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Application of Wireless Network Remote Sensing Image and Video Processing Technology in Smart City Design and planning

Abstract: - With the rapid development of society, regional urban construction has become the main guarantee of economic development, and smart city construction has become the main trend of regional development. Smart cities consist of information images and urban development, which can meet the needs of the modern generation for material life, knowledge and scientific life. Therefore, wireless remote sensing (RS) and video image processing have become key tools for the development of smart cities, which can solve the problems encountered by many professionals before, and become an integral part of urban construction. On this basis, this paper summarized the video processing image and wireless network RS image, and analyzed their development and application in urban design and layout. Based on this, this paper expounded the application of wireless network RS image in smart city design and layout, and analyzed the application prospects of RS technology in building smart city space-time information framework, RS+urban management, RS+smart environmental protection, RS+smart city agriculture and video processing technology in smart city design and planning. It analyzed the application in intelligent security, intelligent transportation and management visualization, and then used the two-dimensional discrete Fourier transform (2D-DFT) definition to strengthen the design and layout of smart cities. According to experiments and surveys, introducing 2D-DFT into the design and layout of smart cities can build a more intelligent city and improve residents' satisfaction by 30%.

Keywords: Smart City Design and planning; Wireless Network RS Image; Video Processing Technology; Two-dimensional Discrete Fourier Transform.

I. INTRODUCTION

The demand for smart city construction is growing, and smart city construction has become the main trend of regional development. In the face of relevant challenges, researchers have studied the design and development of smart cities. Therefore, this paper studied how to strengthen the research of wireless network RS image and video processing technology and make full use of wireless network image processing and RS image application to accelerate the construction and development of smart urbanization.

The application of smart city design and layout is a hot topic of current research, which has been studied and analyzed by many scholars. Nica Elvira proposed an empirical study, which aimed to evaluate and analyze the sustainable governance network in urban big data analysis and integrated smart city planning and management [1]. Caird Sally P's case study of five cities showed that the main challenge of urban evaluation methods is to select appropriate evaluation methods to prove the value and results of the city, so as to meet the requirements of urban authorities. It is recommended that the evaluation design draw on the urban research and measurement framework, and take advantage of big data opportunities to develop appropriate, effective and reliable comprehensive methods in projects, programmes and city-level development [2]. Komninos Nicos argued that the current shift towards smart cities and the intensive use of digital images to optimize urban ecosystems can be reinforced in light of the current development of smart cities [3].

Khan Huma H believed that the development of smart cities faces various challenges. He believed that many studies emphasize the importance of the concept of sustainability in the development of smart cities, but few studies pay attention to the challenges faced by the development of smart cities [4]. The purpose of Broccardo Laura was to investigate why and how multiple actors carry out different institutional work, so as to explain how to build collaborative governance in the context of smart cities [5]. Abusaada Hisham revealed the considerations and challenges of smart city design and development. He summarized some problems and made a wrong morphological analysis. Finally, he re-examined the norms and standards of social distance [6]. The above research has in-depth analysis on the application of smart city design and layout, but there are deficiencies in the application of video processing image in smart city design and layout.

Many scholars have studied and analyzed wireless network RS images. Li Jiayi found that RS practitioners are dealing with a very large and growing amount of data, providing fast and transferable machine learning images for large-scale geospatial information mining. Although some progress has been made in this image, the research of RS image interpretation based on depth learning is still in its infancy [7]. Cheng Gong said that the

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performance of RS image scene classification has been significantly improved, which has greatly promoted the planning and development of smart cities [8]. Wang Qi explored the attention mechanism under the guidance of human visual system, and proposed an end-to-end attention recursive convolution network for scene classification. It can learn to selectively focus on some key areas or locations [9].

Zhang Bin found that with the continuous improvement of the spatial resolution of satellite images, scene classification of high spatial resolution RS images has become a challenging task [10]. Huang Yanbo summarized the existing RS data resources, the latest development of RS big data management image, and RS data processing and management [11]. Kaur Sumit believed that the existence of mixed pixels in RS images is the main problem of accurate classification. He focused on two aspects of the problem of mixed pixels: identifying mixed pixels from images and marking them as appropriate categories [12]. The above studies have in-depth analysis of wireless network RS images, but lack of research on the planning and implementation of wireless network RS images in smart cities.

In order to solve the shortcomings of smart city design and layout, this paper analyzed its application and development status, and studied the application of wireless network RS image and video processing technology in it, so as to improve the application efficiency. It was concluded that the application of 2D-DFT in the design and layout of smart cities has been improved accordingly. Compared with previous wireless network RS image and video processing techniques in smart cities, the utilization of 2D-DFT has qualitatively improved for the efficiency of the service and the accuracy of data extraction.

II. Development of Smart City Design and Layout

The concept of smart cities is gradually penetrating into people's ideas. Smart city is an evolved form of city informatization. It adequately uses the new generation of information images in various fields of urban life and realizes the in-depth fusion of informatization, industrialization and urbanization, so as to improve the efficiency of urban management and the quality of citizens' life.

A. Policies and Regulations for the New Smart City Construction

By promoting the modernization of the governance system and governance capacity with information technology, coordinating the development of e-government and building an integrated online service platform, the construction of a new type of smart city can be promoted in a graded and classified manner. There is a need for a deep understanding of the role of the Internet in the management and governance of the new smart city planning and construction of society. Through the implementation of e-government and the construction of a new smart city, and through the way of data centralization and sharing, an integrated big data center has been built to achieve cross-level, cross-region, cross-system, cross-department and cross-business collaborative management and services.

1) All-round Promotion of New Smart City Construction by Multiple Policies

The construction and development of information economy is the priority of information work. It is necessary to implement a high level of concept and improve the level of information technology, public services and industrial development of urban infrastructure, thus promoting a new type of urban intelligence. Internet innovation, the Internet of Things (IoT), the information age, big data and applications, images, enhanced integration, methods to improve efficiency, urban intelligence and the fair process classification of new types of construction that serve the transparency and efficiency of non-governmental organizations provide public practices, opportunities and efficiency for immigrants and people responsible for accommodation, and remove the "barriers" of information and "location", which makes the information system unique, efficient and transparent across the country. Controllable resources include changes in information systems and facilities of services and facilities, Internet information technology projects, public services and population profits, accelerated development of social public resources, action centers, cadre industrialization centers, construction and application satellite systems, and "Internet service government", which also promote the construction of new smart cities, as shown in Figure 1.

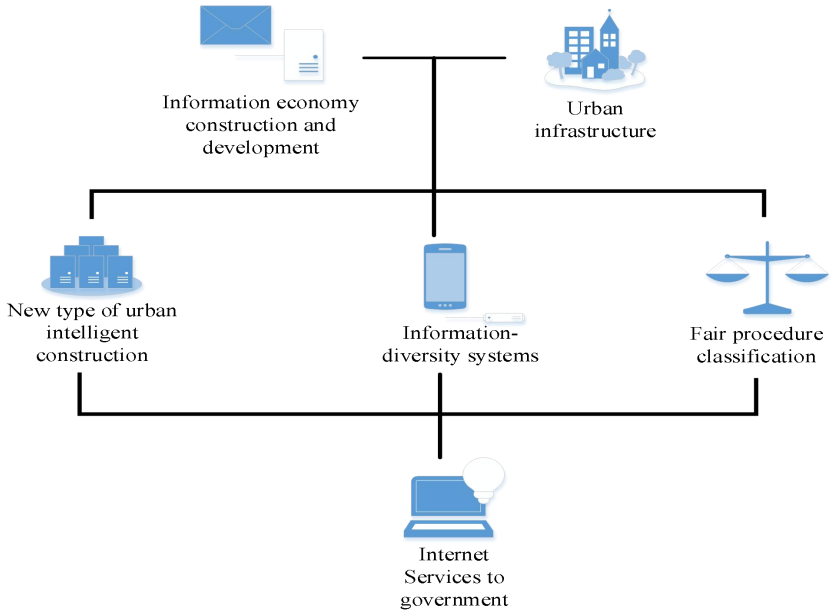


Figure 1. Promoting the construction of smart cities

B. Contents of Smart City Communication Infrastructure Planning and Construction

Due to the rapid development of society, the development of smart cities has become a hot spot at present. Various national policies promote the planning and development of smart cities, so the direction of communication infrastructure construction in the planning and development of smart cities would be discussed here. This paper would analyze from mobile network, broadband network, data center and other aspects.

1) Application of Mobile Network Construction in Smart Cities

At present, the core network of smart city is based on the fourth generation mobile communication technology (4G) network, which can prove the growth and development of smart city. The urban coverage of 4G network has almost been completed, and more than half of the cities have achieved continuous coverage of 4G network. 4G with wide coverage and high quality supports most mobile applications in smart cities with relatively high user awareness. The commercial use of the fifth generation mobile communication technology provides new impetus for the construction of smart cities. The development and commercial application of mobile networks can greatly support the construction of smart cities. Taking the construction of the fifth generation mobile communication technology network as the starting point, the fifth generation mobile communication technology industrial system can provide impetus for urban construction and promote the integration with vertical industrial applications. It permeates almost all fields of smart city construction, including municipal infrastructure, power grid, water, transportation, construction, construction, medical treatment, and even maritime management, providing real-time response and efficient linkage [13]. The application of the fifth generation mobile communication technology with low latency and high bandwidth is the current mainstream, and the demanding real-time applications such as driverless, vehicle internet, remote surgery, etc. are also promising. Therefore, the construction of the fifth generation mobile communication technology network would provide strong support for smart cities in a more intelligent direction.

2) Broadband Network Construction

In order to effectively improve broadband speed, and meet the broadband needs of urban residents in the construction of smart cities, all-electric equipment can be selected as the data information transmission network, so as to ensure high capacity and high reliability of broadband. The comprehensive coverage of urban broadband network through broadband upgrading is the basis of smart city intelligent application.

3) Smart and Secure Housing Service Construction

Smart home services have an important function in the planning and construction of global communication infrastructure, which reflects the original intention and purpose of smart city construction. Therefore, before implementing smart home services, relevant personnel need to do a good job in research and implementation of community pilot projects. After carefully reviewing and analyzing the service results, relevant personnel must scientifically and reasonably plan smart home services according to the actual characteristics and needs of

different regions, so as to meet the different needs of public, residential and commercial space. In addition, services can be provided according to the specific conditions of the region.

C. *Efficient Service Traction Smart City Application*

The exchange of government information and the establishment of data and information links should be encouraged in all sectors and levels. The popularization and application of mobile internet and intelligent mobile devices make citizens' mobile applications more extensive and service content more comprehensive.

III. Application of Wireless Network RS Image in Smart City Design and Layout

A. *Help of RS Technology to the Establishment of Spatiotemporal Information Base in Intelligent Cities*

Urban development takes place in a four-dimensional environment where space and time are intertwined. Time and space are the most effective tools for tracking urban development. Historical events cannot transcend time and space, let alone prove that geographic information maps are the most effective means to provide space-time information and construct space-time information structure. It provides a unified space-time framework for the construction of smart cities, and is an indispensable information infrastructure for urban computing. When building an intelligent city, the spatiotemporal infrastructure must assume the "skeleton and part" function of the brain: on the one hand, geographic information as information carriers, such as IoT nodes, can identify perceptible information accurately and in real time; on the other hand, it is responsible for integrating and processing spatial information analysis and decision-making.

1) Aerial Photographic Image

With the development of sensor technology, aerial photography has more and more obvious advantages in capturing spatial information. Aerial photography has become one of the main technical means to obtain high-resolution images, and is the main source of basic geographic information data such as large-scale digital terrain models, high-altitude digital models, digital images and digital linear maps.

2) High Resolution Satellite RS

At present, high resolution satellite RS is a multi-stage, polygonal and multi-domain observation system from the earth to space and even space. It has become an important tool for collecting and processing information and data, up to global detection and monitoring, interpretation, analysis and application. It can protect the earth's resources and environmental information, and create a high-resolution intelligent urban image database; it can systematize the historical data of urban landscape and integrate various satellite resources; distributed data can be integrated into a transparent continuum of time and space, and scattered non-standard RS resources can be integrated into the dynamic urban database, improving the element specifications and standards. The automatic integration of cloud-based data, quarterly data, monthly and weekly online services enables the regular generation of the latest real-time urban images, thematic RS services and big data analysis reports according to the needs of the application. In addition, various public services can be established.

3) RS of Unmanned Aerial Vehicles

Small unmanned aerial vehicle (UAV) is a new development direction of the application of modern RS technology. The location of RS image center with spatial resolution of 0.1m or higher can be used as the image source of 3D city model, and can provide a database for intelligent city visualization. Low-angle, high-resolution polygon images are the most reliable information source of 3D object texture in urban landscape. Its architecture is the main component of the three-dimensional urban landscape. Based on the existing two-dimensional data, it can easily and accurately obtain information about the height and geometric composition of buildings. Its 3D model can be obtained by retrieving low-altitude RS images and displaying textures, as shown in Figure 2.

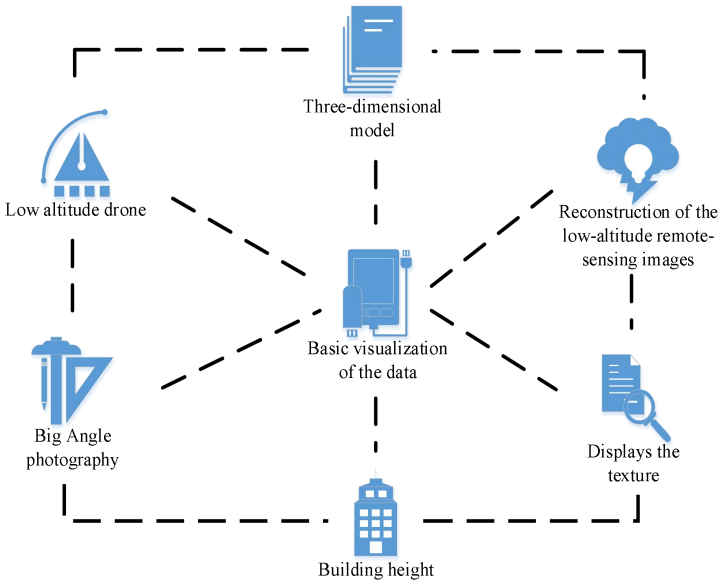


Figure 2. UAV remote sensing

B. RS+Urban Management

Urban RS data is an important source of urban information, which has great application potential in urban environmental assessment, urban planning, topographic map updating and cadastral survey. RS images are extensive and comprehensive. Combining computer image processing, image information classification and extraction, and application case studies, they provide the basis for urban investigation and dynamic identification of urban development and change.

1) Urban Land Use Survey

RS satellite images reflect the current situation of urban land use at that time. In the satellite image with a resolution of more than 2.5 meters, the boundaries of land types such as construction land, cultivated land, forest, water surface, etc. are clear, and the obvious changes of land types in the urban planning system are also easy to compare and explain. The land use survey and statistical results using high-resolution satellite images meet the requirements of urban planning land use status and urban planning land use map.

2) Urban Road Engineering Planning

Using RS satellite images to study roads plays an important auxiliary role in releasing the potential of existing urban roads and improving road conditions. The application of RS images provides accurate and up-to-date information about the distribution, length, width and density of different urban roads, which helps the urban planning department to study the existing urban road problems and the relationship between urban development and construction, and also helps to solve the problem of how road transport can make the urban social and economic development better and faster through governance.

3) Urban Planning Supervision and Investigation

The pace of modern urban construction has accelerated year by year. The effectiveness of the master plan and whether various relevant structures can provide comfort for local residents are issues that governments at all levels attach great importance to. By using point detection and element comparison technology to compare the high-resolution satellite RS images of the same region in different time periods, the planning results can be directly displayed. In addition, RS data and urban planning data can be used to compare, analyze, study and understand the current situation and challenges of cities and urban development.

C. RS+Intelligent Environmental Protection

1) Urban Water Environment Monitoring

Urban environment is an artificial environment combining natural and social environment. Pollutants are generally divided into three categories: chemical, physical and biological, including urban air pollution, water pollution, soil pollution, solid waste and heat pollution, as well as urban land use change, urban traffic, and natural disaster early warning.

Extensive RS can comprehensively understand various water diffusion processes by tracking the emission source, propagation direction, exposure degree and the mixing and dilution of pollutants and clean water, so as to determine the source and source of pollutants. Water is usually dark in color, especially in the infrared range.

Particles suspended in water disperse and reflect the light into it, which increases the albedo of water. The reflection of water increases with the increase of the suspension content. In RS images, these waters have low reflectivity and dark black stripes. The research shows that it is ideal to use color infrared image to monitor water pollution.

2) Urban Air Environment Monitoring

The integrated RS technology in urban environmental monitoring provides an effective means for monitoring and evaluating the quality of atmospheric environment. Based on the features of RS images, it is possible to monitor the level of air pollution, the location of pollution sources and pollutant transmission pathways, and to measure the level of air pollution in conjunction with field observations. Spectral analysis of direct sunlight passing through the atmosphere, light scattered in the atmosphere and clouds, and light reflected from the Earth's surface allows the determination of the levels of exhaust gases and toxic and harmful gases in the atmosphere and the monitoring of the atmospheric environment [14].

D. RS+Smart Urban Agriculture

RS technology can provide objective, accurate and timely information about plant ecology and growth.

1) Urban Crop Growth Monitoring

Yield growth is a comprehensive parameter to measure the total yield of crops. Crop growth monitoring is a macro monitoring of crops, growth conditions and changes. This attribute allows measuring leaf area index by tracking crop growth and evaluating yield. The use of satellite RS to monitor the yield of large urban agricultural areas and evaluate the results of urban agricultural production monitoring and prediction is gradually becoming an important information for urban agricultural production management and decision-making, which would bring huge social and economic benefits.

2) Urban Agricultural Structure Adjustment and Regional Development

The use of RS contributes to the spatial analysis of the adequacy of the imbalance of resource conditions, thus helping to concentrate the spatial basis and reflect the adequacy of various factors. This provides an appropriate scientific basis for guiding urban agricultural production and improving the efficiency of sustainable use of resources. Under the background of urban agricultural structural adjustment, urban agricultural zoning should determine and evaluate the quantitative impact according to the requirements of objective law, especially the geographical difference law, and determine the development and distribution law of natural conditions, and the development, change and distribution law of socio-economic conditions. Under such conditions of urban agricultural production, the quality and spatial distribution of resources are related to urban agricultural production, research, development and utilization, and the protection of these resources according to the similarity and potential, development direction and reasonable structure of territorial production complex. Policy indicators and policy measures provide a scientific basis for urban agricultural planning, as shown in Figure 3.

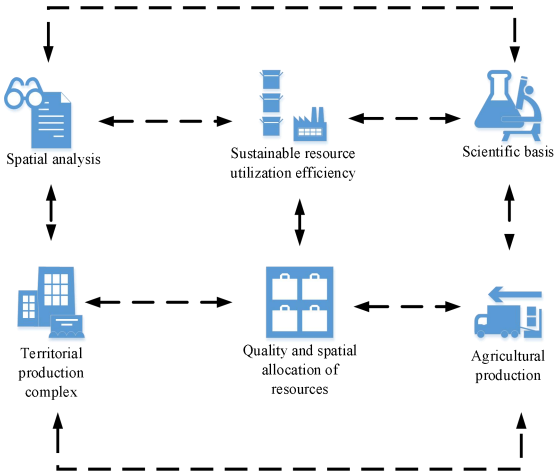


Figure 3. Agricultural structural adjustment

IV. Application Prospect of Video Processing Technology in Smart City Design and Layout

A. *Application in Intelligent Security*

As far as structured video analysis technology is concerned, its role in long-term application is significant, especially in the field of intelligent security. It is very important for employees to apply big data video technology to intelligent security. They need to regularly check the real identity information of specific personnel, that is, create a more comprehensive face database. The facial database mainly includes the facial information of people who participate in daily life and social activities. Big data video technology can be used to quickly find clues to solve disputes and problems. When using video technology, due to the limited number of face databases, there are some corresponding problems, and the corresponding technical bottlenecks gradually appear.

B. *Application in Intelligent Transportation*

In the process of smart city construction, the application of video big data technology has been widely used. In order to obtain better application effect, structured video analysis technology is also needed for data analysis and processing. Therefore, intelligent transportation is also an indispensable part of the process of smart city construction. From the current development trend, traffic big data technology and vehicle intersection data show explosive growth. As the port transit data becomes larger and larger, the entire road system becomes slower and slower, and the user experience becomes worse and worse, thus the corresponding traffic efficiency is also greatly reduced. In this regard, it is needed to use big data video technology to process relevant information. Through distributed and parallel nodes, the data processing capacity can be improved to the maximum extent, and ultimately the traffic construction process of smart cities would be more reliable, safe and economic [15], as shown in Figure 4.

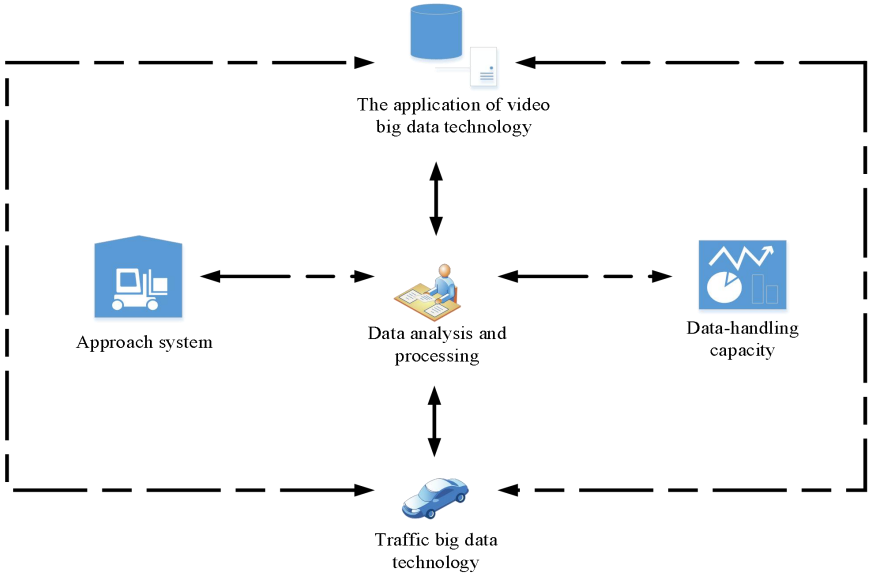


Figure 4. Application of video processing technology in intelligent transportation

C. *Application in Management Visualization*

The application of big data video technology can promote visual control to a new level. For example, in the field of architecture, big data video technology plays a key role in the construction of smart venues. It focuses on construction process management and establishes computer ecosystem projects such as interconnection, security monitoring and intelligent manufacturing. It should effectively perform the hierarchical supervision function to meet the different needs of construction projects at different levels.

V. Design and Layout of Smart Cities Strengthened by the Definition of 2D-DFT

In the development of signal processing and analysis technology, DFT has played a great role. With the development of digital watermarking technology, 2D-DFT domain watermarking technology has also been widely used in the design and layout of smart cities. A still image of a smart city can be regarded as a two-dimensional data array. Therefore, the following is mainly about 2D-DFT.

$I = f(x, y)$ is used to represent a static, flat, monochromatic smart city image.

The 2D-DFT forward transform formula is:

$$f(u,v)=\frac{1}{MN}\sum_{x-0}^{M-1}\sum_{y=0}^{N-1}e^{-yu(ux/M+vy/N)} \tag{1}$$

Among them, $u=0,1,2,3,M-1;v=0,1,2,N-1$.

The inverse transformation is:

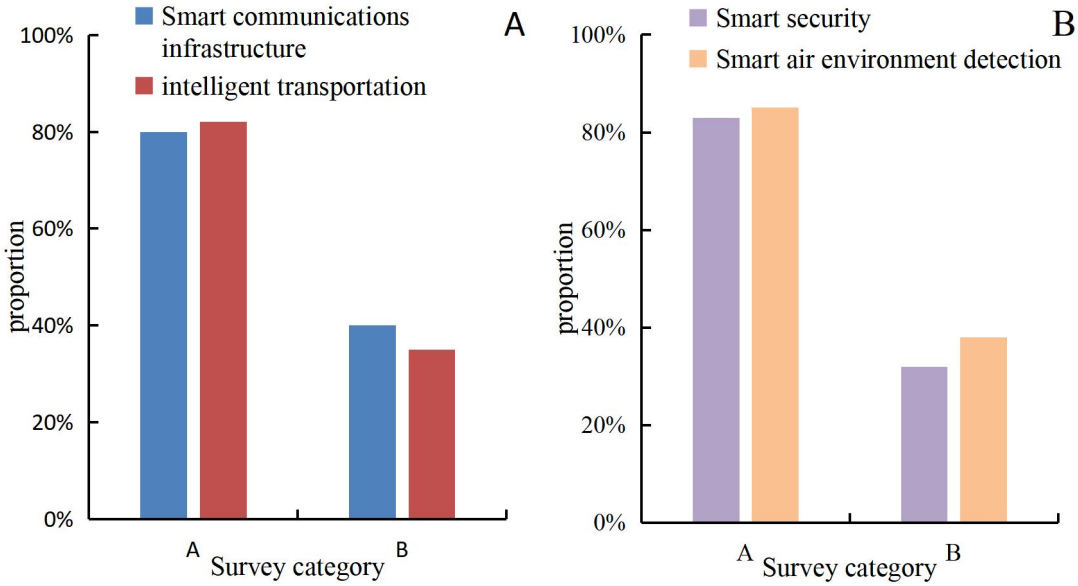
$$f(x,y)=\sum_{u-0}^{M-1}\sum_{v-0}^{N-1}f(u,v)e^{vu(ux/M+vy/N)} \tag{2}$$

Among them, $x=0,1,2,3,M-1;y=0,1,2,N-1$.

In smart city image processing, the image is generally sampled as a square display, as long as $M=N$ is set in Formula (2).

VI. Optimization of Smart City Construction Survey Experiment with 2D-DFT

At present, urban construction is in the transition stage between the old and new management models, the rapid growth of urban population and the prosperity of information technology. The emergence and construction of smart cities is part of the current political, social, technological and practical background. Through the analysis of the application of wireless network RS image and video processing technology in the planning and development of smart cities, the construction and perfection of smart communication infrastructure, smart transportation, smart security and smart air environment detection in the development and planning of smart cities in the two cities were investigated by means of questionnaires. The two cities were set as A and B respectively. City A did not use wireless network RS image and video processing technology, while City B used wireless network RS image and video processing technology, as shown in Figure 5.



A: Smart communication infrastructure and smart transportation

B: Smart security, smart air environment detection

Figure 5. The development and planning of the two cities in four aspects of construction

Figure 5A shows the smart communication infrastructure and smart transportation of cities A and B. Figure 5B shows the detection of smart security and smart air environment in cities A and B. From Figure 5A, it can be seen that cities A and B have different situations regarding the proportion of smart communication infrastructure and smart transportation in the design and layout of smart cities. Among them, the perfection of smart communication infrastructure in City A accounted for 80%, and the perfection of smart transportation accounted for 82%. In city B, the perfection of smart communication infrastructure accounted for 40%, and the perfection of smart transportation accounted for 35%.

From Figure 5B, it can be seen that cities A and B differed in the proportion of smart security and smart air environment detection in the design and layout of smart cities. Among them, the perfection of smart security in

City A accounted for 83%, and the perfection of smart air environment detection accounted for 85%. In City B, the perfection of smart security and detection of smart air environment accounted for 32% and 38% respectively.

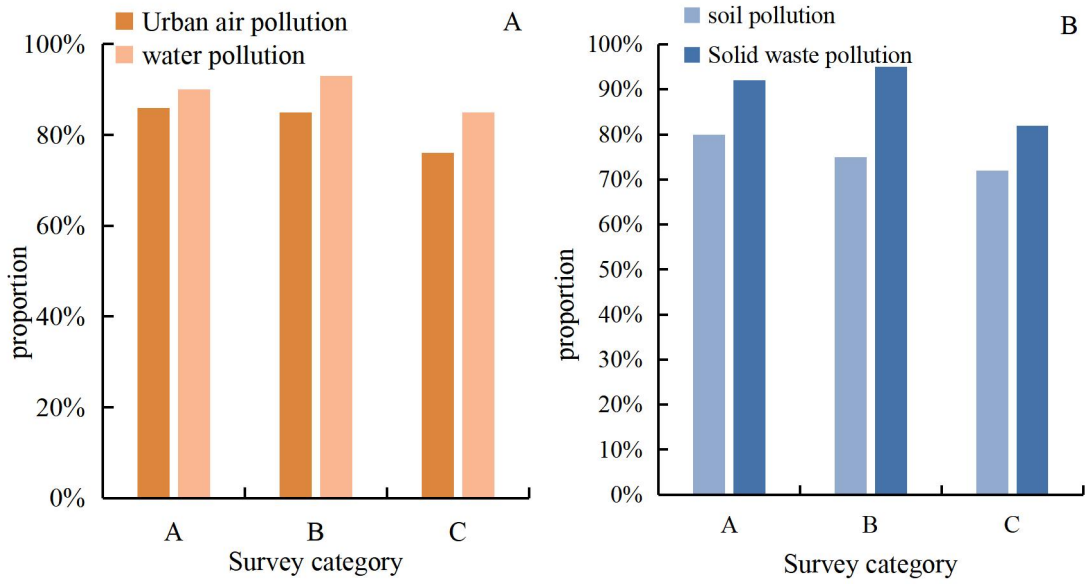
In order to investigate the application of wireless network RS images in smart city design and layout in detail, three regions were selected. In the form of questionnaire survey, the opinions of relevant company personnel in the three regions on the current data systematization, visualization data, land use design and layout were investigated. The three regions surveyed were set as A, B and C, and the number of people surveyed was 300. The specific effect is shown in Table 1.

Table 1. Application of wireless network RS image in smart city design and layout

	Data systematization	Visualization data	land use status
A	66%	72%	80%
B	64%	68%	85%
C	70%	75%	86%

It can be seen from Table 1 that the personnel of relevant companies in Region A thought that the current wireless network RS image application in smart city design and layout accounted for 66% of data systematization and 72% of visual data; land use accounted for 80%. The personnel of relevant companies in Region B believed that the current wireless network RS image application in smart city design and layout accounted for 64% of data systematization and 68% of visual data; land use accounted for 85%. The relevant company personnel in Region C believed that the current wireless network RS image in the application of smart city design and layout accounted for 70% of data systematization and 75% of visual data; land use accounted for 86%.

In order to enhance the current effect of smart city construction, this paper introduced 2D-DFT into the smart city design and layout system, and constructed a more complete smart city design and layout scheme. In order to investigate the practical application effect of the new smart city design and layout, the new smart city design and layout scheme was introduced to three regions for evaluation. After a period of experiments, 100 personnel from urban pollution-related departments in three regions were surveyed by questionnaire, and the decline of the four aspects of urban air pollution, water pollution, soil pollution and solid waste pollution that the personnel from various urban pollution-related departments thought about the new smart city were investigated respectively. The specific results are shown in Figure 6.



A: Urban air pollution and water pollution
B: Soil pollution and solid waste pollution

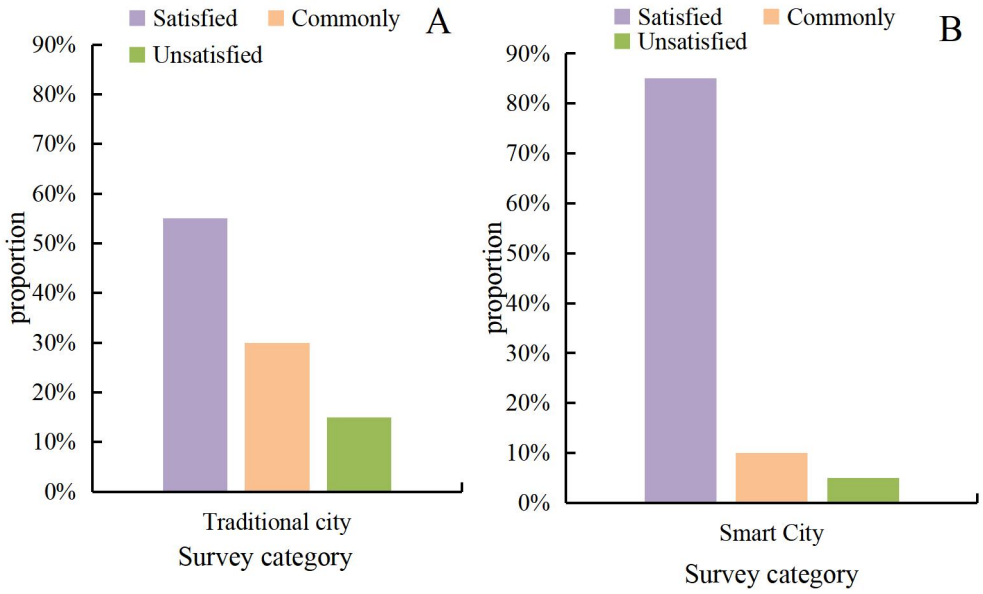
Figure 6. The practical application effect of the new smart city design and layout

Figure 6A shows that the personnel of the three urban pollution-related departments believed that the new smart cities had different degrees of decline in urban air pollution and water pollution. Figure 6B shows that the personnel of the three urban pollution-related departments believed that the decline of the new smart city in terms of soil pollution and solid waste pollution was different. According to Figure 6A, the relevant personnel of the urban pollution control department of Region A believed that the reduction of urban air pollution was 86% and

that of water pollution was 90%. Relevant personnel from the urban pollution control department of Region B believed that the reduction of urban air pollution was 85% and that of water pollution was 93%. Relevant personnel from the urban pollution control department of Region C believed that the reduction of urban air pollution was 76% and that of water pollution was 85%.

According to Figure 6B, the relevant personnel of the urban pollution control department of Region A believed that the reduction of soil pollution was 80% and that of solid waste pollution was 92%. Relevant personnel from the urban pollution control department of Region B believed that the reduction of soil pollution was 75% and that of solid waste pollution was 95%. Relevant personnel from the urban pollution control department of Region C believed that the decline of soil pollution was 72% and that of solid waste pollution was 82%.

In order to investigate the difference between traditional cities and smart cities, this paper compared the residents' satisfaction with the application of traditional and smart city design and layout, and surveyed 100 residents of a city, with satisfaction being satisfied, average and dissatisfied. The specific effect is shown in Figure 7.



A: Traditional urban design and layout
B: Smart city design and layout

Figure 7. Residents' satisfaction with the application of traditional and smart city design and layout

Figure 7A shows the satisfaction of urban residents with traditional cities, and Figure 7B shows the satisfaction of urban residents with smart cities. It can be seen from Figure 7A that 55% of the surveyed urban residents were satisfied with the traditional city, 30% were general, and 15% were dissatisfied. It can be seen from Figure 7B that the residents of a city surveyed were satisfied with 85% of the smart city, 10% with general attitude, and 5% with dissatisfied attitude. According to the experimental survey, the 2D-DFT was introduced into the smart city design and layout system, and the satisfaction of the emerging smart city was improved by 30% compared with the traditional city.

VII. CONCLUSIONS

In short, with the development of modern technology, the application of wireless network RS image and video processing technology in smart city design and layout is also developing. The development of new technologies promotes the development of smart cities to a certain extent. The further improvement of the design and layout of smart cities meets the requirements of contemporary people for material life, and meets the yearning for intelligent and scientific life. This paper analyzed the application and development status of smart city design and layout, and studies the application of wireless network RS image and video processing technology in it, so as to improve the application efficiency of wireless network RS image and video processing technology in smart city design and layout. Moreover, the 2D-DFT was introduced with a view to making further contributions.

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