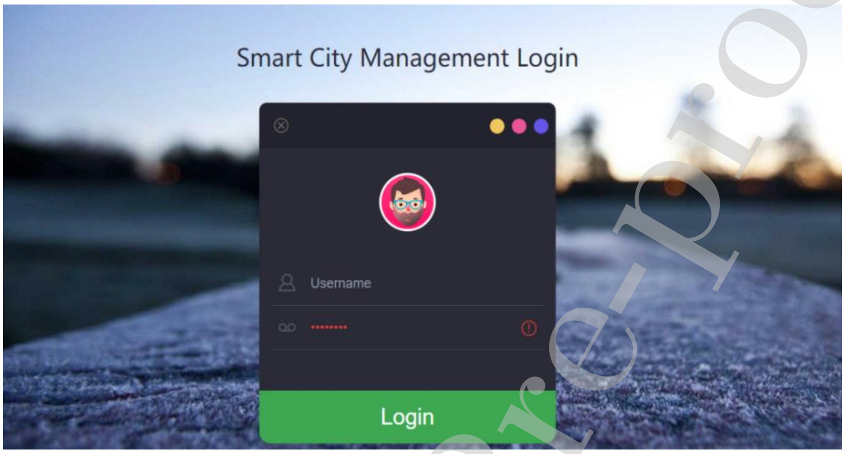

Figure 5. Smart City Management Login Interface

Figure 6. Smart traffic sensor route plan

4.3. Data Aggregation Algorithm Based on Markov Chain

(1) Comparison of performance with optimal solution

The performance of the proposed algorithm and the optimal solution are compared here. For convenience and optimal solution performance comparison, assume that all nodes are source nodes and

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the links are reliable. The parameters α and β are set to 0.2 and 1, respectively.

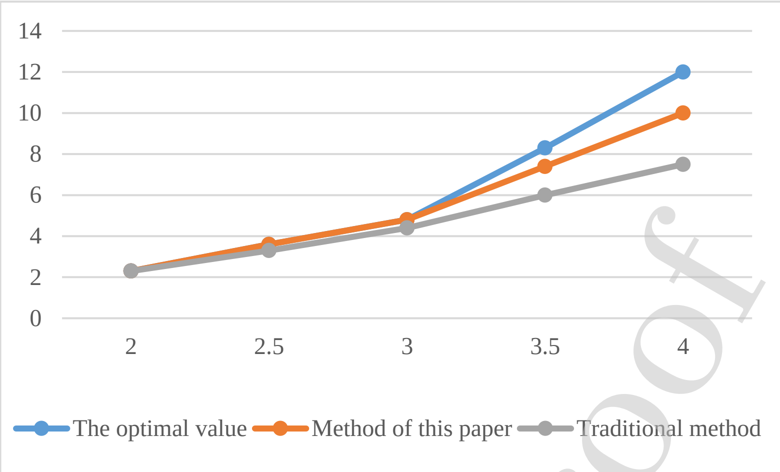

Figure 7. Network aggregation quality

To calculate the state mobility of the Markov chain, two types of methods of valuation are performed in the traditional approach. As shown in Figure 7, compared with the traditional algorithm, the algorithm proposed in this chapter obtains a larger data aggregation quality and is close to the optimal value.

(2) Performance under evenly distributed scenarios

The algorithm proposed in this paper is simulated and analyzed in a large-scale and evenly distributed network environment. In the simulation experiments conducted herein, the parameters α and β were set to 0.2 and 0.5, respectively.

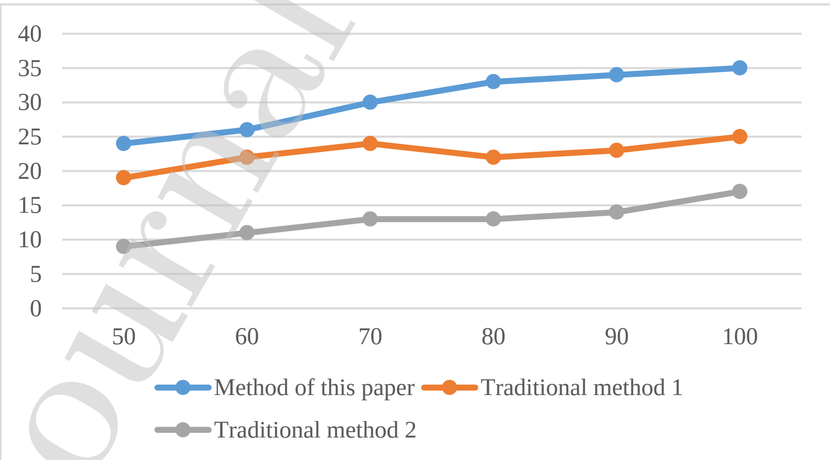

Figure 8. Aggregation quality in different network sizes

Figure 8 shows the data aggregation quality in different network sizes with a time constraint D of 20. As can be seen from Figure 8, the quality of the algorithm proposed in this paper goes beyond the traditional method 1 and the traditional method 2, and increases as the network scale increases. Due to the problem of estimating the state value in the conventional method 2 when calculating the state

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mobility, the performance of the conventional method 2 is even lower than the maximum data aggregation quality under the fixed tree in the conventional method 1. Therefore, the calculation of state mobility in traditional method 2 and the way in which the state is estimated are not suitable for the problems studied in this chapter. Compared with the method in the traditional method 1, the performance of the method proposed in this chapter is improved by at least 18%, up to 42%, and an average 30%.

5. Conclusions

The process of urbanization is accompanied by the progress of human civilization. Urban management must face a series of problems: congestion in transportation systems, inefficient urban management, imperfect environmental monitoring systems, unbalanced educational resources, and imperfect emergency systems. Information systems that act as smart cities must have powerful computing, sensing, and data application capabilities. The development of cloud computing and the Internet of Things technology has provided feasibility for the construction of smart cities.

The main contents of research work are as follows: Firstly, the background and development of the Internet of Things, cloud computing and smart city are briefly analyzed. Then the main concepts of the key technologies related to the Internet of Things and cloud computing involved in the smart city of the Internet of Things are discussed. These concepts are: the key technologies, architectures, application areas of the Internet of Things and related technologies and structures of cloud computing. With the above technical support, this paper constructs the information system of its own smart city. The research focuses on application system design, application support platforms, transmission and sensors in smart cities. The research objectives and functional design of each application system are studied in detail. A data aggregation algorithm based on the Markov chain is proposed, which solves the problem that the sensor in the unreliable communication environment is easy to cause information transmission failure. Finally, by deploying the following systems and devices: (1) Intelligent Environment Monitoring; (2) Intelligent Security; (3) Intelligent Transportation – An analysis of the implementation effects of inter-system interconnection and integration. The experimental results show that the system can realize information sharing, exchange and fusion between various sensing subsystems, solve the previous information island phenomenon and meet the actual needs of smart cities.

With the increasing maturity and accuracy of the key technologies related to the Internet of Things and cloud computing, smart cities will continue to develop in the direction of continuous intelligence. Smart city information systems are more efficient than traditional urban systems, and by introducing some high-tech, such as artificial intelligence, the "wisdom" of smart cities will be more prominent. In the future research of intelligent city information systems, technical research needs to be improved in the following aspects: (1) Internet of Things operating system; (2) Multiple sensor information fusion; (3) Intelligent sensing technology; (4) Industry 4.05 Internet +. Smart cities are gradually facilitating our lives, and we believe that smart cities in the future will be smarter and more efficient.

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Dingfu Jiang was born in Ji'an, Jiangxi Province, P.R. China, in 1977. He received his doctorate from Shanghai University, China. Now, He works in College of Business, Jiaxing University. His research interests include information management systems and e-commerce.

E-mail: dingfujx@126.com

Conflict of interest statement

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work.

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