# Method for recognizing construction land use type based on address resolution data

## TECHNICAL FIELD

The present invention relates to the research field of urban construction land use, and in particular to an address resolution data-based rapid identification method for construction land type.

## BACKGROUND

With the rapid development of new information technologies, the arrival of the big data era has already changed the urban life and also promoted the development of urban planning technology. In recent years, social activities enable rapid data increase. For example, Weibo data, mobile phone data, public transportation card data, picture data, Baidu data and so on provide more computer data support for urban planning. Domestic and foreign researchers have already made some attempts for applying these data to urban planning. Steven (2001) made researches on land usage and open space facilities by using residential data in demographic census; Mark (2010) explored the relationship between land usage and social change by performing text analysis based on paper data; Rob (2013) made researches on geographical type cluster features based on Flicker picture data; WANG, Shuliang (2001) analyzed the land usage condition of urban and village regions using GPS data and network data; NIU, Xinyi (2008) proposed a functional zoning solution generation method by performing scenario simulation of land usage by analyzing resource, environment and economy data based on GIS technology; LIU, Yaolin (2010) proposed a land usage zoning and layout method by performing land usage suitability evaluation using basic statistics data and space data; and TAO, Pei (2014) made researches on the relationship between social functions and land usage using the calling volume and communication volume of mobile phone data. In the big data era, the diverse Internet data is a direct reflection of urban functions, and these data being employed to make researches on urban functions and land usage is helpful to improve the level of urban planning and enrich the means for planning technologies. However, the above technical solution still cannot well solve the rapid identification of construction land usages.

## SUMMARY

The main object of the present invention is to overcome the disadvantages and defects in the prior art and provide an address resolution data-based rapid identification method for construction land type.

In order to achieve the above object, the present invention adopts the following technical means. An address resolution data-based rapid identification method for construction land type, comprising the following steps:

S1, performing mining on research data, using an address resolution tool of an existing open platform to perform address resolution on each item of mined data, performing uniform space positioning and coordinate correction on network data and traditional data through a GIS system, and implementing a functional strength measurement on a classified land and a comprehensive evaluation of land usage;

S2, performing address resolution on the traditional data, and obtaining geographical information thereof;

S3, on the basis of the type and feature of the address resolution data, implementing a functional strength measurement on each type of construction land and a comprehensive evaluation of land usage via a comprehensive evaluation of each type of data, including:

S3.1, a functional strength measurement on each type of construction land, on the basis of the current road network, taking a block unit divided with the center line of a road as a space positioning unit of each type of data, respectively counting the number of facilities of different land usages in a space unit in the GIS system, first performing normalization and weight calculation on different data sources with respect to each type of land usage by means of an entropy weighting method, then performing standard value superposition according to the weights of different data sources, finally obtaining the functional strength distribution situation of each type of land usage by calculating the ratio between the standard value summarized by the unit and the area of the space unit; and

S3.2, a comprehensive evaluation of each type of land usage, on the basis of obtaining a functional strength measurement on each type of construction land, defining the land usage function in each type of land usage function in the space unit of which the strength is higher than the average value by 0.5 standard deviation as a significant function of the space unit; and

S4, after the construction land functional strength measurement and the comprehensive evaluation of the land usage, respectively performing land usage identification rate and land usage identification accuracy rate determination on a generated land usage type division diagram, it being determined that address resolution data-based rapid identification of construction land type is completed when two requirements are simultaneously met.

Preferably, step S1 is land usage identification data acquisition based on Sina open platform and/or land usage identification data acquisition based on Baidu LBS open platform;

S1.1, the steps of land usage identification data acquisition based on Sina open platform are:

S1.1.1, filling relevant webpage information of Sina Weibo open platform according to requirements, and acquiring App Key and App Secret; and

S1.1.2, logging into a data acquisition interface of Sina Weibo open platform, inputting parameters required for data acquisition, clicking a call interface, and obtaining a return result;

S1.1.3, selecting a place/nearby/pois interface in a geographical information interface, compiling a URL request according to the requirements of relevant request parameters, configuring the longitude and latitude, query range, data sequencing manner, the number of single-page return records, starting and ending page number information for returning data for a query center point, and acquiring the data by using a Python tool for grabbing Sina Weibo sign-in data; and

S1.1.4, it should be pointed out that for data acquisition, Sina open platform has limited access, data acquisition suspension can merely continue after the limit is canceled, after encoding format conversion is performed on the returned data, data acquisition is completed, wherein data information mainly includes sign-in address, classification and code, sign-in number, sign-in population, longitude and latitude, and the number of pictures; and

S1.2, land usage identification data acquisition based on Baidu LBS open platform; acquiring facility geographical information, facility name, the number of comments and comment scores within a certain range via an address service interface of Baidu LBS open platform in combination with Locoy Spider data acquisition software, including:

S1.2.1, applying for acquiring an API interface key of Baidu LBS open platform;
S1.2.2, setting relevant URL request parameters;
S1.2.3, opening the set URL request parameters in a browser, and acquiring the number of search objects; and
S1.2.4, importing an address resolution URL with qualified spelling into the Locoy Spider tool, acquiring Baidu land usage data after setting a collection label and a text template, wherein the acquired data information includes facility name, facility longitude and latitude, address, the number of comments and scores.
Preferably, in step S2, address resolution is performed on the traditional data through a Geocoding API service function in Baidu LBS open platform, including:
S2.1, applying for acquiring an API interface key of Baidu LBS open platform;
S2.2, compiling a URL request for address resolution according to relevant parameter requirements and the obtained interface key; and
S2.3, spelling the URL request for address resolution according to the address data, saving the URL request for address resolution with qualified spelling as a TXT format, and importing same into the Locoy Spider tool in batch, performing batch address coordinate resolution on data with address information by using the Locoy Spider tool after setting a collection label and a text template, thus obtaining geographical information thereof.
Preferably, in step S3.1, a functional strength measurement model on each type of construction land is:

$$G_i = \frac{\sum_{k=1}^{n} \alpha_k P_{ik}}{S_i} \quad (1)$$

where $H_i$ is the land usage functional strength of the $ith$ unit, $\alpha_k$ is the weight of the $kth$ type of data element, $P_{ik}$ is the standard value of the $kth$ type of data element in the $i$th unit, and $S_i$ is the construction land area of the $ith$ unit, where $i$=1,2,…,m; $k$ =1,2, …,n, including:
S3.1.1, performing standardization on each data element, assuming that the number of facilities of the kth data element in the ith space unit is $\beta_{ik}$, first defining

$$f_{ik} = (\beta_{ik} + 1) / \sum_{i=1}^{m} (\beta_{ik} + 1) \quad (2)$$

where i=1,2,…,m; k=1,2, …,n;
since when $f_{ik}$=0, $\ln(f_{ik})$ has no meaning, $f_{ik}$ needs to be modified when calculating the standard value $P_{ik}$, thus obtaining the redefined standard values $P_{ik}$ of different elements in each unit:

$$P_{ik} = f_{ik} \cdot \ln(f_{ik}) \quad (3)$$

S3.1.2, determining the weight of each type of data element according to an entropy weighting method;

first defining that the entropy value of the $kth$ element is $\gamma_k$,

$$\gamma_k = -\frac{1}{\ln(m)} \sum_{i=1}^{m} (P_{ik}) \quad (4)$$

where (i=1,2,…,m; k=1,2, …,n);

obtaining the weights of different data elements by using the modified entropy value evaluation indexes:

$$\alpha_k = \gamma_k / \sum_{k}^{n} \gamma_k \quad (5)$$

where (k=1,2, …,n);

S3.1.2, calculating the land usage functional strength of each unit;

performing superposition calculation on the standard value $P_{ik}$ of each type of data element according to the weight relationship $\alpha_k$, and obtaining the land usage functional strength of each unit by calculating the ratio between the sum of the standard value of each data element in the unit and the construction land area $S_i$ of the unit,

$$G_i = \frac{\sum_{k=1}^{n} \alpha_k P_{ik}}{S_i} \quad (1)$$

where (i=1,2,…,m; k=1,2, …,n).

Preferably, the functional strength measurement on each type of construction includes functional strength measurement on residential, functional strength measurement on administration and public services, functional strength measurement on commercial and business facilities, functional strength measurement on industrial, functional strength measurement on logistics and warehouse, functional strength measurement on road, street and transportation, functional strength measurement on municipal utilities and functional strength measurement on green space and square.

Preferably, in step S3.2, the particular method of comprehensive evaluation of each type of construction land is:

S3.2.1, combining land usages, and calculating an average value of the land usage functional strengths of the units,

on the basis of the functional strengths of eight classes of land usages, consolidating municipal utilities, road, street and transportation, industrial and logistics and warehouse respectively to obtain the functional strengths $G_{ik}$ of six classes of land usages;

calculating an average value of six classes of land usages:

$$Q_i = \frac{\sum_{k=1}^{6} G_{ik}}{6} \quad (6)$$

where i=1,2,…,m; k=1,2, …,6;

S3.2.2, calculating a standard deviation of the land usage functional strength of a unit

$$\delta_i = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(G_{ik} - Q_i)^2} \quad (7)$$

where i=1,2,…,m

S3.2.3, calculating the significance of the land usage functional strength of the unit

$$R_{ik} = G_{ik} - Q_i - \frac{1}{2}\delta_i \quad (8)$$

where i=1,2,…,m; k=1,2, …,6;

if $G_{ik} > 0$ and $R_{ik} \geq 0$, then determining that this class of land usage in the unit is significant, otherwise, insignificant; and

S3.2.4, a comprehensive evaluation of land usage, on the basis of obtaining the significance of the land usage of each unit, determining the land usage according to the land usage dominate function, land usage compliance relationship, land usage compatibility and aerial photography image map.

Preferably, in step S3.2.4, the determination is as follows:

residential land usage: determining a unit having merely one significant land usage function which is a residential land usage function in the units as a residential land usage;

residential mixed land usage: determining a unit having two or more significant land usage functions which include a residential land usage function in the units as a residential mixed land usage;

administration and public services land usage: determining a unit having merely one significant land usage function which is a public services land usage function in the units as an administration and public services land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of public services land usage function and green space, industrial and warehouse, municipal road land usage function as an administration and public services land usage;

commercial and business facilities land usage: determining a unit having merely one significant land usage function which is a commercial land usage function in the units as a commercial and business facilities land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of public services land usage function and green space, industrial and warehouse, municipal road land usage function as a commercial and business facilities land usage;

public services and commercial mixed land usage: determining a unit having two or more significant land usage functions which include a public services land usage function and a commercial land usage function in the units as a public services and commercial mixed land usage;

green space and square land usage: determining a unit having merely one significant land usage function which is a green space and square land usage function in the units as a green space and square land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of green space and square land usage function and industrial and warehouse, municipal road land usage function as a green space and square land usage;

industrial and warehouse mixed land usage: determining a unit having merely one significant land usage function which is an industrial land usage function or a logistics and warehouse land usage function in the units as an industrial and warehouse mixed land usage;

municipal utilities and road, street and transportation mixed land usage: determining a unit having merely one significant land usage function which is a municipal utilities land usage function or a road, street and transportation land usage function in the units as a municipal utilities and road, street and transportation mixed land usage;

other mixed land usage: determining other unit which has two or more significant land usage functions in the units as other mixed land usage; and

land usage with indiscernible land usage: determining a unit having no significant land usage function as a land usage with indiscernible land usage.

Preferably, the checking method for the identification accuracy rate of urban construction land usage is:

on the basis of the functional strength measurement on each type of urban construction land usage and the comprehensive evaluation of land usage, obtaining a comprehensive evaluation diagram of each type of urban construction land usage, respectively counting the number $n$ of space units with indiscernible land usage and the number $m$ of space units for construction land usage, and calculating the identification rate of the construction land usage:

$$\theta = \frac{\mathrm{m} - n}{m} * 100\% \quad (9)$$

if the identification rate of the construction land usage is $\theta \geq 80\%$, it indicates that the identification rate of the land usage is qualified, otherwise, the identification rate of the land usage is unqualified and the space units need to be re-divided or relevant land usage identification data needs to be supplemented for calculation and analysis again; and

the checking method for the identification accuracy rate of urban construction land usage is:

delimiting a certain sampling range in the generated construction land usage division diagram, wherein the area of the sampling range shall not be less than 10% of the total construction land area, acquiring a current land usage distribution diagram of this range by a third party, or drawing the current land usage distribution diagram of this sampling range by means of aerial photography image map and electronic satellite map, and calculating the identification accuracy rate of the land usage by comparing the overlap area therebetween.

Preferably, the checking method for the identification accuracy rate of urban construction land usage is:

(1) drawing the current land usage of the sampling range

newly adding a "self-drawn land usage type" field in the GIS system which is different from rapidly identifying land usage type, and recording land usage properties in a corresponding space unit according to aerial photography image map and electronic image map to obtain a self-drawn current land usage analysis diagram; and

(2) counting overlapping land usage units and calculating the identification accuracy rate of land usage

newly adding a field in the GIS system, labeling space units with identical land usage as "$K = 0$", and labeling space units with different land usages as "$K = 1$", respectively counting the total area of the land usage units in the sampling range and the area of the space units with different land usages, and obtaining the identification accuracy rate $\mu$ of land usage by calculating the ratio between the area of the identical land usage in the sampling range to the total land usage area, and the particular calculation formula is:

$$\mu = \frac{\sum_{i=1}^{m} S_i - \sum_{i=1}^{m} S_i K_i}{\sum_{i=1}^{m} S_i} * 100\% \quad (10)$$

where (i=1,2,…,m);

it is defined that when $\mu \geq 80\%$, it can be determined that the accuracy rate of the comprehensive evaluation of construction land usage is qualified; otherwise, unqualified, and it needs to perform calculation and analysis again by means of data correction or checking.

Compared to the prior art, the present invention has the following advantages and technical effects.

1. Compared to the traditional means of drawing a current land usage analytical diagram via on-

site surveying and investigation, the address resolution data-based rapid identification method for construction land type provided in the present invention greatly reduces time costs and labor costs, which is a more convenient and rapid current land usage type identification method. In reality, an urban construction land usage is usually a mixture of multiple functions rather than a land usage with a single characteristic. This method proposes the concept of various mixed land usages on the basis of the current urban construction land usage classification, which more satisfies the actual bearing function of construction land usages.

2. The present invention is built on the basis of address resolution data, and the identification rate and identification accuracy rate of construction land usage are closely relevant to the data sources. For a city or region with accurate and rich address resolution data, the construction land usage thereof can be identified rapidly; instead, a region with lost data will be limited. At the same time, how to apply this research method to the guidance of urban land usage function layout and urban land usage mixed method still needs to be further researched.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a particular implementation flowchart of an address resolution data-based rapid identification method for construction land type;

Fig. 2 is a functional strength measurement map for residential;

Fig. 3 is a functional strength measurement map for administration and public services;

Fig. 4 is a functional strength measurement map for commercial and business facilities;

Fig. 5 is a functional strength measurement map for industrial;

Fig. 6 is a functional strength measurement map for logistics and warehouse;

Fig. 7 is a functional strength measurement map for road, street and transportation;

Fig. 8 is a functional strength measurement map for municipal utilities;

Fig. 9 is a functional strength measurement map for green space and square; and

Fig. 10 is a comprehensive division map of construction land usage.

## DETAILED DESCRIPTION

Hereinafter, the present invention will be described in further detail in combination with embodiments and accompanying drawings, but the present invention is not limited to this.

Embodiment

The present invention is to obtain a functional strength measurement and a land usage comprehensive evaluation of various construction land usages of a city by means of calculation and analysis by taking urban (region) borders, construction land usage ranges and current road networks as a work base map for construction land usage type identification and combining network-opened address resolution data and traditional address resolution data (as shown in Fig. 1).

The most significant feature of the present invention is the rapid identification of construction land usage type using address resolution data, which includes mining of research data, address resolution of traditional data, calculation and analysis method for functional strength measurement on construction land usage, calculation and analysis method for comprehensive evaluation of construction land usage and checking method for construction land usage, which

includes the following steps.

1. Mining of research data

The present invention takes network data as the main data source, including Baidu open platform data, Sina Weibo open platform data and so on, and also employs business directory data and so on to enrich the data sources. The present invention divides urban construction land usages into eight classes of land usages of residential land usage (R), administration and public services land usage (A), commercial and business facilities use (B), industrial land usage (M), logistics and warehouse land usage (W), road, street and transportation land usage (S), municipal utilities land usage (U) and green space and square land usage (G) according to the latest Urban Land Classification and Planning Construction Land Standard for extensive research, and selects different data sources for different types of land usages respectively. The present invention adopts an address resolution tool of Baidu open platform to perform address resolution on data such as business directory, and performs uniform space positioning and coordinate correction on network data and traditional data through a GIS system, and implements a functional strength measurement on a classified land usage and a comprehensive evaluation of land usage.

1.1 Land usage identification data acquisition based on Sina open platform

Address information, classification code, the number of sign-ins and so on of Weibo sing-in points within a certain range are acquired via a Weibo interface and geographical information interface (http://open.weibo.com/wiki/2/place/nearby/pois) in the API data service of Sina Weibo open platform, and the particular operation steps are as follows:

(1) filling relevant webpage information of Sina Weibo open platform according to requirements, and acquiring App Key and App Secret, wherein this step does not acquire data directly but is an essential step for data acquisition authorization;

(2) logging into a data acquisition interface of Sina Weibo open platform, inputting parameters required for data acquisition, clicking a call interface, and obtaining a return result;

(3) selecting a place/nearby/pois interface in the geographical information interface, compiling a URL request according to the requirements of relevant request parameters, configuring relevant parameter information such as the longitude and latitude, query range, data sequencing manner, the number of single-page return records, starting and ending page number information for returning data for a query center point, and acquiring the data by using a Python tool compiled by the author for grabbing Sina Weibo sign-in data; and

(4) it should be pointed out that for data acquisition, Sina open platform has limited access, data acquisition suspension can merely continue after the limit is canceled. After encoding format conversion is performed on the returned data, data acquisition is completed. Data information mainly includes sign-in address, classification and code, sign-in number, sign-in population, longitude and latitude, and the number of pictures.

1.2 Land usage identification data acquisition based on Baidu LBS open platform

Acquiring facility geographical information, facility name, the number of comments and comment scores and so on within a certain range via an address service interface of Baidu LBS open platform in combination with Locoy Spider data acquisition software. The operation steps are as follows:

(1) applying for acquiring an API interface key of Baidu LBS open platform;

(2) setting relevant URL request parameters, including key number, search object (such as park, KTV and so on ), longitude and latitude coordinates in a rectangular search range (an example

URL request parameters is http://api.map.baidu.com/place/v2/search?ak=key number&output=json&query=search object&page_size=1&page_num=0&scope=2&bounds=coordinate I, coordinate II);

(3) opening the set URL request parameters in a browser, and acquiring the number of search objects. It should be in particular pointed out that due to the interface limitation of Baidu open platform, the number of search objects within each URL request shall not exceed 760, and once the number of objects in a target unit exceeds this value, the unit search range shall be narrowed.

(4) importing an address resolution URL with qualified spelling into the Locoy Spider tool, acquiring Baidu land usage data after setting a collection label and a text template, wherein the acquired data information includes facility name, facility longitude and latitude, address, the number of comments, scores and so on.

2. Address resolution of traditional data

Address resolution is performed on the traditional data such as business directory and so on through a Geocoding API service function in Baidu LBS open platform to acquire geographical information thereof. It should be in particular pointed out that there is a certain deviation in the acquired address resolution address and needs to be screened and corrected during the subsequent data space positioning. The operation steps are as follows:

(1) applying for acquiring an API interface key of Baidu LBS open platform;

(2) compiling a URL request for address resolution according to relevant parameter requirements and the obtained interface key; and

(3) spelling the URL request for address resolution according to the address data, saving the URL request for address resolution with qualified spelling as a TXT format, and importing same into the Locoy Spider tool in batch, performing batch address coordinate resolution on traditional data by using the Locoy Spider tool after setting a collection label and a text template, thus obtaining geographical information thereof.

3. After the basic data is collected and the work base map is processed, the acquired data is divided into eight corresponding classes according to the type of urban construction land usage, space positioning is performed in the GIS system, and coordinate transform and data correction are performed. The current construction land usages are divided according to the current road center lines, and the formed block units are used as the space units for data positioning. It should be in particular pointed out that since some space units are lack of relevant address resolution data, some block units which are lack of address resolution data and in which the road networks are intensive are combined to improve the identification rate of construction land usage.

Based on this, on the basis of the type and feature of the address resolution data, the present invention implements a functional strength measurement on each type of construction land and a comprehensive evaluation of land usage via a comprehensive evaluation of each type of data, including two aspects:

First, a functional strength measurement on each type of construction land. On the basis of the current road networks, the block units divided according to road center lines are used as the space positioning units of various data, and the number of facilities with different land usages in the space units is respectively counted in the GIS system. First performing normalization and weight calculation on different data sources with respect to each type of land usage by means of an entropy weighting method, then performing standard value superposition according to the weights of different data sources, finally obtaining the functional strength distribution situation

of each type of land usage by calculating the ratio between the standard value summarized by the unit and the area of the space unit.

Second, a comprehensive evaluation of land usage. On the basis of obtaining a functional strength measurement on each type of construction land, defining the land usage function in each type of land usage function in the space unit of which the strength is higher than the average value by 0.5 standard deviation as a significant function of the space unit. In order to reflect the use condition of the current construction land usage more really, this research re-divides the land usages of various units into nine classes of land usages of residential land usage (R), residential mixed land usage (R+), administration and public services land usage (A), public services and commercial mixed land usage (A/B), industrial and warehouse land usage (M/W), municipal utilities and road, street and transportation land usage (S/U), other mixed land usage (O) and land usage with indiscernible land usage (N) according to the compatibility condition of construction land usages, thus obtaining a comprehensive evaluation of the current construction land usage.

3.1 Functional strength measurement on each type of urban construction land

In terms of the functional strength measurement on a construction land, different data sources are respectively selected as elements for evaluation and measurement (see Table 1) based on various construction land usages, block units divided according to road center lines are used as space positioning units, and atomic data of different data sources in the units are summarized and counted.

Table 1 Main data sources for functional strength measurement on each type of construction land

| **Land usage type** | **Main data sources** |
|---|---|
| R-class land use | Baidu open platform data, 2014 business directory data |
| A-class land use | Baidu open platform data, Sina Weibo sign-in data, 2014 business directory data |
| B-class land use | Baidu open platform data, Sina Weibo sign-in data |
| M-class land use | Baidu open platform data, Sina Weibo sign-in data |
| W-class land use | Baidu open platform data, 2014 business directory data |
| S-class land use | Baidu open platform data, Sina Weibo sign-in data, 2014 business directory data |
| U-class land use | Baidu open platform data, Sina Weibo sign-in data |
| G-class land use | Baidu open platform data, Sina Weibo sign-in data |

Based on this, normalization and weight calculation are performed on absolute data values summarized according to units by means of an entropy weighting method to solve the problem of different dimensions caused by different data sources. Then standard value superposition is performed according to the weights of different data sources, finally the functional strength

distribution situation of each type of land usages is obtained by calculating the ratio between the standard value summarized by the unit and the area of the space unit.

A functional strength measurement model on each type of construction land is:

$$G_i = \frac{\sum_{k=1}^{n} \alpha_k P_{ik}}{S_i} \quad (1)$$

where $H_i$ is the land usage functional strength of the $ith$ unit, $\alpha_k$ is the weight of the $kth$ type of data element, $P_{ik}$ is the standard value of the $kth$ type of data element in the $i$th unit, $S_i$ is the construction land area of the $i$th unit, where =1,2,…,m; =1,2, …,n.

The calculation steps are as follows:

① performing standardization on each data element

Since the dimensions and orders of various data elements are different, the various elements need to be standardized. Assuming that the number of facilities of the $kth$ data element in the $i$th space unit is $\beta_{ik}$, first defining

$$f_{ik} = (\beta_{ik} + 1) / \sum_{i=1}^{m} (\beta_{ik} + 1) \quad (2)$$

where (i=1,2,…,m; k=1,2, …,n);

since when $f_{ik}$=0, $\ln(f_{ik})$ has no meaning, $f_{ik}$ needs to be modified when calculating the standard value $P_{ik}$, thus obtaining the redefined standard values $P_{ik}$ of different elements in each unit:

$$P_{ik} = f_{ik} \cdot \ln(f_{ik}) \quad (3)$$

② determining the weight of each type of data element according to an entropy weighting method;

first defining that the entropy value of the $kth$ element is $\gamma_k$,

$$\gamma_k = -\frac{1}{\ln(m)} \sum_{i=1}^{m} (P_{ik}) \quad (4)$$

where (i=1,2,…,m; k=1,2, …,n);

obtaining the weights of different data elements by using the modified entropy value evaluation indexes:

$$\alpha_k = \gamma_k / \sum_{k}^{n} \gamma_k \quad (5)$$

where (k=1,2, …,n);

③ calculating the land usage functional strength of each unit

performing superposition calculation on the standard value $P_{ik}$ of each type of data element according to the weight relationship $\alpha_k$, and obtaining the land usage functional strength of each unit by calculating the ratio between the sum of the standard value of each data element in the unit and the construction land area $S_i$ of the unit,

$$G_i = \frac{\sum_{k=1}^{n} \alpha_k P_{ik}}{S_i} \quad (1)$$

where (i=1,2,…,m; k=1,2, …,n).

3.1.1 Functional strength measurement for residential

Functional strength measurement for residential selects Baidu open platform data and 2014 business directory data, and the distribution condition of the residential land usage is determined according to space distribution features of "residential area" and "neighborhood committee" (seeTable 2).

Table 2 Main data for functional strength measurement for residential

| Main data sources | Screening data | Determination method |
|---|---|---|
| Baidu open platform data | Neighborhood, village | Keyword |
| 2014 business directory data | Neighborhood committee, village committee | Industry code |

Taking Tianhe District of Guangzhou as an example, first residential area point data within a certain range is acquired by first searching for keywords such as "community", "village" and so on in Baidu development platform, and this point data is positioned and summarized in the GIS system according to the already divided space units. Then, relevant data of "neighborhood committee" and "village committee" are screened out from 2014 business directory, and address resolution is performed using Baidu LBS open platform. The business directory data after address resolution is imported into the GIS system for space positioning and coordinate correction, and the space units within the coverage are uniformly assigned with 300 meters as the radius (in this research, the coverage units are uniformly assigned with an average value of Baidu data), and the data are summarized according to space units just like Baidu data.

Based on this, the above Baidu data and business directory data summarized according to units are normalized by means of entropy weighting method formulas (2) and (3) to obtain a standard value $P_{ik}$ of these two kinds of data, and the weights $\alpha_1$ and $\alpha_2$ of Baidu open platform data and business directory data are obtained by means of entropy weighting method formulas (4) and (5), which are respectively 0.5005 and 0.4995.

Finally, these two classes of data elements are overlapped according to the relationship between space units and weights using land usage functional strength formula (1), and the residential land usage functional strength $G_i$ of each unit is obtained by calculating a ratio between the total sum of standard values after superposition and the area $S_i$ of the construction land. In this case, the south land usage of Tianhe District is presented as the outcome, as shown in Fig. 2.

3.1.2 Functional strength measurement map for administration and public services

Functional strength measurement for administration and public services selects Baidu open platform data, Sina Weibo sign-in data and 2014 business directory data, and the distribution condition of the administration and public services land usage is determined according to space distribution features of the administration and public services (see Table 3).

Table 3 Main data of functional strength measurement for administration and public services

| Main data sources | Screening data | Determination method |
|---|---|---|
| Baidu open platform data | Hospital, university, middle school, primary school, library, swimming pool, theater and so on | Keyword |

| | | |
|---|---|---|
| Sina Weibo sign-in data | Government organization, taxation, campus life, police office, court, museum, library, culture palace, exhibition hall, middle school and primary school and so on | Classification label |
| 2014 business directory data | Health, social insurance and social welfare, public administration and social organization, culture, sports, and education | Industry code |

Taking Tianhe District of Guangzhou as an example, point data of various facilities are obtained by first searching for keywords such as hospital, university, middle school, primary school, library, swimming pool, theater and so on in Baidu development platform. Considering the specificity that there are many colleges and universities in Tianhe District, in this research, university is separately extracted as an individual data element, and space positioning is performed on this data element and other data respectively.

Secondly, administration and public services in Sina Weibo sign-in data labeled as government organization, taxation, police office, court, gerocomium, campus life, museum, library, cultural palace, exhibition hall, middle school, primary school and so on are screened out, and space positioning and coordinate correction are performed in the GIS system, and summarization is performed according to space units.

Then, in the business directory data, business data classified Health, social security and social welfare, Public Administration and Social Organizations, Culture and Sports, Education and so on are screened out, and address resolution is performed in Baidu LBS development platform, and the data after resolution is imported into the GIS system for coordinate correction and unit summarization.

The absolute point data which is summarized according to units is normalized using entropy weighting method formulas (2) and (3) to obtain a standard value $P_{ik}$ of the above four classes of data elements. The weight relationship between Baidu university data $\alpha_1$, Baidu other data $\alpha_2$, Weibo sign-in data $\alpha_3$, and business directory data $\alpha_4$ are 0.2550, 0.2482, 0.2485 and 0.2483 using entropy weighting method formulas (4) and (5).

Finally, the standard values of four classes of elements are overlapped according to the weight relationship using land usage functional strength calculation formula (1). The ratio between the summarized standard value of each unit and the unit construction land area is the land usage functional strength $G_i$ of administration and public services, as shown in Fig. 3.

3.1.3 Functional strength measurement for commercial and business facilities

The functional strength measurement for commercial and business facilities selects Baidu open platform data and Sina Weibo sign-in data. The functional strength of a commercial land usage is determined by selecting representative commercial facility data in some commercial land usages (see Table 4). Since the commercial facility data in the business directory data is relatively complicated, it is not selected for the functional strength measurement for commercial and business facilities land use.

Table 4 Main data of functional strength measurement for commercial and business facilities

| **Main data sources** | **Screening data** | **Determination method** |
|---|---|---|

| | | |
|---|---|---|
| Baidu open platform data | Restaurant, supermarket, hotel, wholesale market, shopping mall, bank, KTV, cinema, bar and so on | Keyword |
| Sina Weibo sign-in data | Restaurant, coffee shop, tea house, dessert shop, style of cooking, shopping service, specialty store, hotel, exhibition hall, shopping mall, furniture and construction material market, and so on | Classification label |

Taking Tianhe District of Guangzhou as an example, keywords such as restaurant, supermarket, hotel, wholesale market, shopping mall, bank, KTV, net bar, cinema, foot massage, chess, bar, coffee shop and so on within Tianhe District are searched in Baidu open platform to obtain the commercial facility data of Tianhe District.

Commercial facility data in Sina Weibo sign-in data labeled as restaurant and food, coffee shop, tea shop, dessert shop, foods, car maintenance, shopping service, shopping mall, specialty shop, furniture and construction material market, hairdressing, hotel and so on are screened out, and space positioning and unit summarization are performed on these data and Baidu data in the GIS system.

Then, a standard value $P_{ik}$ of Baidu data and Weibo sign-in data and the weight relationship between these two classes of data are obtained using entropy weighting method formula (2), (3), (4) and (5), wherein the weights $\alpha_1$ and $\alpha_2$ of Baidu data and Sina Weibo sign-in data are both 0.5.

Finally, the functional strength $G_i$ of the commercial and business facilities land usage may be obtained by performing superposition on the weights of various classes of data according to the weight and dividing same by unit construction land area $S_i$ using land usage functional strength calculation formula (1), as shown in Fig. (4).

3.1.4 Functional strength measurement for industrial

Functional strength measurement for industrial selects Baidu open platform data and Sina Weibo sign-in data (seeTable 5). Taking Tianhe District of Guangzhou as an example, Baidu data selects data with keyword of factory, Sina Weibo sign-in data selects data with classification label of industry park, and space positioning and coordinate correction are performed in the GIS system. It should be in particular pointed out that there are few industrial land usages in Tianhe District, and thus relevant address resolution will also reduce.

Table 5 Main data for functional strength measurement for industrial

| **Main data sources** | **Screening data** | **Determination method** |
|---|---|---|
| Baidu open platform data | Factory | Keyword |
| Sina Weibo sign-in data | Industrial park | Classification label |

Based on this, two classes of atomic data are normalized using entropy calculation formulas (2), (3), (4) and (5), and the weight $\alpha_1$ of Baidu data and the weight $\alpha_2$ of Sina Weibo sign-in data are , and $\alpha_1$ and $\alpha_2$ are 0.4926 and 0.5074.

Finally, the functional strength $G_i$ of the industry land usage may be obtained by performing superposition on the weights of two classes of data according to the weight and dividing same by

unit construction land area $S_i$ using land usage functional strength calculation formula (1), as shown in Fig. (5).

3.1.5 Functional strength measurement for logistics and warehouse

Functional strength measurement for logistics and warehouse selects Baidu open platform data and 2014 business directory data (see Table 6).

Table 6 Main data for functional strength measurement for logistics and warehouse

| Main data sources | Screening data | Determination method |
|---|---|---|
| Baidu open platform data | Warehouse, logistics | Keyword |
| 2014 business directory data | Transportation and handling and other transport service industries, warehousing industry and so on | Industry code |

Taking Tianhe District of Guangzhou as an example, relevant data with keywords of "warehouse" and "logistics" are obtained in Baidu open platform. It should be in particular pointed out that in the relevant data obtained by searching for keyword "logistics", very few logistics and warehouses belong to logistics and warehouse land usage and most of them belong to logistics operation sites for commercial facility, which should be screened out and eliminated.

In the 2014 business directory data after address resolution, data with industry classification codes of "57 transportation and handling and other transportation services" and "58 warehousing industry" are screened out, and the commercial facility data of some logistics companies are eliminated.

Then, the above two classes of data are respectively imported into the GIS system for space positioning and coordinate correction, and are summarized and counted according to space units. Based on this, the absolute value are normalized using entropy weighting method normalization formulas (2) and (3), and the weight $\alpha_1$ of Baidu data and the weight $\alpha_2$ of business directory data are respectively 0.5002 and 0.4998 by performing weight calculation using formulas (4) and (5).

Finally, the functional strength $G_i$ for logistics and warehouse land usage is obtained using land usage functional strength calculation formula (1) (as shown in Fig. 6).

3.1.6 Functional strength measurement for road, street and transportation

Functional strength measurement for road, street and transportation selects Baidu open platform data, Sina Weibo sign-in data and 2014 business directory data. Since this research takes roads and streets as the working base map, some roads and streets need to be drawn and identified with aerial photography or satellite imagery (see Table 7).

Table 7 Main data of functional strength measurement for road, street and transportation

| Main data sources | Screening data | Determination method |
|---|---|---|
| Baidu open platform data | Passenger station, railway station, wharf, social parking lot | Keyword |
| Sina Weibo sign-in data | Airport, coach station, railway station | Classification label |
| 2014 business directory data | Railway transport industry, road transport industry, urban public | Industry code |

| | | |
|---|---|---|
| | transport industry, water transport industry, airline transport industry | |

Taking Tianhe District of Guangzhou as an example, relevant data with keywords of passenger station, railway station, wharf and parking lot are obtained in Baidu open platform. It should be in particular pointed out that in the relevant data obtained by searching for keyword parking lot, very few public transportation stations and large social parking lots belong to road, street and transportation land usage and most parking lots belong to auxiliary land usages with other land usage and shall be eliminated.

In the acquired Sina Weibo sign-in data, relevant data with classification labels of airport, coach station and railway station are screened out, and other facility data such as near railway station are eliminated.

In 2014 business directory data after address resolution, data with industry classification of 51 railway transportation, 52 road transportation, 53 urban public transportation, 54 water transportation 55 aerial transportation are screened out and facility data except wharf or station yard are eliminated.

Then, the above three classes of data are imported into the GIS system for space positioning and coordinate correction, and are summarized and counted according to space units. The absolute value are normalized using entropy weighting method normalization formulas (2) and (3), and the weight $\alpha_1$ of Baidu data, the weight $\alpha_2$ of Sina Weibo sign-in data and the weight $\alpha_3$ of business directory data are respectively 0.3499, 0.3258 and 0.3243 by performing weight calculation using formulas (4) and (5).

Finally, the functional strength $G_i$ for road, street and transportation land usage is obtained using land usage functional strength calculation formula (1) (as shown in Fig. 7).

3.1.7 Functional strength measurement map for municipal utilities

Functional strength measurement for municipal utilities selects Baidu open platform data and 2014 business directory data (see Table 8).

Table 8 Main data of functional strength measurement for municipal utilities

| **Main data sources** | **Screening data** | **Determination method** |
|---|---|---|
| Baidu open platform data | Petrol station, garbage station, fire station, water plant and so on | keyword |
| Sina Weibo sign-in data | Petrol station | Classification label |

Taking Tianhe District of Guangzhou as an example, public facilities with keywords of petrol station, garbage station, fire station, water plant are searched in Baidu development platform, and at the same time data in Sina Weibo with classification label of petrol station is screened out. The two classes of data are imported into the GIS system for space positioning and coordinate correction, and are summarized and counted according to space units.

Then, the absolute values are normalized using entropy weighting method normalization formulas (2), (3), (4) and (5), and the weight $\alpha_1$ of Baidu data and the weight $\alpha_2$ of business directory data are respectively 0.4947 and 0.5053.

Finally, the functional strength $G_i$ for municipal utilities land usage is obtained using land usage functional strength calculation formula (1) (as shown in Fig. 8).

3.1.8 Functional strength measurement for green space and square

Functional strength measurement for green space and square selects Baidu open platform data and Sina Weibo sign-in data (see Fig. 9)

Table 9 Main data for functional strength measurement for green space and square

| Main data sources | Screening data | Determination method |
|---|---|---|
| Baidu open platform data | Park | Keyword |
| Sina Weibo sign-in data | Park, zoo, urban square, botanical garden | Classification label |

Taking Tianhe District of Guangzhou as an example, public facilities with keyword of park are searched in Baidu development platform, and at the same time data in Sina Weibo with classification label of park, zoo, urban square and plant park is screened out. Then, the above two classes of data are respectively imported into the GIS system for space positioning and coordinate correction, and are summarized according to space units.

Then, the absolute value are normalized using entropy weighting method normalization formulas (2), (3), (4) and (5), and the weight $\alpha_1$ of Baidu data and the weight $\alpha_2$ of business directory data are respectively 0.4947 and 0.5053. Finally, the functional strength $G_i$ for green space and square land usage is obtained using land usage functional strength calculation formula (1) (as shown in Fig. 9).

3.2 Comprehensive evaluation of various urban construction land usage

On the basis of completing the functional strength measurement of various urban construction land usages, significance determination is made on the land usage of each unit using a mean square error calculation method. Based on the current urban construction land usage classification, new land usage classification is proposed according to the land usage compatibility feature and compliance relations, which mainly includes nine classes of land usages of residential land usage (R), residential mixed land usage (R+), administration and public services land usage (A), public services and commercial mixed land usage (A/B), industrial and warehouse land usage (M/W), municipal utilities and road, street and transportation land usage (S/U), other mixed land usage (O) and land usage with indiscernible land usage (N).

It should be in particular pointed out that since the mixture degree of residential land usage and other land usage is the highest, residential mixed land usage (R+) is proposed here; the mixture of commercial land usage and public services land usage is also common, public services and commercial mixed land usage (A/B) is proposed here; in addition, since there are very few municipal utilities land use, road, street and transportation land use, industrial land usage and logistics and warehouse land usage and there are lack of sampling data, industrial and warehouse land usage (M/W) and municipal utilities and road, street and transportation land usage (S/U) are proposed here; and other various complicated mixed land usage will not be further sub-divided in this research, which are uniformly classified as other mixed land usage (O).

The steps of significance determination and comprehensive evaluation of construction land usage are as follows:

(1) combining land usages, and calculating an average value of the land usage functional strengths of the units

on the basis of the functional strengths of eight classes of land usages, consolidating municipal utilities, road, street and transportation, industrial and logistics and warehouse respectively to

obtain the functional strengths $G_{ik}$ of six classes of land usages;
calculating an average value of six classes of land usages:

$$Q_i = \frac{\sum_{k=1}^{6} G_{ik}}{6} \quad (6)$$

where (i=1,2,…,m; k=1,2, …,6);
(2) calculating a standard deviation of the land usage functional strength of a unit

$$\delta_i = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(G_{ik} - Q_i)^2} \quad (7)$$

where (i=1,2,…,m);
(3) calculating the significance of the land usage functional strength of the unit

$$R_{ik} = G_{ik} - Q_i - \frac{1}{2}\delta_i \quad (8)$$

where i=1,2,…,m; k=1,2, …,6;
if $G_{ik} > 0$ and $R_{ik} \geq 0$, then determining that this class of land usage in the unit is significant, otherwise, insignificant.
(4) Comprehensive evaluation of land usage
①on the basis of obtaining the land usage significance of each unit, determining the land usage according to the land usage dominate function, land usage compliance relationship, land usage compatibility and aerial photography image map.
②residential land usage (R): determining a unit having merely one significant land usage function which is a residential land usage function in the units as a residential land usage;
③residential mixed land usage (F): determining a unit having two or more significant land usage functions which include a residential land usage function in the units as a residential mixed land usage;
④administration and public services land usage (A): determining a unit having merely one significant land usage function which is a public services land usage function in the units as an administration and public services land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of public services land usage function and green space, industrial and warehouse, municipal road land usage function as an administration and public services land usage;
⑤commercial and business facilities land usage (B): determining a unit having merely one significant land usage function which is a commercial land usage function in the units as a commercial and business facilities land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of public services land usage function and green space, industrial and warehouse, municipal road land usage function as a commercial and business facilities land usage;
⑥public services and commercial mixed land usage (A/B): determining a unit having two or more significant land usage functions which include a public services land usage function and a commercial land usage function in the units as a public services and commercial mixed land usage;
⑦green space and square land usage (G): determining a unit having merely one significant land usage function which is a green space and square land usage function in the units as a green space

and square land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of green space and square land usage function and industrial and warehouse, municipal road land usage function as a green space and square land usage;

⑥industrial and warehouse mixed land usage (M/W): determining a unit having merely one significant land usage function which is an industrial land usage function or a logistics and warehouse land usage function in the units as an industrial and warehouse mixed land usage;

⑦municipal utilities, road, street and transportation mixed land usage (S/U): determining a unit having merely one significant land usage function which is a municipal utilities land usage function or a road, street and transportation land usage function in the units as a municipal utilities and road, street and transportation mixed land usage;

⑧other mixed land usage (O): determining other unit which has two or more significant land usage functions in the units as other mixed land usage; and

⑨land usage with indiscernible land usage (N): determining a unit having no significant land usage function as a land usage with indiscernible land usage.

Based on this, land usage classification information of each unit is imported into the space unit of the GIS system for classified display, auxiliary determination is performed on indiscernible mixed land usage units by means of satellite aerial photography image map and electronic map to obtain a division diagram of various urban construction land usage types (see Fig. 10).

4, checking of various urban construction land usage: after the rapid identification of construction land usage is completed, respectively performing land usage identification rate and land usage identification accuracy rate determination on a generated land usage type division diagram, it being determined that address resolution data-based rapid identification of construction land type is completed when two requirements are simultaneously met.

4.1 checking of the identification rate of urban construction land usage

On the basis of the functional strength measurement and land usage comprehensive evaluation of various urban construction land usages, obtaining a comprehensive evaluation diagram of the various urban construction land usages. Respectively counting the number $m$ of space units with indiscernible land usage and the number $n$ of space units for construction land usage , and calculating the identification rate of the construction land usage:

$$\theta = \frac{\mathrm{m} - n}{m} * 100\% \quad (9)$$

in this research, it is defined that if the identification rate of the construction land usage is $\theta \geq 80\%$, it indicates that the identification rate of the land usage is qualified, otherwise, the identification rate of the land usage is unqualified and the space units need to be re-divided or relevant land usage identification data needs to be supplemented for calculation and analysis again; and

Taking Tianhe District of Guangzhou as an example, the number of space units for the identification of construction land usage is 847, wherein the number of space units with indiscernible land usage is 12, and the identification rate $\theta$ of construction land usage is 98.58%, which satisfies the requirements.

4.2 checking of the identification accuracy rate of urban construction land usage

A certain sampling range is delimited in the generated construction land usage division map, wherein the area of the sampling range shall not be less than 10% of the total construction land

area. Acquiring a current land usage distribution diagram of this range by a third party, or drawing the current land usage distribution diagram of this sampling range by means of aerial photography image map and electronic satellite map. The identification accuracy rate of land usage is calculated by comparing the superposition area therebetween. The operation steps are as follows:

①drawing the current land usage of the sampling range

newly adding a "self-drawn land usage type" field in the GIS system which is different from rapidly identifying land usage type, and recording land usage properties in a corresponding space unit according to aerial photography image map and electronic image map to obtain a self-drawn current land usage analysis diagram. It should be in particular pointed out that since this research proposes a new land usage classification standard for the identification of construction land usage, the same classification standard is employed in the self-drawn current condition land usage map.

②counting overlapping land usage units and calculating the identification accuracy rate of land usage

newly adding a field in the GIS system, labeling space units with identical land usage as "$K = 0$", and labeling space units with different land usages as "$K = 1$", respectively counting the total area of the land usage units in the sampling range and the area of the space units with different land usages, and obtaining the identification accuracy rate of land usage by calculating the ratio $\mu$ between the area of the identical land usage in the sampling range to the total land usage area, and the particular calculation formula is:

$$\mu = \frac{\sum_{i=1}^{m} S_i - \sum_{i=1}^{m} S_i K_i}{\sum_{i=1}^{m} S_i} * 100\% \quad (10)$$

where (i=1,2,…,m);

in this research, it is defined that when $\mu \geq 80\%$, it can be determined that the accuracy rate of the comprehensive evaluation of construction land usage is qualified; otherwise, unqualified, and it needs to perform calculation and analysis again by means of data correction or checking.

Taking Tianhe District of Guangzhou as an example, the construction land area of Tianhe District is 1096391.10 ㎡, the delimited sampling range area is 132161.56 ㎡, which exceeds the total construction land area by 10%. The characteristics of the construction land usage in Tianhe District may be obtained by means of address resolution data. In addition, the current construction land usage analysis diagram may be re-generated in the GIS system by means of aerial photography image map and relevant planning paper provided by a third party.

Then, the accuracy rate is calculated by comparing the consistency between two land usage maps in the GIS system. It should be in particular pointed out here that since the square surface of the Huacheng Square in Tianhe District is green space and the underground is commercial, which is classified as commercial land usage in the rapid identification result and classified as green space in the self-drawn land usage current map, and thus the land usage of the Huacheng Square shall be identified as consistent. In addition, since the west sports community and the east sports community are both open commercial-community mixed land use, it is classified as commercial land usage in the rapid identification result and classified as residential land usage in the self-drawn land usage current map, and thus the land usage thereof shall also be identified as consistent.

Finally, the area of the space units with consistent land usage and the total area of the space units in the sampling range are respectively counted as 132161.56 ㎡ and 158564.04 ㎡ according to formula (10), and the identification accuracy rate of construction land usage is μ=83.35% by calculating the ratio therebetween, and thus the checking is qualified.

The above embodiments are preferred embodiments of the present invention. However, the embodiments of the present invention are not limited by the above embodiments. Any other changes, modifications, replacements, combinations and simplifications not departing from the spirit essence and principle of the present invention shall all be regarded as equivalent substitutions and shall all be contained in the protection of scope of the present invention.

WHAT IS CLAIMED IS:

1. An address resolution data-based rapid identification method for construction land type, comprising the following steps:
S1, performing mining on research data, using an address resolution tool of an existing open platform to perform address resolution on each item of mined data, performing uniform space positioning and coordinate correction on network data and traditional data through a GIS system, and implementing a functional strength measurement on a classified land and a comprehensive evaluation of land usage;
S2, performing address resolution on the traditional data, and obtaining geographical information thereof;
S3, on the basis of the type and feature of the address resolution data, implementing a functional strength measurement on each type of construction land and a comprehensive evaluation of land usage via a comprehensive evaluation of each type of data, including:
S3.1, a functional strength measurement on each type of construction land, on the basis of the current road network, taking a block unit divided with the center line of a road as a space positioning unit of each type of data, respectively counting the number of facilities of different land usages in a space unit in the GIS system, first performing normalization and weight calculation on different data sources with respect to each type of land usage by means of an entropy weighting method, then performing standard value superposition according to the weights of different data sources, finally obtaining the functional strength distribution situation of each type of land usage by calculating the ratio between the standard value summarized by the unit and the area of the space unit; and
S3.2, a comprehensive evaluation of each type of land usage, on the basis of obtaining a functional strength measurement on each type of construction land, defining the land usage function in each type of land usage function in the space unit of which the strength is higher than the average value by 0.5 standard deviation as a significant function of the space unit; and
S4, after the construction land functional strength measurement and the comprehensive evaluation of the land usage, respectively performing land usage identification rate and land usage identification accuracy rate determination on a generated land usage type division diagram, it being determined that address resolution data-based rapid identification of construction land type is completed when two requirements are simultaneously met.

2. The address resolution data-based rapid identification method for construction land type according to claim 1, wherein step S1 is land usage identification data acquisition based on Sina open platform and/or land usage identification data acquisition based on Baidu LBS open platform;
S1.1, the steps of land usage identification data acquisition based on Sina open platform are:
S1.1.1, filling relevant webpage information of Sina Weibo open platform according to requirements, and acquiring App Key and App Secret;
S1.1.2, logging into a data acquisition interface of Sina Weibo open platform, inputting parameters required for data acquisition, clicking a call interface, and obtaining a return result;
S1.1.3, selecting a place/nearby/pois interface in a geographical information interface, compiling a URL request according to the requirements of relevant request parameters, configuring the

longitude and latitude, query range, data sequencing manner, the number of single-page return records, starting and ending page number information for returning data for a query center point, and acquiring the data by using a Python tool for grabbing Sina Weibo sign-in data; and

S1.1.4, it should be pointed out that for data acquisition, Sina open platform has limited access, data acquisition suspension can merely continue after the limit is canceled, after encoding format conversion is performed on the returned data, data acquisition is completed, wherein data information mainly includes sign-in address, classification and code, sign-in number, sign-in population, longitude and latitude, and the number of pictures; and

S1.2, land usage identification data acquisition based on Baidu LBS open platform; acquiring facility geographical information, facility name, the number of comments and comment scores within a certain range via an address service interface of Baidu LBS open platform in combination with Locoy Spider data acquisition software, including:

S1.2.1, applying for acquiring an API interface key of Baidu LBS open platform;

S1.2.2, setting relevant URL request parameters;

S1.2.3, opening the set URL request parameters in a browser, and acquiring the number of search objects; and

S1.2.4, importing an address resolution URL with qualified spelling into the Locoy Spider tool, acquiring Baidu land usage data after setting a collection label and a text template, wherein the acquired data information includes facility name, facility longitude and latitude, address, the number of comments and scores.

3. The address resolution data-based rapid identification method for construction land type according to claim 1, wherein in step S2, address resolution is performed on the traditional data through a Geocoding API service function in Baidu LBS open platform, including:

S2.1, applying for acquiring an API interface key of Baidu LBS open platform;

S2.2, compiling a URL request for address resolution according to relevant parameter requirements and the obtained interface key; and

S2.3, spelling the URL request for address resolution according to the address data, saving the URL request for address resolution with qualified spelling as a TXT format, and importing same into the Locoy Spider tool in batch, performing batch address coordinate resolution on data with address information by using the Locoy Spider tool after setting a collection label and a text template, thus obtaining geographical information thereof.

4. The address resolution data-based rapid identification method for construction land type according to claim 1, wherein in step S3.1, a functional strength measurement model on each type of construction land is:

$$G_i = \frac{\sum_{k=1}^{n} \alpha_k P_{ik}}{S_i} \quad (1)$$

where $H_i$ is the land usage functional strength of the $i$ unit, $\alpha_k$ is the weight of the $k$ type of data element, $P_{ik}$ is the standard value of the $k$ type of data element in the $i$ unit, $S_i$ is the construction land area of the $i$ unit, where =1,2,…,m; =1,2, …,n, including:

S3.1.1, performing standardization on each data element, assuming that the number of facilities of the k data element in the space unit i is $\beta_{ik}$, first defining

$$f_{ik} = (\beta_{ik} + 1) / \sum_{i=1}^{m} (\beta_{ik} + 1) \quad (2)$$

where i=1,2,…,m; k=1,2, …,n;

since when $f_{ik}$=0, $\ln(f_{ik})$ has no meaning, $f_{ik}$ should be corrected when calculating the standard value $P_{ik}$, thus obtaining the redefined standard value $P_{ik}$ of different elements in each unit:

$$P_{ik} = f_{ik} \cdot \ln(f_{ik}) \quad (3)$$

S3.1.2, determining the weight of each type of data element according to an entropy weighting method;

first defining that the entropy value of the $k$ element is $\gamma_k$,

$$\gamma_k = -\frac{1}{\ln(m)} \sum_{i=1}^{m} (P_{ik}) \quad (4)$$

where (i=1,2,…,m; k=1,2, …,n);

obtaining the weights of different data elements by using the modified entropy value evaluation indexes:

$$\alpha_k = \gamma_k / \sum_{k}^{n} \gamma_k \quad (5)$$

where (k=1,2, …,n);

S3.1.2, calculating the land usage functional strength of each unit;

performing superposition calculation on the standard value $P_{ik}$ of each type of data element according to the weight relationship $\alpha_k$, and obtaining the land usage functional strength of each unit by calculating the ratio between the sum of the standard value of each data element in the unit and the construction land area $S_i$ of the unit,

$$G_i = \frac{\sum_{k=1}^{n} \alpha_k P_{ik}}{S_i} \quad (1)$$

where (i=1,2,…,m; k=1,2, …,n);

5. The address resolution data-based rapid identification method for construction land type according to claim 1 or 4, wherein the functional strength measurement on each type of construction land includes functional strength measurement on residential, functional strength measurement on administration and public services, functional strength measurement on commercial and business facilities, functional strength measurement on industrial, functional strength measurement on logistics and warehouse, functional strength measurement on road, street and transportation, functional strength measurement on municipal utilities and functional strength measurement on green space and square.

6. The address resolution data-based rapid identification method for construction land type according to claim 5, wherein in step S3.2, the comprehensive evaluation on each type of construction land includes:

S3.2.1, combining land usages, and calculating an average value of the land usage functional

strengths of the units,
on the basis of the functional strengths of eight classes of land usages, consolidating municipal utilities, road, street and transportation, industrial and logistics and warehouse respectively to obtain the functional strengths of six classes of land usages $G_{ik}$;
calculating an average value of six classes of land usages:

$$Q_i = \frac{\sum_{k=1}^{6} G_{ik}}{6} \quad (6)$$

where i=1,2,…,m; k=1,2, …,6;
S3.2.2, calculating a standard deviation of the land usage functional strength of a unit

$$\delta_i = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(G_{ik} - Q_i)^2} \quad (7)$$

where i=1,2,…,m
S3.2.3, calculating the significance of the land usage functional strength of the unit

$$R_{ik} = G_{ik} - Q_i - \frac{1}{2}\delta_i \quad (8)$$

where i=1,2,…,m; k=1,2, …,6;
if $G_{ik} > 0$ and $R_{ik} \geq 0$, then determining that this class of land usage in the unit is significant, otherwise, insignificant;
S3.2.4, a comprehensive evaluation of each type of land usage, on the basis of obtaining the significance of the land usage of each unit, determining the land usage according to the land usage dominate function, land usage compliance relationship, land usage compatibility and aerial photography image map.

7. The address resolution data-based rapid identification method for construction land type according to claim 6, wherein in step S3.2.4, the determination is as follows:
residential land usage: determining a unit having merely one significant land usage function which is a residential land usage function in the units as a residential land usage;
residential mixed land usage: determining a unit having two or more significant land usage functions which include a residential land usage function in the units as a residential mixed land usage;
administration and public services land usage: determining a unit having merely one significant land usage function which is a public services land usage function in the units as an administration and public services land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of public services land usage function and green space, industrial and warehouse, municipal road land usage function as an administration and public services land usage;
commercial and business facilities land usage: determining a unit having merely one significant land usage function which is a commercial land usage function in the units as a commercial and business facilities land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of public services land usage function and green space, industrial and warehouse, municipal road land usage function as a commercial and

business facilities land usage;
public services and commercial mixed land usage: determining a unit having two or more significant land usage functions which include a public services land usage function and a commercial land usage function in the units as a public services and commercial mixed land usage;
green space and square land usage: determining a unit having merely one significant land usage function which is a green space and square land usage function in the units as a green space and square land usage; and in addition, determining a unit having two or more significant land usage functions which include a mixture of green space and square land usage function and industrial and warehouse, municipal road land usage function as a green space and square land usage;
industrial and warehouse mixed land usage: determining a unit having merely one significant land usage function which is an industrial land usage function or a logistics and warehouse land usage function in the units as an industrial and warehouse mixed land usage;
municipal utilities and road, street and transportation mixed land usage: determining a unit having merely one significant land usage function which is a municipal utilities land usage function or a road, street and transportation land usage function in the units as a municipal utilities and road, street and transportation mixed land usage;
other mixed land usage: determining other unit which has two or more significant land usage functions in the units as other mixed land usage; and
land usage with indiscernible land usage: determining a unit having no significant land usage function as a land usage with indiscernible land usage.

8. The address resolution data-based rapid identification method for construction land type according to claim 1, wherein the checking method for urban construction land usage is:
on the basis of the functional strength measurement and land usage comprehensive evaluation of various urban construction land usage, obtaining a comprehensive evaluation diagram of the various urban construction land usage, respectively counting the number $n$ of space units with indiscernible land usage and the number $m$ of space units for construction land usage , and calculating the identification rate of the construction land usage:

$$\theta = \frac{\mathrm{m} - n}{m} * 100\% \quad (9)$$

if the identification rate of the construction land usage is $\theta \geq 80\%$ , it indicates that the identification rate of the land usage is qualified, otherwise, the identification rate of the land usage is unqualified and the space units need to be re-divided or relevant land usage identification data needs to be supplemented for calculation and analysis again; and
the checking method for the identification accuracy rate of urban construction land usage is:
delimiting a certain sampling range in the generated construction land usage division diagram, wherein the area of the sampling range shall not be less than 10% of the total construction land area, acquiring a current land usage distribution diagram of this range by a third party, or drawing the current land usage distribution diagram of this sampling range by means of aerial photography image map and electronic satellite map, and calculating the identification accuracy rate of the land usage by comparing the overlap area therebetween.

9. The address resolution data-based rapid identification method for construction land type

according to claim 8, wherein the checking method for the identification accuracy rate of urban construction land usage is:

(1) drawing a sampling range current land usage

newly adding a "" field in the GIS system which is different from rapidly identifying land usage type, and recording land usage properties in a corresponding space unit according to aerial photography image map and electronic image map to obtain a self-drawn current land usage analysis diagram; and

(2) counting overlapping land usage units and calculating the identification accuracy rate of land usage

newly adding a field in the GIS system, labeling space units with identical land usage as "$K = 0$", and labeling space units with different land usages as "$K = 1$", respectively counting the total area of the land usage units in the sampling range and the area of the space units with different land usages, and obtaining the identification accuracy rate $\mu$ of land usage by calculating the ratio between the area of the identical land usage in the sampling range to the total land usage area, and the particular calculation formula is:

$$\mu = \frac{\sum_{i=1}^{m} S_i - \sum_{i=1}^{m} S_i K_i}{\sum_{i=1}^{m} S_i} * 100\% \quad (10)$$

where (i=1,2,…,m);

it is defined that when $\mu \geq 80\%$, it can be determined that the accuracy rate of the comprehensive evaluation of construction land usage is qualified; otherwise, unqualified, and it needs to perform calculation and analysis again by means of data correction or checking.