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Research Article

Characteristic Analysis of Multisource Heterogeneous Data in Digital City Planning Based on Internet of Things

Xiao Xiao

Shandong Agriculture and Engineering University, Jinan 250100, Shandong, China

Correspondence should be addressed to Xiao Xiao; z2013191@sdaeu.edu.cn

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The purpose of this article is to use the Internet of Things related technology to analyze the characteristics of multisource and easy-to-purchase data for the different types of planning data and different levels of cognitive needs of participants in the entire urban planning process. This paper uses the ontology idea to reconstruct the relationship between multisource and heterogeneous planning data including Internet of Things data, planning documents, and planning drawings, to design the data semantic relationship of the ontology model elements, define the relationship between the data types, and implement the ontology-based method. The semantic expression algorithm in the planning field facilitates the exchange of various planning participants' understanding of the planning scheme, at the same time, according to the classification of multisource heterogeneous data features, logical reasoning of ontology relationships, filtering redundant information, and multisource heterogeneous planning data visualization. Finally, the information of the same nature collected by the sensor nodes of the Internet of Things is batched, and the calculated fusion information is closer to the true value through a series of weighting formulas. Experiments prove that the feature analysis method proposed in this paper can maintain a loss of 0.02% and achieve an accuracy rate of 79.1% when the overall characteristics of digital city planning are reduced by 67%, which effectively proves the multisource heterogeneous data feature analysis for digital city planning importance.

1. Introduction

With the rapid development of modern information technology, digital city management becomes an important means for urban planning technology methods, design concepts, management mechanisms, and implementation [1]. The mode of market-based operation of information collection is essentially the method of "the government spends money on services, but does not support people". This is also the current mainstream thinking. It enables the government to unburden its burdens, evade management conflicts, and reduce management costs. The operation of the market-based operating mode of information collection frees the government from the burden of personnel management and concentrates on functional management [2]. At the same time, it also strengthened the general public's awareness of active supervision and participation in politics. The marketization of information collection is done by attracting specialized information collection service companies to engage in information collection services, and information collection service companies are more professional in personnel management, business operations, and technical support, and more standardized now, a large number of wireless sensor networks for information collection or target monitoring and other tasks are completed through their own sensor nodes [3]. Due to the huge number of nodes, all nodes are used to jointly transmit data to the sink node, resulting in a large number of redundant information, which will cause a lot of waste of communication bandwidth, make some valuable resources not fully utilized, greatly reduce the efficiency of information collection, and affect the real-time operation of information [4, 5]. For the above description problem, people began to use a technology called data fusion. The data fusion mentioned here refers to the process of integrating many unordered data and information to get more and more efficiency and meet the needs of users [6]. In modern Internet of Things network applications, more often than not, we only pay attention to the monitoring results. The process is not particularly fancy. A large amount of raw data is not very important for the results, and data fusion is a kind of problem for this type of problem, powerful means [7].

Digital city refers to the use of digital city theory; comprehensive use of key technologies such as geographic information systems, remote sensing, telemetry, network, multimedia, and virtual simulation; in-depth development and application of spatial information resources; automatic collection and dynamic monitoring of urban infrastructure and functional mechanisms; and technical system for management and auxiliary decision-making services [8]. It includes two aspects: spatialized, networked, intelligent, and visual technology systems and urban system systems based on spatial information [9]. In the traditional urban management model, there are shortcomings such as untimely information, passive management, unclear responsibilities, extensive methods, and lack of effective supervision and evaluation mechanisms. To solve the problem of the implementation of the digital city management model in Dongcheng district, Beijing, breakthrough progress has been made in urban management, greatly improving work efficiency and reducing operating costs [10, 11]. The new model of digital city management is to use a combination of "10,000-meter cell grid management method" and "urban component and event management method" to apply many new digital city technologies such as computer network technology, 3S technology, and database technology. And integration developed the information collector urban management link to realize the process of real-time information collection and transmission, creating a two-axis management system of the city command center and management supervision and then creating a city management system, thus achieving precision, speed, efficiency, and the whole process. A city management model with all-round coverage [12, 13]. The core of the new model of digital city management information system is the innovative management model. It promotes management improvement through informatization; builds a set of scientific and standardized city management models, intelligent management methods, and long-term management processes; quickly achieves results; and continues to play a role [14, 15].

Due to the rapid development of the Internet of Things theory, technical research, and application, the digital form of Internet of Things data continues to increase. How to better manage and use data from multiple data sources, different industries, different departments, and different scales is in the field of Internet of Things applications. The key issue is that the digital city planning of the Internet of Things is one of the important fields of GIS application. Urban planning data has both geographic data and characteristic data in the planning field. Multisource heterogeneity constitutes the main characteristics of urban planning data [16, 17]. Digital city planning is a digital method to achieve the effective allocation and rational arrangement of urban space resources. It is a sustainable and effective means of adapting to urban development and changes. It covers every aspect of the urban planning business [18]. The tasks of digital city planning include digital on-site investigation and analysis, digital planning and design, digital planning and design plan review and report construction, and digital planning management [19].

This article mainly analyzes and constructs mathematical models based on the multi-source heterogeneous data characteristics of traditional Internet of Things network data, which will cause high computational complexity and other problems. Combining network and data fusion technology, a Kalman filtering batch estimation fusion algorithm based on the extension of IoT wireless sensor network is proposed. The algorithm is mainly to batch the information of the same nature collected by the sensor nodes of the Internet of Things and make the calculated fusion information closer to the true value through a series of weighting formulas starting from energy saving at the source, by reducing the amount of data transmission and thereby reducing the energy consumption in the transmission process, to achieve the purpose of extending the entire network life cycle. The simulation shows the effectiveness and practicability of the algorithm proposed in this paper, which saves the energy of data fusion and can still maintain a loss of 0.02% to achieve an accuracy rate of 79.1% when the overall characteristics of digital city planning are reduced by 67%, proving the importance of multisource heterogeneous data feature analysis for digital city planning.

2. Proposed Method

2.1. *The Characteristics of Urban Planning in the Era of Internet of Things*

2.1.1. The Internet of Things Promotes the Transformation of Traditional Urban Planning to the Era of Big Data. In the initial stage of urban planning, the planning work was frequently carried out with the help of questionnaire surveys, statistical methods, and analysis of existing reference materials. However, in the era of big data, urban planning departments can use IT technology to plan urban spaces and can use smaller data as parameters to analyze and process urban planning-related data, which not only improves the efficiency of planning but also reduces cost.

2.1.2. Urban Planning in the Era of the Internet of Things Is in Line with the Trend of the times. The traditional urban planning work mainly uses backward planning techniques and methods, which obviously cannot meet the pace of development of the times and is eventually eliminated in the process of urban planning development. In the era of big data, the use of IT technology to process urban planning-related data, the application of advanced technology has greatly improved work efficiency and ensured the quality of planning. Therefore, urban planning in the era of big data conforms to the trend of the times.

2.1.3. The Era of Big Data Has Improved the Efficiency of Urban Planning. Since the traditional urban planning method is single and the planning methods used are relatively backward, most of the urban planning investigation stage still uses manual data collection, and the analysis for the later investigation is still done manually. This processing method affects the accuracy of the data to a certain extent, which is not conducive to the development of urban spatial planning, and the traditional planning method also consumes a lot of manpower, material resources, and financial resources. In the era of big data, the use of IT technology can directly process relevant data and realize the transformation of urban planning from artificial to intelligent. Staff can make various decisions in urban planning only through relevant procedures.

2.2. Urban Planning Path in the Era of Internet of Things

2.2.1. Build a Multi-Intelligence and Coordinated Collaborative System. Normally, urban development planning mainly includes urban planning, land management, and economic development. Each of the above aspects must be involved in the preparation of urban planning, but they can be allowed to play freely according to their professions. However, there are some shortcomings in this form. The common ones are as follows: it is difficult to merge the various professional fields in the end so that there are so many types of resource data. In the initial stage of planning, each field is independent so that the final summary planning stage of unification is still impossible, let alone cooperating with each other to complete the plan. The direct consequence of this phenomenon is that after the project planning, it is not conducive to the sustainable development of the city. Although the relevant departments have put forward many strategies to solve the above problems, the effect is still not good. In the era of big data, you can try to build an intelligent multirule synergy system and use multirule synergy as the basic blueprint for urban planning, thereby reducing the confusion in urban construction and ensuring urban health and sustainable development.

2.2.2. Build a Digital Spatial Characteristics Planning System. The urban physical space planning is mainly composed of four stages: the urban space development strategy; the evaluation and evaluation of the urban space; the conjecture of the urban development scope; and the distribution of the urban space skeleton. In the era of big data, the construction of a digital spatial characteristics planning system can be started from four aspects: first, the basic indicators of urban space growth and development programs should be social development planning and national economic development planning, which requires a clear grasp of the interaction between different regions of network connection, analyzing in advance the requirements of urban subjects in space development, to ensure the rationality and reliability of the deployment of urban development plans. Second, the evaluation and evaluation of urban space should be based on a perfect and compliant system, to make full use of local resource information network facilities and various social new media channels to collect the opinions and suggestions of the people, to accurately grasp the majority of residents satisfaction with urban space quality, find out the problems existing in different regions, and analyze the causes of space defects in order to explore effective solutions. Third, we can use the relevant data such as smart buses, mobile smartphones, GPS positioning systems for taxis, and land resource allocation to understand the distribution of urban population, to guess the scope of urban development. Through the above-mentioned ways, we can also understand the changes in population land use, which is convenient for scientifically predicting the optimal capacity range of urban space development in the future. Fourth, in the construction of urban space, it is necessary to deeply analyze the relationship between government departments, enterprise departments, and residents. The relationship between the three and the construction of urban space must not be overlooked. In a word, in the era of big data, urban planning cannot adopt partial division and must be considered comprehensively. Only in this way can the rationality and scientificity of urban space be guaranteed.

2.3. Heterogeneous Data Fusion Algorithm Based on Internet of Things. The Internet of Things realizes the interconnection of things and things, and its main function is to reduce the distance between the physical world and information systems. The bottom layer of the physical network can be connected to the wireless network, RFID, and personal area network. The network for the crop domain is the same as the network shrinkage. The physical connection layer is connected to the heterogeneous fusion network of the Internet of Things, thereby forming a widely interconnected network. The Internet of Things is composed of various heterogeneous networks. Therefore, the Internet of Things generates a lot of redundant information, resulting in a waste of communication bandwidth and poor real-time performance. How to integrate these data has become a problem that must be solved. Data fusion technology can effectively solve the above problems. In the Internet of Things, the fusion of perceptual information only transmits a small amount of meaningful information to the sink node, greatly reducing the amount of data transmission and improving the real-time nature of the Internet of Things. At present, there is relatively little information about data fusion in the Internet of Things, mainly concentrated in the decision-making layer. No one has proposed to fuse data from three aspects of time, space, and attributes. This paper proposes an algorithm that includes time, space, and attribute fusion at the same time. The algorithm first fuses the original data in time and space and then on the basis of the data fusion attribute.

As a new generation of communication networks, the main features of the Internet of Things are as follows: first, it expands the network connection objects and realizes the multidimensional interaction between people, computers, and objects. The Internet of Things can bring all kinds of objects in the world into the network to realize data transmission and information sharing among each other. The second is to enrich the connotation of intelligent management and achieve comprehensive management of information and goods. In the Internet of Things, people use this network to establish contact with items through information, manage various items through the network, and realize automatic identification and remote monitoring of items. The third is to expand the information transmission channels, realize the wired and wireless use of the Internet of Things, and widely use wireless mobile communication data transmission. The Internet of Things widely uses radio frequency identification and sensor technology. The interconnection of the entire network is more based on wireless communication technology. Mobile phones will become the most common input and output terminals like computers.

Time effectiveness: the underlying network of the Internet of Things is composed of a variety of heterogeneous networks. The data types of each network are different, the expression is different, and the effective win of the data is also different. The Internet of Things needs to process, transmit, and utilize data within a certain time frame, to effectively reduce the amount of network transmission, balance the load, and improve real time.

Spatial fusion: suppose $S = (s1, s2, s3, \ldots, sn)$ is the identification of node data, and the sink node can judge whether the number of nodes is in the same range according to the mark. There is a spatial correlation between the data of each node of the same type. After receiving multiple spatial correlation data, perform fusion calculation counting, summing, averaging, and so on, and then pass the data to the sink node.

The data collected by each node of the Internet of Things is massive, multisource, and heterogeneous. The data fusion based on the decision layer is integrated into the Internet of Things. The purpose is to eliminate the redundancy and uncertainty of the data. At present, the commonly used classification-based fusion methods include Bayesian inference, fuzzy sets, and D-S evidence theory. These algorithms have different degrees of defects in different degrees. Relatively speaking, rough set theory is superior to Bayesian inference, fuzzy set, D-S evidence theory, and other methods when dealing with uncertainty. And the advantage of rough set theory is that it does not need to provide any prior information beyond the basic data. Through the simplification of knowledge and the analysis of knowledge dependence, the decision rules are completely derived from the known data. However, the efficiency of the traditional rough set theory is not high. A genetic algorithm is introduced into the rough set theory to improve the efficiency of data fusion. The genetic algorithm is an effective optimization technology, and its characteristic parallelism has obvious advantages for large and complex search problems.

3. Experiments

3.1. Experimental Data Set. In this paper, the temperature in the room detected by the Internet of Things is the experimental object, and the effectiveness of the proposed method is verified. 12 nodes are distributed together in a range. The temperature, humidity, environmental noise, and other related factors in the range are collected through the gathered nodes to the nodes of the indoor city planning model. Then, each node will automatically establish an optimal Path; this article will analyze the data features at the intersection of the path.

At the same time, in facility management, by implanting radio frequency identification chips on various city management components such as street lamps and billboards, the city management facility information can be quickly collected and dynamically updated; the second is vehicle monitoring, through the development of vehicle GPS grid management system to realize GPS monitoring of vehicles such as law enforcement, slag transportation, sanitation, and transmit vehicle position and route information to the supervision and command center in real time through the wireless network, which is convenient for the supervision and command center to implement dispatching and illegal monitoring; third, street light monitoring through the system flexibly formulates the time and method of switching lights, grasps the running status of lighting equipment in real time, and finds lighting equipment failures in time; fourth is video surveillance, through the video surveillance system on the digital city management platform, to the project site, industrial and commercial areas, and other key areas of monitoring and management; and fifth is noise monitoring through the installation of noise sensors to implement the collection and supervision of noise in key areas such as construction sites. In addition, the Internet of Things technology can also be applied to achieve real-time information monitoring and data analysis of various city daily operating indicators such as electricity, water quality, sewage, gas, heat, transportation, sanitation, and air and can be integrated into a digital city management system.

3.2. Experimental Environment. Under the Windows operating system, all the experiments in this paper were conducted on the laptop computer 8G RAM, Inter I7 computer, and the experimental environment was MATLAB 7.0. To ensure the accuracy and stability of the experimental data, it is necessary to use python to preprocess and analyze the data in the early stage of data processing and remove the data for some special value data.

4. Discussion

4.1. Analysis of the Characteristics of Urban Digital Planning.

(1)

Spatial features, spatial reference features refer to the spatial coordinates, spatial location, and spatial distribution of planning data in a unified geographic reference. In urban geographic coordinates, planning data always expresses the graphic data of a certain spatial unit (plot, census plot, street office, road section, etc.) or spatial entity and the attribute data of this unit or entity. For example, subway lines and subway stations have certain spatial positions, as well as graphical information describing their geometric shapes and attribute information describing their characteristics. Spatial topological characteristics refer to the spatial relationship between spatial entities in the planning data. The topological relationships between different spatial entities

Table 1: Passenger feature categories in the study area.

	Number of passengers	Plot	Census tract	Street office	Road section
Boarding	123	23	32	27	50
Get off	131	35	37	33	26

include intersection, adjacency, inclusion, and connectivity. Here, this paper selects a certain area of Kunshan city as the research object, as shown in Table 1. According to the spatial location information extracted above, it can be found that the location points of passengers getting on and off are mostly concentrated on both sides of the road, and compared with the distribution of getting off points, the distribution of passengers getting on the car is more concentrated. Most taxis use the roadside "beckoning" to carry passengers with the same operating characteristics, and the passenger's drop-off position will be as close as possible to its real travel destination; that is, the taxi pick-up and drop-off positions generally exist with the passenger's actual travel starting and ending positions difference. Therefore, to further analyze the similarities and differences between taxi passengers "hotspot and disembarkation hotspot areas, the above methods will be used to analyze the taxi passengers" pick-up and drop-off positions in the selected area. On this basis, this article comprehensively considers the location information of taxi passengers getting on and off and performs hotspot analysis without distinction. The final results of the above three situations are shown in Figure 1.

(2) It can be found that the distribution of taxi passengers "boarding hotspots and disembarkation hostspots" in the study area almost overlap in their positions, that is, the hotspot area for passengers is often where the hotspot for passengers getting on the bus is. Based on the distribution of land use properties in the studied area, it can be found that the distribution of taxi hotspot areas coincides with the distribution of land use properties with obvious travel generation and attraction characteristics. These areas include large residential distribution areas; commercial and entertainment areas are shown in Figure 2.

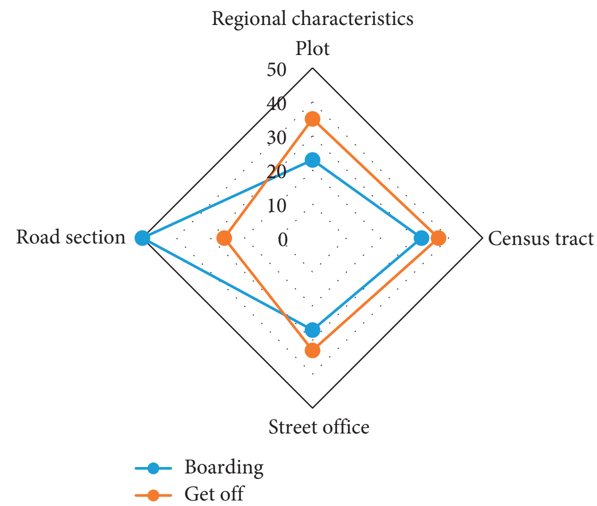

Figure 1: Differences in passengers' choices of location in different areas.

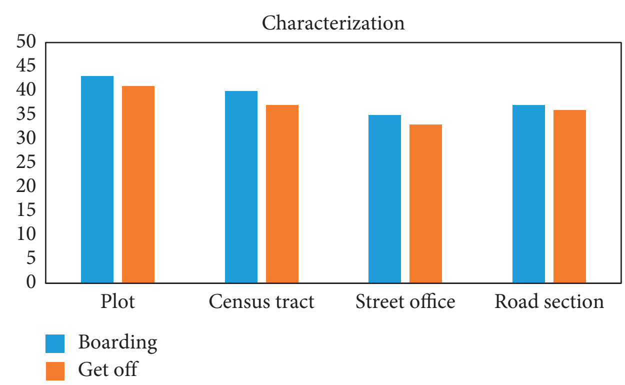

Figure 2: Different passenger choices in different areas.

Table 2: The importance of digital city planning features.

	Dimension	Noise	Position	Humidity
Business area	67	71	63	53
Industrial area	56	45	56	76
Residential area	85	83	62	67

4.2. City Characteristics Internet of Things Data Characteristics Analysis

(1) In this paper, the ambient temperature at that time was calculated by the calculation method to be 25.30 degrees celsius, so as shown in Table 2, the data feature extraction and analysis algorithm proposed in this paper can obtain data very close to the true value. To illustrate the generality of the algorithm in this paper, different nodes were fused and tested separately. The simulation results are shown in Figure 3. It can be seen that the multisource data analysis method also has a great effect on energy saving.

(2) Through the analysis of many feature data, the Internet of Things feature data is extracted from the urban digital features as shown in Table 1. The importance of the extracted features is analyzed, and different weights are given to different features to obtain the relative for accurate digital city planning multisource heterogeneous data feature analysis results. Through experiments, it was found that different characteristics such as noise and

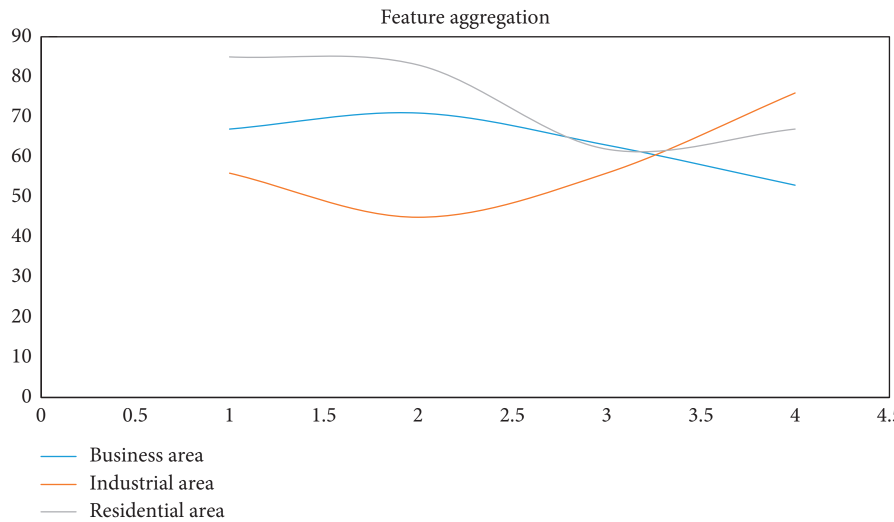

Figure 3: Analysis of temperature feature fusion.

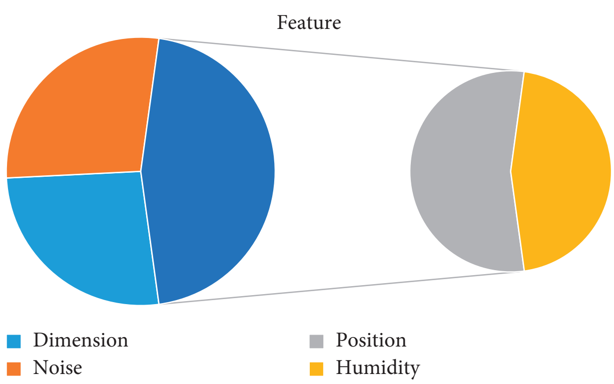

Figure 4: Feature analysis importance analysis.

temperature account for 70% of the urban planning, which will have an important impact on urban planning. Compared with taxi rear planning, the ability to perceive environmental information is stronger than Figure 4.

5. Conclusions

In urban planning, it is inevitable to count and analyze the relevant data of the urban development status and then formulate a reasonable urban planning plan based on the data. This original survey statistical method is only applicable to the initial stage of urban planning. However, with the development of urbanization and the systematization of social life in recent years, it is more difficult to obtain data related to urban development as a whole. Especially in the era of big data, the data itself is in a dynamic development state. Therefore, in the era of the Internet of Things, it is necessary to innovate the way of obtaining urban planning data, make full use of various modern information tools and means, and integrate all aspects of social development into urban planning. In summary, in the era of big data, the way of urban planning has undergone tremendous changes. The arrival of the era of big data has greatly promoted the integration of urban planning with international standards and promoted the development of urban planning and economy. But big data is not a panacea for solving urban planning problems. In the era of big data, urban planning staff should combine big data analysis methods with traditional research methods to ensure that urban planning results are more objective, scientific, and fair.

The Internet of Things connects all objects in the world to Xinzi and the network by accessing various heterogeneous networks, reducing the distance between the physical world and the information system. Combining the data of the Internet of Things with time and space characteristics, this paper integrates various heterogeneous data of the Internet of Things in terms of time, space, and attributes, which improves the real-time nature of the Internet of Things and reduces the redundancy of the Internet of Things data and the bandwidth of the Internet of Things. The application of the Internet of Things technology in the digital urban management system is more and more extensive, which not only brings innovation and reform of the digital city management technology but also effectively saves the cost of urban management and improves the level of public service management. With the in-depth development of the Internet of Things technology, digital city management will develop towards smart city management, thereby generating higher social and economic benefits.

Urban planning and urban management, especially the foundation of the urban management information system is data. The data involved in urban planning is very different due to different acquisition methods, data formats, and data structures. These multisource heterogeneous data give urban planning. In particular, the informatization of cities brings great difficulties in utilization and processing. Analyzing and summarizing these data characteristics can provide useful exploration for the method of multisource heterogeneous data fusion and integration and the analysis, processing, and utilization of data.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares no conflicts of interest.

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