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The study on mathematical processing methods of the farmland mobile collected information packet

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ABSTRACT

To meet the needs of machinery integrated intelligent mobile operating information collected function, study the information service system mobile data collection,processing, and storage methods based on fuzzy mathematical theory, discussesmathematical mechanism ofthe mobile information collected point data storage in the integrated informationdatabase, describes the design of the field information collected node, the design of the transmission system of mobile information collected terminal, and packet structure, mainly studies the information packet processing method and the generating method of the matrix information table, Initially solves the storage problems of the mobile information collected point packet in the comprehensive database, deep analysis the output data methods.

KEYWORDS

Field information collection; Fuzzy mobile terminal; GPS positioning.

INTRODUCTION

Informatization has become an irresistible trend of the social and economy in the Present Age. Informatization level has become a important criteria of a country and region modernization level and comprehensive strength[1]. Multi-source information service system is a typical application of information technology. At present, Multi-source information collection is based on the fixed points, the fixed points need large investment, long cycle, and IT professionals to repair and maintain, rely solely on the fixed point to information collection, on the currently condition that the information process depends on government-led investments, There are great difficulties. The mobile information collection methods greatly compensate for the shortcomings of the fixed information collection. It mainly use the way by increasing the intelligence operating machinery information gathering function. In the article, the location determination of the collection data, acquisition and storage of information are pioneerly done, establish a model for theacquisition information position determination, Construct the information processed, stored mathematical model, the work is a better solution to the above problem. In recent years, information technology has begun to accelerate the penetration and application in the field of agriculture[2].

THE SHORTCOMING OF AN INFORMATION COLLECTION NODE

For the example of the typical farmland information collection system, the fixed wireless sensor network nodes and aggregation nodes regularly distributed in the area which is monitored,responsible for collecting, a network is composed[3], send the information to the aggregation nodes, and achieve the dynamic display and the mass storage of the acquired information. The typical farmland information collection system fixed node's height respectively 0.5, 1.0 and 2.0m[4]. The information collection node hardware system consists of five parts, namely: the sensor parts, RF communications, the controller portion, the power and the expansion interface, enables access to multiple physical farmland soil temperature and humidity, conductivity, ambient air temperature and humidity in the field of small, light intensity, etc., And send message through RF (Radio Frequency, RF) unit. Node also has a multi-channel analog digital extension, RS232, SD card expansion interface, connected according to the actual needs.

Taking the three fixed malpractice into account on the fixed nodes, must develop mobile collection point so that a combination of fixed and mobile use, in order to meet the needs of agricultural information collection, and the development trend of the agricultural mechanization and automation.

(1)These hardware laying affects the large-scale mechanization and automation such as wheat, rice, etc., loss the scale economies, largely reduce the production efficiency, and increase the costs, also increase the farmers' agricultural information inconsistent.

(2)Poor working conditions, such as sprinkler operation, pesticide spraying, wet, etc., reduce the stability of the nodes work. When the collection system expand to the province, the country, the world's largest regional, the specialized technical personals are required for the Node maintenance, The lack of the agricultural technical personnel is a great challenge, also a challenge of the government investment funds to promote agricultural informatization.

(3)The fixed need more nodes over the mobile, also need more fund, becomes a barrier for the system applications.

From the above analysis, the mobile information collection point is the trend. The obstacle lies in its application for the purposes of scientific computing in agriculture, mathematical programming models, statistical methods of information research and forecasting applications, it requires that the research object is the same region, conducive to store information, comparison, processing, output and other work smoothly; but the mobile nodes collect different areas information. The difference has caused difficulties for the information storage and integration, a mechanism is needed to overcome this difficulty.

THE MOBILE INFORMATION COLLECTION TERMINAL TRANSMISSION SYSTEM DESIGN AND PACKET STRUCTURE

The mobile intelligent agricultural information service system terminal PDA based on the built-in GPRS communications, GPS positioning, digital cameras, embedded GIS and other functional modules can be effectively applied to the field of information gathering and interaction management. In such applications, it communicates very frequently between the PDA and the host computer, to ensure the accurate exchange of data; a reliable and efficient GPRS connection is needed. Generally, the communication between the PDA and the host computer is based on the TCP / IP protocol. At present,although a great plenty of the remote agricultural information collection and transmission system is established both here and abroad, such as farmland[5], a greenhouse[6-7], poultry farms[8], food[9-10], agriculture intelligence operations machinery[11], the study o f agricultural data wireless transmission application layer protocol[12] and other fields, whereas according to the characteristics of agricultural information collection and transmissionbased on the GPRS and TCP/IP protocols,study the mobile agriculture terminal data management and transmission method[13], expand to formulate the agricultural data application layer protocol for wireless transmission, to solve the Mobile information collection terminal data packet transmission problems.

A typical mobile agricultural information collection system consists of a digital sensor, ZigBee networks, agricultural PDA, GPRS wireless network and the host computer[14]. The farm PDA has GPS positioning and navigation, location-based access to images, thematic map production, property information search, wireless data farmland meshing, exchanged with the host computer and other functions. the mobile agricultural Information collected terminal system is

exchanged data via GPRS with the host computers, a host computer connects with multiple PDA, as the PDA does not bind to a specific farm, In the actual work, the PDA not only uploads the farmland information to the PC, but also downloads the relevant data of farmland from the PC to the current location (such as sampling points distributed data, attribute data), the flow of data exchange is larger, both data type information exchange and command-based information exchange. The work pattern is shown in the Figure 1.

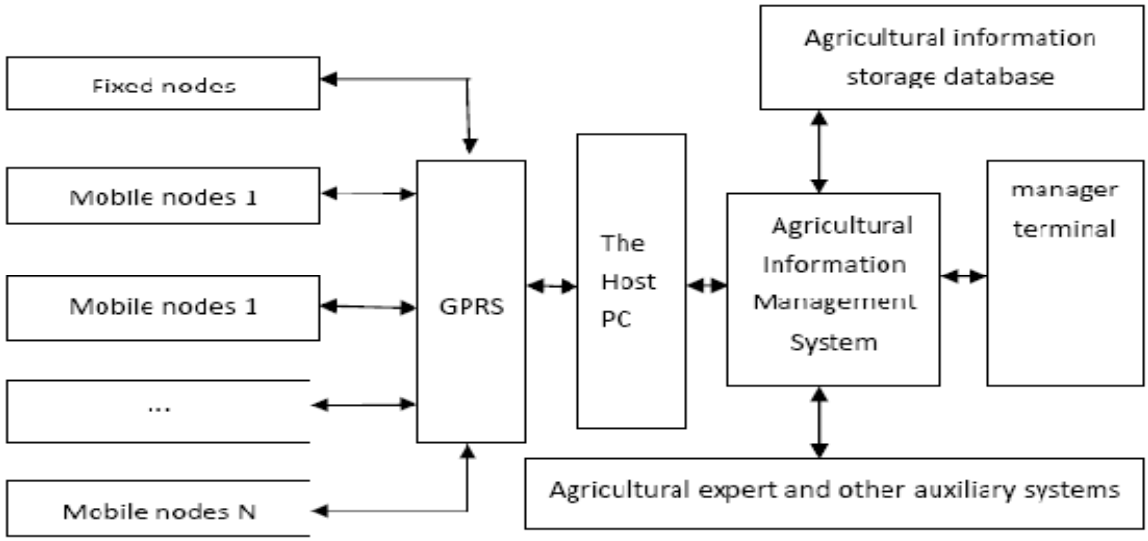

Figure 1 : The field information collection system working mode

The data Type of the field information collection points currently is mostly double-precision floating-point. For comparison of the data analysis in space and time, it is need that the information package contains the latitude and longitude location information, and also data binding between the information package and location. For this reason, the location information of the packet header contains the following contents, by region, descending, three levels, as is shown in the TABLE 1.

TABLE 1 : The agricultural information collection point zoning

Grade	Location information presentation
1	Large area of a plain, a mountain, a valley, etc., containing the region encoding ID, membership Region, affiliated companies, description of climatic zones, etc.;
2	Divideby crop type,including sub-region encoding ID, planted crops, varieties and other descriptive information;
3	Mobile collection points, including collection point code ID, latitude and longitude information, acquisition time (unity expressed by the East Area 8 time) and other information

Thus, the attribute data on the space-time is directly related. Based on the position information of the packet, Each mobile packet data is written in the sampling time point corresponding to the region, and the region information corresponding to the matrix information table, This approach to data management is efficient, also comprehensive store all agricultural data, the matrix data structure can be easily applied to extract, compare and analyze.

Through the analysis above,it can be seen that the same sampling point may be multiple sampling, acquire the dynamic change information. The mobile collection point packet uses a tree structure.

THE HANDLING MECHANISM OF THE MOBILE FIELD COLLECTION POINT INFORMATION PACKET

The field information data's analyses and applications are on the basis of the farm integrated information database. Due to the lack of mobile information collection point packet effective treatment, storage method, The main difficulties hinder the establishment of mobile information collection point. The following is the analysis of solving the difficulty.

The determination of the information packet location

According to the GPRS data, establish the network of the geographic Information, in accordance with the accuracy, any size mesh area will have mesh generation, the size of the unit area depends on the number of the intelligence work machine and the detail level of the information.

By means of the information collection function of the agricultural intelligence operation machinery, with different workplaces, data are collected in different areas, obviously, the data which is acquired is dynamic, so every time the information transmitted or recorded, the GPS calibration is required. In other words, each information contains the location information of the agricultural intelligent operation machinery; each unit area corresponds to a massive information matrix

table, according to the location information, fill the collected information into the different unit area information matrix table, Each unit area matrix information store in chronological table. According to thedistribution of the intelligent operating machinery, broadly divided into four cases, as is shown in Figure 2

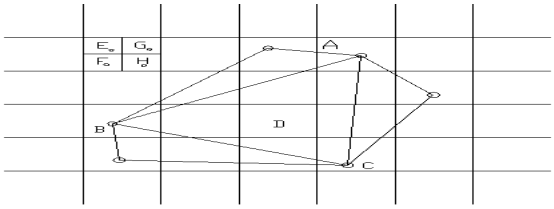

Figure 2 : The distribution of the mobile information collection point in farmland

The first type: within the designated units area, at this time, the intelligent operating machinery including information gathering function is being, then the collected information is filled in the information table which the designated unit area corresponds to, this type data written has the highest priority.

The second type: a type such as the area which is coded D, at this time, without the intelligent operating machinery including information gathering function, its information values can be used the data which the nearest point of the region's, Other methods may also be used, for example, use the arithmetic mean of its nearest three points' values, if the three values have large differences, take the sample standard of the three-point values,$s = \sqrt{\frac{\sum_{k=1}^{n}(x_k-\bar{x})^2}{n-1}}$, priority,followed by the first type.

The third type: the EFGH area as shown in Figure 2, for example, at the time, there are four intelligent operating machinery including information gathering function, then the values of an index take the arithmetic average of all the information values collected, if the three values have large differences, take the sample standard of the three-point values,$s = \sqrt{\frac{\sum_{k=1}^{n}(x_k-\bar{x})^2}{n-1}}$, priority followed by the second type.

The fourth type: the area is crossed by the smallest triangular which consists of the location of the three nearest intelligent operating machinery including information gathering function, the values of an index in the information packet take the arithmetic mean of the connection ends, if the difference of the values is large, take the sample standard of the four-point values,$s = \sqrt{\frac{\sum_{k=1}^{n}(x_k-\bar{x})^2}{n-1}}$, to this type of mobile information collection point distribution, the priority of data written in the matrix information table is lowest.

Through the upper graphical analysis, the above four cases include all the distribution of information gathering intelligence work machine in the every unit area. Through the upper four types information processing method, whether a particular moment in the region without a intelligence information collection work machine, the matrix corresponding to the area can fill information or fitting information. it is noted that the upper analyses based on the Numeric information, the other types data needs fuzzy processing, accompanied by the following normalization process.

The information standardization storage

According to the position information of the packet, judge the collection location number, fill the data into the corresponding position;'N' represents the total number of the regional division, 'X' represents the variable name, Equal to the total number of variables for each region, 'm ' represents it, 'y' represents every indicator of each variables, the y total number is 'n', According to the sampling period, the received packets at periodic fill the matrix information table shown in TABLE 2. The variable index values are filled in the matrix according to the upper four types, the qualitative information processing method is the same to the value information after the fuzzy standardization processing, generate the different scale region's matrix information shown in TABLE 2, it is stored into the farm information database, then, fill the different variables into a different storage unit.

The agricultural intelligent operating machinery acquired information contains the values data, random data, fuzzy data, etc, considering the wide application of fuzzy matrix of information processing in agriculture, In the different real variables indicators, the different data are generally the different dimensions, in order to make different dimensionless quantity compared, Usually need to make the appropriate transformation of the data, However, even this, the data is not always in the interval [0,1], so here's data standardization, According to the requirements of the fuzzy relation matrix, The data is compressed to the interval [0,1], the common transformations are following:

1) Pan - standard deviation transformation

$x'_{ik} = \frac{x_{ik}-\bar{x}}{s_k}$(i=1,2,⋯,n;k=1,2,⋯,m)

Whereby $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_{ik}$,$s_k = \sqrt{\frac{\sum_{i=1}^{n}(x_{ik}-\bar{x})^2}{n}}$

After conversion,the mean values of each indicator is '0',the standard deviation is '1', and eliminate the effects of dimensionless, but,So to $x_{ik}^{'}$' is not always in the interval [0,1].

2) Pan - range conversion

$$x_{ik}^{''} = \frac{x_{ik}^{'} - \min\limits_{1\le i\le n}\{x_{ik}^{'}\}}{\max\limits_{1\le i\le n}\{x_{ik}^{'}\} - \min\limits_{1\le i\le n}\{x_{ik}^{'}\}} (k=1,2,\cdots,m)$$

Obviously, $0 \le x_{ik}^{''} \le 1$, and eliminate the effects of dimensionless.

3)logarithmic transformation. The purpose is to reduce the magnitude different from the same region of the same index values between variables through the logarithmic.

$$x_{ik}^{'} = \lg x_{ik} (i=1,2,\cdots,n;k=1,2,\cdots,m)$$

After these three transformations, After the value conditions being met in the interval [0,1],the calibration also needed,to create a matrix of information tables' fuzzy similar matrix, the following is the method:

Let the domain $U = \{x_1, x_2, \cdots, x_n\}$,$x_i = \{x_{i1}, x_{i2}, \cdots, x_{im}\}$,determine similarity coefficients according to the traditional clustering methods,Seek the degree of fuzzy similarity matrix 'x_i', 'x_j',expressed as $r_{ij} = R(x_i, x_j)$, the methods of solving $r_{ij} = R(x_i, x_j)$are mainly borrowed traditional similarity coefficient method, distance method and subjective scoring methods, ect, the specific mothed is determined according to the nature of the specific indicators.

After conversion and calibration, the collected information matrix is converted into the fuzzy matrix information table.

TABLE 2 : The matrix information table

area number	indicator variables	y_1	y_2	…	y_n
1	X_1	a_{11}	a_{12}	…	a_{1n}
	X_2	a_{21}	a_{22}	…	a_{2n}
	…	…	…	…	...
	X_m	a_{m1}	a_{m2}	…	a_{mn}
2	X'_1	b_{11}	b_{12}	…	b_{1n}
	X'_2	b_{21}	b_{22}	…	b_{2n}
	…	…	…	…	…
	X'_m	b_{m1}	b_{m2}	…	b_{mn}
…	…	…	…	…	…
N	X''_1	c_{11}	c_{12}	…	c_{1n}
	X''_2	c_{21}	c_{22}	…	c_{2n}
	…	…	…	…	...
	X''_m	c_{m1}	c_{m2}	…	c_{mn}

THE MATHEMATICAL MECHANISMOF THE MATRIX INFORMATION TABLE DATA APPLICATIONS

Under the conditions of integrating fixed, mobile information collected to establish a comprehensive matrix information table, the breadth and depth of application of fuzzy mathematics will be greatly increased, and more and better information processing matrix table mathematical analysis will also appear, especially after the agricultural Comprehensive information base which based on the matrix information table is combined with the artificial intelligence and the expert systems of agriculture, the field information mathematical modeling capability will have a qualitative leap. The acquired information store and process through the method which the upper mentioned. Each dynamic indicators of all the information in every region can be extracted, and accordingly establish the matrix information table. Here are some mathematical methods conventional processing matrix information tables.

Fuzzy Comprehensive Evaluation based on Agricultural Comprehensive Database

Many phenomenons is caused by a combination of factors, Such as environmental pollution, meteorological situation, product yield, grain and cotton growth, etc, it is required to make a comprehensive evaluation and analysis. Most of these problems can be solved by using fuzzy transform.

Let factor set $X = \{x_1, x_2, \cdots, x_n\}$, x_i represent the factors which is needed to solve question;

Let judgment set $Y = \{y_1, y_2, \cdots, y_n\}$, y_i represent the levels of the determination;

From X to Y is a fuzzy mapping R, it reflects the fuzzy relationship as shown in TABLE 3:

TABLE 3 : The fuzzy relationship matrix

R X	Y			
	y_1	y_2	…	Y_n
x_1	a_{11}	a_{12}	…	a_{1n}
X_2	a_{21}	a_{22}	…	a_{2n}
…	…	…	…	
X_m	a_{m1}	A_{m2}	…	a_{mn}

Row vector $(a_{11}, a_{12}, \cdots, a_{in})$is the judgment considering of x_i in the Y.

Let X on fuzzy sets $A = (r_1, r_2, \cdots, r_m)$, $r_i$express the weighting factors on some question.

Then, the matrix' $A \circ R = B$' isa comprehensive evaluation of various factors,

$$\mu_{A\circ R} = \bigvee_{x\in X}\{\mu_A(x) \wedge \mu_R(x,y)\}$$

When considering the factors' heavy centralization, similarly, the multilayer comprehensive evaluation results can be obtained. Fuzzy Comprehensive Evaluation is an important tool of information processing; the range of applications is quite wide.

The fuzzy map theory based on agricultural comprehensive database

The fuzzy map is transplanted from a weighted graph from graph theory, the difference is that the weights are [0,1], the same to the fuzzy relationship matrix, Fuzzy graph can also be given fuzzy relations of two sets

A fuzzy graph G, a triple sequence group$G = (G, \sigma, \mu)$

Whereby $G = (G, E, \varphi)$, an undirected graph,named the base map,σ, μ are two maps:

$$\sigma : V \to (0, 1]$$

$$\mu: E \to (0, 1]$$

for any $e \in E$, meet:

$$\mu(e) \leq \sigma(u_e) \wedge \sigma(v_e)$$

(0,1] represents that they did not include the half-open interval 0, u_e , v_e represent two ends of the edge E.

Let G is the fuzzy graph G the base map $G = (G, E, \varphi)$, named the sequence that the points and edges spaced without the same edge:

$$W = (v_0 e_1 v_1 \cdots e_n v_n)$$

The sequences are called the chain of G,' n' is called the length of the chain, the chain is called path when the vertex is not the same.

Let u, v, two vertexes in the graph G, If there is a (u, v) path in G, Called vertices u and v are connected, the start and end points coincide which is called loop.

Let T be a subgraph of G, if it is connected, and no loop, then T is a tree of G, the connection of all points in the tree G is called support tree.

If T is a spanning tree of G, then, $T=(T, \sigma, \mu)$is alled the fuzzy support tree of G = (G, σ, μ),

For all the spanning tree T ' of G, if:

$$\sum_{e\in E(T')} \mu(e) \leq \sum_{e\in E(T)} \mu(e)$$

T is called a maximal tree of G, in T, the minimum weights on each side of the tree$\mu(e_1) \wedge \mu(e_2) \wedge \cdots \wedge \mu(e_n)$ is called the path's power called (u, v) (u, vIndicates the start and end), it can be proved that T is the largest tree of G with a necessary and sufficient condition that T has a unique strongest way.

Cluster analysis of agricultural information with the data source of information table matrix

From the fuzzy matrix obtained from the calibration, it can do the clustering analysis with the motheds of the transitive closure, direct clustering method, the biggest tree method, netting,etc.

In the fuzzy clustering analysis, it is that which is needed to be noted,For each type of $\lambda \in [0,1]$, to obtain the different classification,thus form a dynamic clustering Figure, it is more intuitive and image for the comprehensive understanding of the sample. In agriculture, a lot of time questions require to choose a certain threshold λ,to determine the specific classification of samples. This need to solve the problem of determining the threshold λ,there are two methods commonly used:

1)According to the actual needs,in the dynamic clustering graph,the value adjustments of λcan get the proper classification,Without the need to accurately estimate in advance a good sample should be divided into several categories, and also determineλwith the experienced experts who have the extensive expertise,so as to arrive at λ classification level.

2)Determine λ the optimum values with F statistic

Let the domain $U = \{x_1, x_2, \cdots, x_n\}$(Total number of samples 'n'), as the sample space,Each samplex_i with the m feature(acquired m data of the farmland information collection point);The original data matrix$x_i = \{x_{i1}, x_{i2}, \cdots, x_{im}\}$ is acquired, whereby,$\overline{x_k} = \frac{1}{n}\sum_{i=1}^{n} x_{ik}\ (k = 1,2,\cdots,m)$,

$\bar{x}$Become the center of the overall sample vector.

Let the value λ corresponds to the number of categories r, the class j sample size is n_j, the class j sample:$x_1^{(j)}, x_2^{(j)}, \cdots, x_{n_j}^{(j)}$, the class j cluster center is the vector$\overline{x^{(j)}}$=$(x_1^{(j)}, x_2^{(j)}, \cdots, x_{n_j}^{(j)})$, whereby $x_k^{(j)}$ represents the average of the k-th feature, that,

$$x_k^{(j)} = \frac{1}{n_j}\sum_{i=1}^{n_j} x_{ik}^{(j)}\ (k = 1,2,\cdots,m)$$

For the F statistic: $F = \frac{\sum_{j=1}^{r}\|\overline{x^{(j)}} - \bar{x}\|^2/(r-1)}{\sum_{j=1}^{r}\sum_{i=1}^{n_j}\|x_i^{(j)} - \overline{x^{(j)}}\|^2/(n-r)}$,

Whereby $\| \bar{x}^{(j)} - \bar{x} \| = \sqrt{\sum_{k=1}^{m}(\overline{x_k^{(j)}} - \overline{x_k})^2}$, represents the distance between$\bar{x}^{(j)}$and $\bar{x}$, $\| x_i^{(j)} - \bar{x}^{(j)} \|$is the distance between the i-th class in the J samples $x_i^{(j)}$ and the center $\bar{x}^{(j)}$.

The statistic F comply with F distribution which the degrees of freedom is r-1, n-r. its molecular characterizs the distance of classes to classes, the denominator characterize the distance among the classes from in the sample. Thus,if the value of F is larger, then the distance between classes greater, the difference between class and class is bigger,so the classification is better..

If $F > F_\sigma(r-1, n-r)(\sigma = 0.05)$,according to the theory that the variance of Mathematical Statistics,the differences between classes is remarkable,Shown that the classification is reasonable. If $F > F_\sigma(r-1, n-r)$has one more value F, at the case, it's desirable for the further examination with the difference proportional size$(F - F_\sigma)/F_\sigma$,finding a satisfactory value from the larger F can meet the requirement.

When using the F statistic to determine λ,If the distance between two vectors use the distance consist with the mothed of fuzzy similar matrix methods, it's related with the mothed of establish the fuzzy similar matrix.

For most of the information in the matrix information table is vague or statistics information, a broad space is provided for the application such as fuzzy probability, fuzzy comprehensive evaluation, fuzzy clustering analysis, application of the theory of fuzzy relational equations. The establishment of the agricultural integrated information database,solve the biggest obstacle to the application of mathematical methods, So as to determine pests and diseases, climatic conditions, production forecasts and other activities smoothly.

CONCLUSIONS

(1)Through further analysis of the structure of the mobile information collection point packet, and with the position information in the information packet, directly store in the farmland comprehensive information database when there are the mobile collection points in the division of the area, use the fitting the data when the division area is without the mobile collection points. The theoretical explanation of the collected data's transformation, calibration and other related work is conducted. Finally, the application of mathematical methods of matrix Information Table are analyzed in detail, the results shows that the methods are effective which are used to store, process data.

(2) The difference between fixed and the mobile information packet is that the mobile packet is with mobile location information, both are not affected the data outputting in a farmland comprehensive database.

(3) Information collection should be combined with the fixed and the mobile, play their strengths. For some large-scale, high mechanization and automation of cropland, use the intelligent operating machinery to collect information dynamically; with the Fruit, animal husbandry, fisheries, forestry, choosing the fixed will be greater economical.

(4) For the same area of the region, the mobile points are less needed,but, the above analysis shows that the cardinality of the mobile point can't be too low in order to ensure the data accuracy because of the Fitting data.

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