Research Article

Optimization of Electronic Data Investigation Mode Based on Intelligent Perception and Positioning Technology

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The exploration reported here is aimed at obtaining the geographic information and ecological information of the user’s specific location to understand the real-time needs of the user and provide users with accurate and timely services. Firstly, intelligent sensing and positioning technology is introduced under the background of big data. Then, the Geographic Information Systems (GIS) and Location-Based Service (LBS) technology are sketched out. Besides, an environmental intelligent perception and positioning model is proposed based on the GIS technology, LBS technology, and visible light propagation model. Finally, the proposed model is verified by experiments. The research results demonstrate that the environmental intelligent perception and positioning model can improve the positioning ability and efficiency of the users’ location and significantly enhance the accuracy of the location of the target. The positioning accuracy of the positioning system based on GIS combined with LBS reaches more than 80%, meeting the positioning requirements in daily life. Therefore, the research reported here provides a new perspective and new method for intelligent perception, makes a guarantee for further improving the efficiency of user work and life, and sets an example for future research.

1. Introduction

With the further expansion of China’s urban scale, the increasing population, and the continuous development of various electronic information technologies, the emergence of diverse intelligent technologies and equipment has completely changed the life and learning style of people. Smart devices carried by device users and the growing popularity of Internet of Things (IoT) facilities can not only connect to the Internet anytime and anywhere, but also feel the user’s movements and changes in the environment at any time. When the smart device can obtain the user’s movements and the changes of the surrounding geographical environment and ecological environment, it can help users to improve their limited perception range [1, 2] and help users to expand their perception.

Big data technology refers to the application of big data to solve problems. Big data denotes a large-scale data collection that greatly exceeds the capabilities of traditional database software tools in terms of acquisition, storage, management, and analysis [3]. It has four major characteristics, namely, massive data scale, fast data circulation, diverse data types, and low value density. Intelligent perception involves visual, auditory, tactile, and other perceptual abilities. Both humans and animals can interact with nature through various intelligent perception abilities. For example, autonomous vehicles obtain intelligent perception ability by sensing equipment like laser radar and other artificial intelligence algorithms [4]. Machines have more advantages than humans in perceiving the world, since human beings perceive the surroundings passively, but machines can perceive the environment actively, such as laser radar, microwave radar, and infrared radar. Either a
2. Construction of the Intelligent Perception and Positioning Model

2.1. Big Data and IoT Technology

2.1.1. Big Data Technology. Big data refers to the data set that cannot be captured, managed, and processed by conventional software tools within a certain period. It is a massive and diversified information asset with high growth rate that requires a new processing model for stronger abilities of decision-making, insight, and optimization [9, 10].

Here are the multiple advantages of big data:

(a) Better decision-making: big data analysis can provide business decision-makers with the data-driven insight they need to help enterprises compete and develop their business and improve productivity. In addition, the insights gained from these analyses often enable organizations to improve productivity more widely throughout the company and reduce costs.

(b) Improve customer service: social media and customer relationship maintenance systems can provide enterprises with much information about their customers. Naturally, they will use these data to serve these customers better.

(c) Fraud detection: another common use of big data analysis is fraud detection, especially in the financial services industry. One advantage of big data analysis systems that rely on machine learning is that they are excellent in detection.

(d) Increasing revenue: when organizations use big data to improve decision-making and customer service, increasing revenue is usually a natural result, improving flexibility.

(e) Better innovation: innovation is another general interest of big data.

The most prominent feature of big data is the huge size beyond the analysis capability of traditional data processing software such as Excel and MySQL. This also means that in the big data era there will be completely different processing technologies for either data storage or data processing, such as Hadoop and Spark. Within the enterprise, data experiences various processing processes from production, storage, analysis, to application, and interrelates with each other, forming the overall architecture of big data. Figure 1 illustrates the basic architecture of big data [11].

For big data technology, there are usually the following processing steps for data before the finalizing data report or algorithmic prediction by data:

(a) Data acquisition: it refers to the synchronization of data and logs generated by the application into the big data system.

(b) Data storage: massive amounts of data need to be stored in the system to facilitate the next use of queries.

(c) Data processing: the original data needs to be filtered, spliced, and converted to be finally applied, collectively called data processing. Generally, there are two types of data processing. One is offline batch processing, and the other is real-time online analysis.

(d) Data application: the processed data can provide services to the outside world, such as generating visual reports, providing interactive analysis materials, and providing training models for recommendation systems.

2.1.2. IoT. The IoT technology is an emerging information service architecture based on the Internet and recognition technology and communication technology, which was proposed in 1999 at Massachusetts Institute of Technology in the United States. This architecture aims to enable the information technology infrastructure to provide safe and reliable commodity information through the Internet, and to create an intelligent environment to identify and determine commodities to facilitate information exchange within the supply chain. The increasingly booming IoT technology at present has brought changes to all aspects of human life, but also brought a series of urgent technical and ethical issues,
security issues, and legal issues to be addressed. The IoT on the user side is usually deployed in the device domain, network domain, data domain, and application domain, which empowers the device with the ability of intelligent perception, automatic assembly connection, and deployment strategy. Besides, IoT devices can solve the problem of data concentration and provide local business logic and intelligent service [2, 12]. Figure 2 reveals the architecture of IoT.

Through Figure 2, the IoT architecture is primarily composed of three layers, namely, two perception layers and a network layer. The perception layer consists of intelligent terminals, local networks, virtualization, and operating systems. The network layer mainly contains networks, wireless networks, and wired networks. The last perception layer is a port mainly responsible for communication and service. The first perception layer transmits information to the relevant perception layer through the network layer, thus forming the universal interconnection of IoT.

Big data technology and IoT technology complement each other. The IoT is the “Internet of things connected to each other.” The perception layer of IoT generates massive data, greatly promoting the development of big data. Similarly, big data applications also play the value of the IoT, which in turn stimulates the use demand of IoT. The intelligent perception and positioning technology studied here cannot be separated from the support of IoT and big data.
technology. Big data technology provides abundant data resources for intelligent perception. The accurate positioning of an object can be easily determined according to data, which not only realizes intelligent perception but also provides convenience for the demanders. Similarly, the IoT technology can integrate all resources, including relevant positioning data, through its own broad channels, to meet the various needs of the masses. The IoT technology and big data can provide impetus for the rapid development of intelligent sensing and positioning technology. In turn, intelligent sensing and positioning technology can enrich the field of IoT, and they complement each other.

2.2. Positioning Technology and Behavior Perception System Based on GIS and LBS. The system design follows the following principles: (1) security: system security and confidentiality mainly refer to the security of system operation, data security, and confidentiality; (2) practicability: the practicability of the system is the premise of system maintenance and operation and benefit creation, and the primary goal of system construction; (3) advanced nature: the system must have advanced solid nature, including system design, operation platform, development tools, database selection, and hardware equipment selection, all of which should conform to the mainstream technology development direction; (4) friendliness: the friendliness of the system refers to the unified style, beautiful, and convenient use of the interface.

2.2.1. GIS Positioning. GIS is a comprehensive discipline combining geography, cartography, remote sensing, and computer science, which has been widely used in different fields. It is also a computer system for inputting, storing, querying, analyzing, and displaying geographic data. GIS is a computer-based tool that can analyze and process spatial information (in short, it maps and analyzes phenomena and events on the Earth). GIS technology integrates the unique visual effect and geographic analysis function of maps with general database operations such as query and statistical analysis. Figure 3 shows the structure of the GIS system [13, 14].

The GIS system can be divided into the following sections: (a) developers, the most important part of the GIS system. Before using the GIS system, developers need to define the various types of data and tasks in the GIS system, and write relevant programs. Therefore, high-level developers are particularly important for the GIS system; (b) data: the accuracy of data will directly affect the query results; (c) hardware: the performance of computer hardware also directly affects computing power and the speed of data processing; (d) software: the software includes the system software of, database, and GIS software of the computer; (e) process: the GIS system needs to clearly define tasks to generate testable results.

2.2.2. LBS Positioning Technology. LBS positioning technology uses mobile terminals to connect the wireless communication network or Global Positioning System [15], to find the corresponding coordinate data of the user in the database. Then, the user’s geographic coordinate information is combined with other information around the user to provide location-related peripheral service information [16, 17]. Figure 4 provides the fundamental structure of LBS positioning technology.

2.2.3. Behavior Perception System. The positioning technology can be used to obtain the real-time physical state of current equipment users, but the intelligent perception technology is the foundation of the subsequent understanding of user information and surrounding information. The perception of the surrounding information is completed by GIS system and LBS system, while the user behavior perception requires the user perception system of the device. The sensor installed in the corresponding position of the device is utilized to collect the user’s current state data and analyze the data. The processed data is compared with the
user’s behavior data set to obtain accurate services for different users [18].

The system is mainly divided into the data layer, business layer, transmission layer, and display layer. The data layer contains the server data layer and terminal data layer server. The data layer is mainly responsible for storing spatial data, attribute data, and map data, while the terminal data layer is responsible for storing system pictures. The business layer is responsible for data reading, transformation, analysis, and requests and responses to client data. The transport layer is responsible for data transfer, mainly via the mobile Internet. The display layer is responsible for displaying attribute data, spatial data, data operation, etc. Figure 5 reveals the structure of this system.

2.3. Indoor Perception and Positioning Model Based on Visible Light

2.3.1. Module Composition. System A is designed as an indoor positioning system based on visible light, which is composed of several modules shown in Figure 6. Table 1 indicates the operation flow of System A [19, 20].

In addition, the corresponding protection mechanism is set up, since the environment of the system application is relatively complex and changeable. When the environment in which the device is deployed changes (such as communication equipment falling from the height or being loaded into the container by the user), the system operation will be disturbed. Then, the protection mechanism with excellent system stability and robustness will first determine the obtained data to exclude the input value obtained under abnormal conditions. If it is the output value obtained under abnormal conditions, the system will adjust the weight of the particles. Otherwise, the system will run according to the previous process.

2.3.2. Visible Light Receiving Model. The direction of the user’s handheld device significantly impacts the visible light intensity. This paper uses the mobile camera as the visible light receiving device. The visible light intensity is significantly affected by the orientation of the device held by the user. Therefore, when the device is laterally twisted or yawed, there is an appreciable impact on the light intensity received by the device. However, the horizontal rotation has little effect on the light intensity received by the device, so the following model is obtained [21–23]. Figure 7 is the light incidence diagram.

In Figure 7, $\phi$ represents the radiation angle of the light source, $\theta$ denotes the incident angle of the light source, and $d$ refers to the distance from the light source to the device receive. Among them, two variables are fixed to test the relationship between the third variable and the received light intensity. Hence, the propagation of basic visible light can be described as follows:

$$J = L_0 \cos \phi \cdot e^{-\frac{(\theta/2)^2}{d^2}}.$$  \hspace{1cm} (1)

In (1), when $L_0$ equal to the received light intensity $\theta + 0$, $d = 1$ m, and $J = 1$. 
Considering the robustness of the device, it is necessary to simulate and set up a defense mechanism for various interferences. For example, consider the following:

(a) Different devices have different efficiencies in their light collectors, which will result in pronounced differences between the light data sequences collected by different devices even if the user’s actions and routes are identical. Therefore, the received light intensity values here are normalized and transformed it into the closed region $[0, 1]$. Then, the system can use the dynamic time warping algorithm to normalize the collected light data.

(b) Obstacles blocking light: since obstacles will make the light intensity data collected by the light sensor different from the actual value, a function $b(l)$ is set to describe this. If the light is not covered, $b(l) = 1$. Otherwise, $b(l) = 0$.

(c) The condition of multiple light sources: when there are multiple light sources in a scene, which are
distributed densely, the received light intensity is likely to be affected by multiple light sources. At this moment, it is insufficient to only consider the influence of a single light source. Therefore, the following theoretical model is used for analysis: set a region containing $n$ light sources, and the received light intensity data at $m$ position are collected, as shown in the following equations:

$$J_j = \sum_{i=1}^{n} L_{ij}, \quad (2)$$

$$J_j = \sum_{i=1}^{n} L_{0i} \cdot p_{ij}, \quad (3)$$

$$p_{ij} = \frac{e^{\theta_{ij}/\delta}}{d_{ij}^2}, \quad (4)$$

Among the above three equations, $\phi_{ij}$ represents the radiation angle of the light source $i$, $\theta_{ij}$ signifies the incident angle of the light source $i$, and $d_{ij}$ denotes the relative distance of the light source $i$. Meanwhile, $L_0$ is the matrix, which is calculated according to

$$[L_0] = [p_{ij}][L_0]. \quad (5)$$

(6) describes the complete visible light model, and (7) illustrates the three-dimensional position of the light source $i$. Moreover, (8) indicates the position vector of the equipment, while (9) shows the direction vector of the equipment. Among them, $d_i$, $\phi_i$, and $\theta_i$ are the radiation angle, incidence angle, and relative distance of the light source $i$.

$$I_i = (I_{ix}, I_{iy}, I_{iz}), \quad (7)$$

$$c = (c_x, c_y, c_z), \quad (8)$$

$$v = (v_x, v_y, v_z), \quad (9)$$

$$d_i = |l_i - c|. \quad (10)$$

2.3.3. Positioning Scheme. The principle of the positioning module is to use the movement of the device holder to weaken or even eliminate the error caused by the single light-source receiving system, to obtain the current specific location information of the user. Therefore, $L(t)$ is denoted as the receiving light intensity of the light source at the time $t$, and $G(t)$ represents the gyroscope parameters of the collected equipment. Besides, $D(t)$ denotes the rotation matrix data of the collected equipment, and $V(t)$ shows the direction of the equipment. The step number of the equipment owner is indirectly calculated by collecting the acceleration of the equipment. Therefore, the data input of the positioning module contains $L(t)$, $G(t)$, $D(t)$, and $V(t)$. After operation, the system outputs real-time position information and the three-dimensional coordinate position,

<table>
<thead>
<tr>
<th>Step</th>
<th>Module</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Visible light sensor</td>
<td>Collect received light intensity</td>
</tr>
<tr>
<td>2</td>
<td>System</td>
<td>Collect the corresponding acceleration sensor data and gyroscope sensor data</td>
</tr>
<tr>
<td>3</td>
<td>Positioning module</td>
<td>A series of candidate positions are generated according to the current scene, or candidate particles are selected in a particle filter</td>
</tr>
<tr>
<td>4</td>
<td>Pedometer</td>
<td>The RLS sequence collected in this step, the corresponding acceleration sampling sequence, and the gyroscope sampling sequence are packed as the input of the positioning module</td>
</tr>
<tr>
<td>5</td>
<td>Positioning module</td>
<td>The received light intensity of each candidate particle is calculated by the designed visible light propagation model</td>
</tr>
<tr>
<td>6</td>
<td>System</td>
<td>By comparing the received light intensity calculated by RLS and visible light propagation model, the system gives each candidate particle different weights. Particles with weak weight and those violating scene restrictions will be deleted. Further, the system checks whether the remaining particle sets meet the convergence requirements. If it is satisfied, the system outputs the best candidate particle and constantly updates its location for real-time tracking. Otherwise, the system is ready to accept the user’s next data input. In this process, the last round of surviving candidate particles is taken as candidate particles of the current calculation round</td>
</tr>
</tbody>
</table>

**Table 1: Operational process of indoor positioning system based on visible light.**
step size, and moving direction of the user. The steps of the positioning scheme are as follows [24].

a. Initialization. Firstly, numerous particles are distributed discretely in the three-dimensional space. The $i$-th scattered particle is denoted as $P(i)$. Moreover, for each single particle in the space, $p \in P(i)$, and the state of the particle is represented by

$$p_i = f(\omega, c, s, o). \quad (11)$$

In (11), $\omega$ refers to the possibility that this particle locates in the same position with the device holder, while $c$ denotes the three-dimensional coordinates of the device holder, and $s$ stands for the possible step size of the device user. Besides, $o$ stands for the orientation vector of the device user. Due to the uniform distribution of particles in the space, the positioning perception system must select $c$, $s$, and $o$ uniformly and randomly and add different weights to the three parameters, respectively. The weight is calculated according to (12), where $|p(i)|$ is the number of particles in the space system.

$$\omega = \frac{1}{|p[0]|} \quad (12)$$

The mobility of the device holder leads to the iteration calculation of the system in the case of the original initial particle distribution, as the basis of the calculation of the next state. The state of the newly generated particles is calculated according to the particle distribution in the previous state and the motion state of the device holder during this period. Hence, the particles generated by a single iteration are called sub-generations, represented by $p_c$. The original particle in a single iteration is called parent generation, denoted as $p_m$. The single iteration time of the system increases from $t_i$ to $t_{i+1}$, during which the particle state can be expressed as (13) and (14).

The owner of the device has a mobility feature that allows particles to operate continuously. The state of newly generated particles is calculated from the distribution of particles in the previous state and the motion state of the current device holder. Therefore, the particles generated by a single iteration are called sub-generations, which are represented by the symbol $p_c$.

$$p_m = p[i - 1], \quad (13)$$

$$p_c = p[i]. \quad (14)$$

When the solution of $p_c$ converges to a single particle and its position, or the number of iterations passes a certain threshold, the iteration will stop and the system outputs the particle $p_{\text{best}}$ of $p_c$ with the maximum weight. So the single parent particle state for the parent particle set $p(m)$ can be written as, and the single sub-generation particle state can be presented as (16).

$$p(m) = (\omega_m, c_m, s_m, o_m), \quad (15)$$

$$p_c = p[i]. \quad (16)$$

According to the above equations, the step size of the device holder is controlled in an annular range of $r \leq s \leq R$. Figure 8 displays the distribution of the walking interval of particles to more vividly illustrate the dispersion interval of particles [25].

The sub-generation particle $p(c)$ should fall into a ring range $r \leq |c_c - c_m| \leq R$, but if the particle $p(m)$ falls outside this range, $p(c)$ needs to be removed from the sub-generation set $p(m)$.

After the $i$-th step, the time increases from $t_i$ to $t_{i+1}$. In this process, it is necessary to obtain the new received light intensity data to update the weight $\omega_c$ of the sub-generation particle set $p(c)$. The collected light intensity data is represented by the set $\{L\}$, and the light intensity data calculated by the visible light propagation model is represented by the set $\{H\}$.

There need to be $2||L||$ spatial locations for the parent particles and sub-generation particles generated during the iteration time increasing from $t_i$ to $t_{i+1}$, to obtain the smooth data of set $\{H\}$. Each spatial position is denoted as $q_k$, and $H_k$ denotes the light intensity corresponding to each position $q_k$. The corresponding occurrence time $T_k$ of each position is shown in

$$T_k = t_i + \frac{k}{2||q_k||} \cdot (t_{i+1} - t_i). \quad (17)$$

A large weight represents a high possibility of the user to appear in the position, so when a position has the highest particle weight, it is most likely to be the position of the user. The dynamic time warping (DTW) is in the established system as the similarity detection method, with the relatively simple purpose to measure the similarity of two time series of different lengths. DTW is also applied widely, mainly in template matching, such as speech recognition of isolated words (recognition of whether the two voices represent the same word), gesture recognition, data mining, and
information retrieval. The basic principle of DTW is shown in Figure 9, and the weight is expressed as (18).

When a location has a large particle weight, the user is more likely to appear here. A new DTW algorithm is established here, which is a method to measure the similarity of two time series with different lengths. It has an extensive application range, such as isolated word speech recognition, and gesture recognition. Figure 9 reveals the fundamental principle of DTW algorithm, and (18) describes the weight [26].

\[
\omega_c = \exp \left[ -\frac{\mathrm{DTW}(\mathcal{L}, \mathcal{H})}{K} \right].
\] (18)

2.4. Verification Experiment of the Visible Light Intelligent Perception and Positioning Model. The received light intensity calculated by the model is compared with the true value of the received light intensity in the experiment to verify the validity of the proposed model. Firstly, the gyroscope carrying the illumination test equipment is used for illumination tests. The light intensity data is collected by rotating the gyroscope into multiple angles and keeping it at multiple specific positions near the light source. The exponential model is expressed as the traditional EXP model. The light propagation model is expressed as the EXT model, and the real model is expressed as the TRUE model. The mean square error is calculated according to

\[
\text{MSE}(\bar{\theta}) = E((\bar{\theta} - \theta)^2).
\] (19)

In (19), \(\bar{\theta}\) denotes the point estimate, and \(\theta\) represents the true value of parameters.

The experiment is carried out on the proposed model with one male and one female. Due to the height, the average step lengths of the two subjects are different. The average step length of the male is 0.88 meters, and the average step length of the female is 0.56 meters. Twenty indoor points are selected as the starting point of the test, and 30 outdoor points are selected as the starting point for walking [27].

2.5. Optimization and Classified Modeling for Heterogeneous Training Sets. In data acquisition, various reasons lead to category errors of detection objects, such as artificial interpretation and evaluation of stratigraphic lithology errors. When using these data with potential anomalies for modeling, it is necessary to detect and correct the abnormal categories of these data to improve the recognition accuracy of the established model and enhance the generalization ability of the model. Data analysis on massive data often requires relatively high hardware and time costs. This paper chooses to implement data analysis on the Hadoop platform, a flexible structure to deal with different types of data quality problems. One or more modules handle each type of data quality problem. Hadoop is a distributed system infrastructure making full use of the power of the cluster for high-speed computing and storage. Users can develop distributed programs without understanding the underlying details of the distribution. Hadoop implements a distributed file system with high fault tolerance and deploys it on low-cost hardware; moreover, it provides high throughput to access applications’ data, suitable for applications with a large data set. It can access data in the file system as streams.

The interactive module in the system provides an input interface for both the files to be cleaned and the requirements of cleaning data. The result display module provides the download link of cleaning data and compares dirty data and cleaned data. The entity recognition and truth-value discovery module is used to eliminate redundancy. Entity recognition clusters tuples pointing to the same real-world entity, and truth-value discovery is responsible for finding
the real value in the conflict. The inconsistency detection module finds the data part that violates the dependency rules and repairs the data to the state that meets the rules. The numerical filling part detects the missing part of the data and fills it. It can select an appropriate module to deal with the encountered data quality problems to optimize the data quality and improve the quality of the constructed data set. Due to the characteristics of the MapReduce programming model, a problem is often decomposed into many simple tasks, and a MapReduce round implements each task. This “decomposition” is excessive in most cases, resulting in redundant MapReduce. This paper appropriately merges the convergent tasks and meets the conditions such as reducing the number of MapReduce rounds and times of the original system without changing the algorithm complexity and iteration terminability of the original system to achieve the optimization purpose.

3. Experimental Results of the Visible Light Perception and Positioning Model

3.1. Visible Light Intensity Test. The test of intelligent perception and positioning model is inseparable from the test of visible light intensity. To verify the scientificity of the environmental intelligent perception and positioning model, comparative analysis is conducted on the test errors of light intensity and the received light intensity at different incident angles of several different models. Figures 10 and 11 provide the comparison results and the deviation between simulation values and real values.

As shown in Figure 10, the mean square error of the model increases with the continuous growth of light intensity. However, compared with the EXP model, the calculated value of the proposed model is closer to the true value, so the detection effect of the model is better than that of the traditional EXT model. In Figure 11, with the increase of incident angle, the deviation between the real light intensity and the received light intensity detected by the model is getting smaller and smaller. Besides, there is 50% probability that the error of calculated received light intensity is within 10 LuX, and there is 95% probability that the error keeps within 50 LuX. The purpose of this experiment is to intelligently perceive objects according to the light intensity of visible light. The light intensity test proves that the error of the visible light test is getting smaller and smaller, indicating that the selected model is effective.

3.2. Positioning Accuracy Test. The precision of positioning detection is the research focus in this experiment. Relevant data such as gender and indoor and outdoor positioning
precision is collected and studied to further improve the effectiveness of the experiment. The results are presented in Figure 12.

From Figure 12, the overall positioning accuracy in the indoor is not as good as the overall positioning accuracy in the outdoor, and with the increase of the step number, the positioning accuracy increases gradually. When the experimenter walks within 10 steps, the accuracy increases fast, but after 10 steps, the accuracy increases rate of positioning decreases. Furthermore, after 20 steps, the accuracy increases slowly. Since step size of the male tester is larger, the distance of male tester moving each step increases faster, which is more conducive to the positioning accuracy. Therefore, the overall positioning accuracy of the male tester is always higher than that of the female tester. The radio frequency identification technology and Ultra Wide Band technology mentioned previously have limitations at that time, cannot be implemented in a large area, and do not have communication ability. In contrast, the environmental intelligent perception and positioning model presented here is not affected by space, so it can move indoors or outdoors for free.

3.3. Comparison of Positioning Accuracy. The analysis of many matching results shows in Table 2 that the positioning accuracy on the straight road is very high, reaching more than 80%. At intersections and more complex sections, the positioning accuracy is not very good, caused by the great randomness of the travel direction at intersections and the low prediction accuracy of steam travel direction and speed. Increasing sample training and adding auxiliary parameters may improve the prediction accuracy. In the case of rugged roads, the position prediction algorithm can accurately locate the travel trajectory. Besides, the positioning error does not change much over time. In addition, because the interruption time of the positioning signal is generally short, the position prediction algorithm can achieve more accurate positioning in a short time.

4. Conclusion

A visible light positioning model based on the combination of IoT intelligent perception system with GIS and LBS technology is established to change the traditional intelligent perception and positioning technology for electronic data investigation modes. Firstly, the intelligent perception and positioning technology under the background of big data is introduced. Then GIS technology and LBS technology are adapted to propose the indoor perception and positioning model based on GIS technology, LBS technology, and visible light propagation model. Meanwhile, the front-end perception of positioning work is used to achieve comprehensive data collection. Finally, the proposed model is experimentally verified. The experiment proves that the intelligent perception and positioning technology based on GIS and LBS can improve the ability and efficiency of location positioning for users, significantly ameliorate the accuracy of location positioning for targets, and further improve the efficiency of electronic data investigation.

The vigorous development of mobile computing and the upgrading of intelligent devices have revolutionized the lifestyle of modern human beings. Obviously, the traditional intelligent sensing positioning technology is inaccurate to electronic data reconnaissance. An environmental intelligent perception and positioning model is constructed based on GIS technology, LBS technology, and visible light propagation model. Through relevant experiments, the following conclusions are drawn. (1) By comparing the light intensity of the model reported here with that of the EXP model and EXT model, the proposed environmental intelligent perception and location model can not only provide results closer to the real light, but also achieve the data with decreasing error. (2) In indoor and outdoor positioning precision experiments found that the positioning precision indoors is not as good as outdoors.

Although the original expected research objectives have been basically reached, and some valuable research conclusions have been obtained, due to the limited academic literacy, there are still some deficiencies in the research work. The conclusions may be limited by the following two factors. (1) The positioning accuracy of the model and the intersection becomes lower under the condition of weak light. (2) Due to the problems of personal privacy regulations, many practical application cases cannot be found for analysis. Therefore, it is worth improving the model from the following two aspects in future research. (1) Develop weak light recognition patterns and use more intersection location data sets for model training. (2) More volunteers will be recruited for consultation and practical testing.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References


Table 2: Comparison between positioning point coordinates and actual coordinates.

<table>
<thead>
<tr>
<th>Anchor name</th>
<th>Anchor point coordinates</th>
<th>Actual coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(110.545451, 30.292760)</td>
<td>(110.545472, 30.292781)</td>
</tr>
<tr>
<td>B</td>
<td>(110.544021, 30.290873)</td>
<td>(110.543998, 30.291272)</td>
</tr>
<tr>
<td>C</td>
<td>(110.543012, 30.285766)</td>
<td>(110.542971, 30.286001)</td>
</tr>
<tr>
<td>D</td>
<td>(110.526177, 30.266101)</td>
<td>(110.526159, 30.266105)</td>
</tr>
<tr>
<td>E</td>
<td>(110.501073, 30.201130)</td>
<td>(110.501059, 30.201164)</td>
</tr>
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