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Research On Mobile Medical Integration System for Children

Zhou Lianru, Jiao Xiongfei, Liu Lijun and Li yuanqin

Hebei children's Hospital of Information Center
zhoulianru@126.com

Abstract

In view of the valuable medical resources at home and abroad, especially considering the fact that children's medical resources can't meet the needs,the author designed the mobile medical integration system with the help of mobile Internet platform and cloud computing platform.The system is divided into two parts of the mobile terminal and cloud computing platform, which are used respectively by the guardian and the doctor. The health monitoring terminal designed for children are wearable watches whileAPP is developed for the guardian and the doctors.Cloud platform designed a platform for data storage, message processing, functional applications and other modules, forming a "cloud+client" service model.This system makes the children's disease prevention, emergency treatment and medical treatment behavior become more convenient and fast, protects the healthy growth of children, provides reference and solution for the future development of medical care.

Keywords*: mobile medical; cloud platform; data compression; message push*

1.Introduction

Health care reform is a worldwide problem, the rapid development of the Internet brought tremendous impact to the traditional industry, but also provided a new way of thinking to solve the medical problems and to relieve the contradiction between doctors and patients, that is, mobile medical.In foreign countries, taking one to one treatment model based on a private doctor through the mobile phone or e-mail appointment of common disease treatment has become a norm.But in the domestic, the patient population base is bigger, mobile medical treatment in our country is still in the initial stage, social cognition degree is low, the specific business operation mode is still immature [1].The wearable medical instrument introduced in the literature [2] can realize non-invasive detection, diagnosis and treatment to the human body;literature [3] used a variety of mobile medical server and intelligent mobile terminal applications in the hospital to achieve a mobile medical system;literature [4] used the smart phone to collect, transfer and analyze the pulse data, and used the self-organizing method to set up the medical sharing network, that complete the sharing of medical data.

These studies and products have only improved the flexibility of medical devices, or completed the medical treatment and medical information sharing in the hospital by using smart phones.For this particular group of children who are susceptible, susceptible to accidental injury, prevention is paramount. The above research and products cannot meet the requirements that monitor the health status of children and establish a child health record card.A "cloud+client" mode of mobile medical integration system is proposed in this paper.The system is divided into two parts of wearable mobile devices and cloud computing platform,which make the medical resources play a more efficient role and provide personalized, accurate and full life cycle of health care services for each patient and their families.

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2. Platform and Innovation of System Development

System development is divided into two parts of the mobile terminal and the cloud. Mobile terminal development selects general Android platform while cloud development selectscloud computing platform.With basic services, it focuses on the development of application level. The following on the two platform were introduced.

2.1 Android Platform

The Android platform [5] launched by Google is a development platform for smart phones. Android is based on Linux system. Usually, we divide the Android architecture into four layers: application layer, application framework, function library and Linux kernel.

2.2 Cloud Platform

The basic framework of cloud computing platform [6] integrates extensive and huge IT hardware infrastructure, data storage facilities, system platform and other basic resources through virtualization, then unified scheduling and management, created a pool of resources sharing and cooperation with each other. Users in such a basic platform can get 3 levels of service, namely: infrastructure that service IaaS, the platform that service PaaS[7] and software that service SaaS. Each layer of the service can not only provide services to the upper level, but also can provide users with information services.

The system innovation of cloud platform [8] has the following several points:

(1) Using the Internet of things technology, combining with the new trend of health management, providing a platform for two-way selection of users and health management institutions.

(2) The design of the system that achieve the service platform simplifies the complexity of the business platform itself and reduces the cost of building a health guard platform.

(3) The system platform integrates the health sensing terminal, communication networks, hospitals, communications operators and other resources.

(4) Realizing the collection, storage, calculation, display function of massive data through the establishment of mobile Internet platform based on cloud.

3. System Design

Children mobile medical integration system is shown in figure1. The system set up two kinds of role of supervision institutions and ordinary users. Ordinary users are divided into guardian users and physician users. Setting up the children's medical service function module in the guardian client end, such as children's health status, health care methods, dietary recommendations, hospital appointment, love rescue, online medical and other modules. Setting up the module of online visit, disease feedback in the doctor client end. The data provided by children wear products will be processed back to the guardian client end and the doctor client end. And under the supervision of the institutions, the doctor and patients are more collaborative with the aid of children's medical integration system. System provides personalized, accurate, full life-cycle health medical services for each patient and their families.

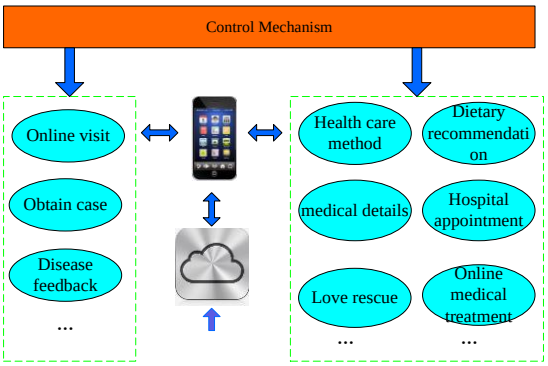


Figure 1. Children's Mobile Medical Integration System

3.1 Database Design

In order to store and share system data, this paper uses Server SQL database software to build database [9], the database mainly includes three modules, they are user data module, hospital data module and disease data module. According to the three data module, the data is subdivided into eight tables, they were the user information table, the hospital information table, the doctor information table, the treatment recommendations table, the disease information table, the disease prevention table, the previous diagnosis table and the health recommendation list. Establishingthe data tables according to the relationship between the table.This paper takes the user information table as an example andestablishes table 1.

Table 1. User Information Table

Name	Type	Properties	empty	Additional	Indexes
ID	int(10)	UNSIGNED	No	AUTO_INCREMENT	Primary
Name	varchar(20)		No		
Sex	varchar(5)		No		
Password	varchar(20)		No		
Email	varchar(30)		Yes		
Telphone	varchar(11)		No		
IdentityCard	varchar(18)		No		
Guardian	varchar(10)		No		
MedicalHistory	varchar(20)		No		

3.2 Data Compression

The system should detect the objective data in the children's body at the detection end, and upload the data to the cloud. The detection information of each child is stored in the database, so as to carry out cloud processing. Because the historical data need to be analyzed, so the amount of historical data to be saved is very large. If these data are stored directly, it will not only take up a large amount of system storage space, but also reduce the real time of the database, so that data transmission and query becomes difficult. So the data compression technology is introduced into the real time database, it can keep the database high real-time and increase the capacity of the database as far as possible.

The system uses OPMC algorithm, it clustered the data into fewer cluster center point by clustering method to eliminate similar, redundant data, so as to realize the data compression. The data object is mainly the row data of the data table in the database.

An optimal matching model of OPMC algorithm using the general clustering method. Suppose $A = \{a_1, a_2, ..., a_3\}$ is the data set to be performed,

where $a_i = [a_{i1}, a_{i2}, ..., a_{im}]^T$ represents m attribute values of the i sample. A is divided into k sub sets $AB_1, AB_2, ..., AB_k$ .Here, $\bigcup_{i=1}^{k} AB_i = A, AB_i \cap AB_j = \varnothing$, $i \neq j$ .The problem to be solved by clustering is to give the objective function $\min/\max J(A;P)$,obtain an optimal k partition. Matching refers to the allowable error e of a given attribute. After cluster grouping, if the clustering center value and the actual value in the attributeerror r within the e range, the more the number of the attributes satisfied the matching condition, the better the match. At the same time, it also seeks to minimize the storage costs, including model data and isolated data. The better the overall degree of matching, the less the independence of the data. So it's going to find the best match.

The objective function of OPMC algorithm is $\max\ sumH = \sum h(a_i)$, $i = 1, 2, ..., n$,while $h(a_i) = \max h(a_i, P_i)$, $h(a_i, P_i) = m - \sum_{c=1}^{m} g(|a_{ic} - P_{jc}| - e_c)$, $j = 1, 2, ..., k$,when $a \geq 0$, $g(a) = 1$ while $a < 0$, $g(a) = 0$ .Among them, $h(a)$ is the best matching attribute number of a_i ; $sumH$ is the sum of the optimal matching attributes for all tuple.

Algorithm It-Compress [10] classifies the table data tuple and selects a representative tuple in each category according to the similarity of some attributes in the large data table, any tuple of each class is represented by a tuple, unless its error with representative tuple is out the specified range. OPMC algorithm references the idea of It-Compress algorithm and carries out appropriate treatment. For example, in the process of adjusting the value of the cluster center, calculating the attribute interval that most frequently occurring. It-Compress uses the sliding window mechanism between the split cell while this algorithm uses two pointers s and t to scan data. Time complexity is $O(n)$, n is the number of samples. OPMC algorithm is based on the data table and error e of the allowable to compute tuple M cluster center matrix P and isolated data. Giving the initial cluster center matrix P , then loop to calculate the total number of matches $sumH(P)$,and for each tuple A_n in the data table to calculate tuple in the P , finally, adjust the value of each tuple in the cluster center matrix on the basis of the temporary cluster grouping P .

OPMC algorithm first uses the optimal matching model to screen before compression, overcome the impact of the large amount of calculation when DHFXSC algorithm structure Huffman tree, so as to MSA algorithm. It can also improve the compression efficiency and OPMC algorithm is especially suitable for linear correlation between data attributes, this is better than incremental SDT algorithm.

3.3. System Function Design

According to different users, the system design is applicable to the two types of APP: guardian and physician client, the main work process is as follows:

According to the measure of children's wear products: body temperature, pulse, blood pressure, trace elements, blood routine test, allergen test and other objective data, the guardian user terminal upload detected data to the cloud through the Internet technology. Through the cloud computing platform, it feedback processed information to the guardian client. Guardians view the child's health status according to the information from the cloud feedback, timely understand children's disease prevention and health knowledge and can always consult a doctor at any time through the mobile terminal.Physician client guide and treat based on the previous medical records of patients and the patient's condition, and provide prevention and treatment programs based on the data detected by the patient every day, until the patient recovered.

On the basis of the above system and main work flow, if the guardian client detects the child's temperature is high, guardian should take care of the children according to treatment and dietary recommendations provided by client, until all the indicators of children tend to be normal. If the guardian wants to treat the child through the hospital, there are two kinds of treatment: the hospital appointment, online medical treatment. If you choose the hospital appointment, the system will recommend the hospital according to the patient's condition through the map service function module. System automatically recommend the experts and the time according to the hospital selected by the guardian, then, guardians order appointment time according to their own circumstances. Guardian can also choose online treatment to see a doctor, the system will recommend the doctor in accordance with the terms of the patient's condition, the guardians choose the doctor according to the doctor's introduction and clinical experience. If doctor see online patients,they automatically pick up patients' information through the cloud, including name, age, gender, medical history, previous medical record, and provide a treatment plan for the patient. The specific system function diagram is shown in Figure 2 and 3.

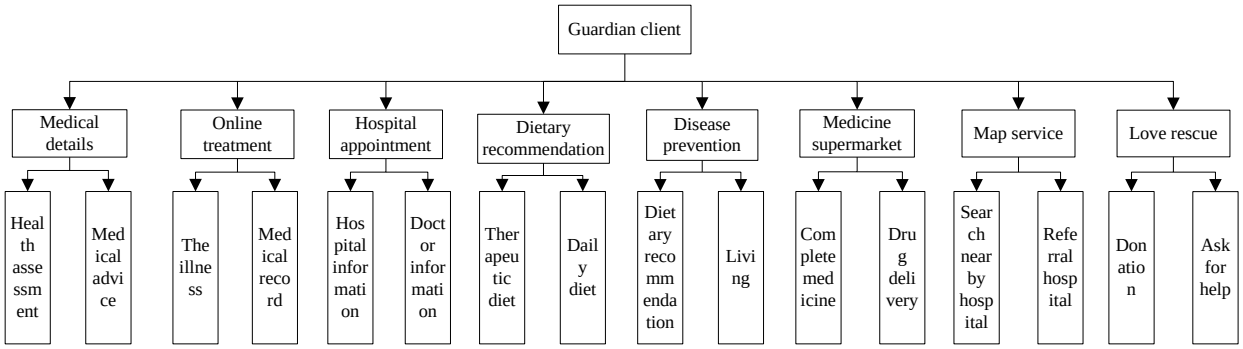


Figure 2. Function of the Guardian User Terminal System

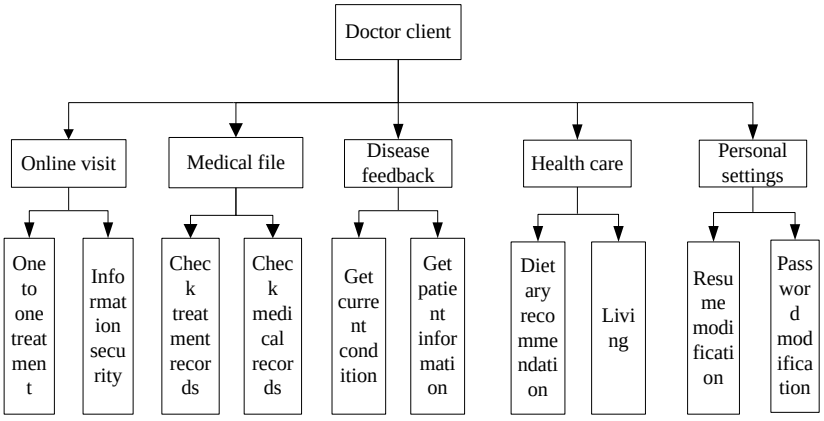


Figure 3. Function of the Physician Client System

4. Main Modules of the System

Data storage and processing are completed by the cloud computing platform, therefore, cloud computing platform is the key design of the system, the main module of the cloud computing platform are storage module, message sending module and map service module.

4.1 Storage Modules on the Cloud Platform

All of the data in the system is stored in the cloud, so it is necessary to design and develop the storage module on the cloud platform. Storage module for cloud platform

development HMegatore adopts Megatore that similar to Google distributed storage system. The aim is to combine the advantages of the relational database and the NoSQL database, and achieve the scalability and consistency of the storage system by using replication techniques. The system architecture is shown in figure 4.

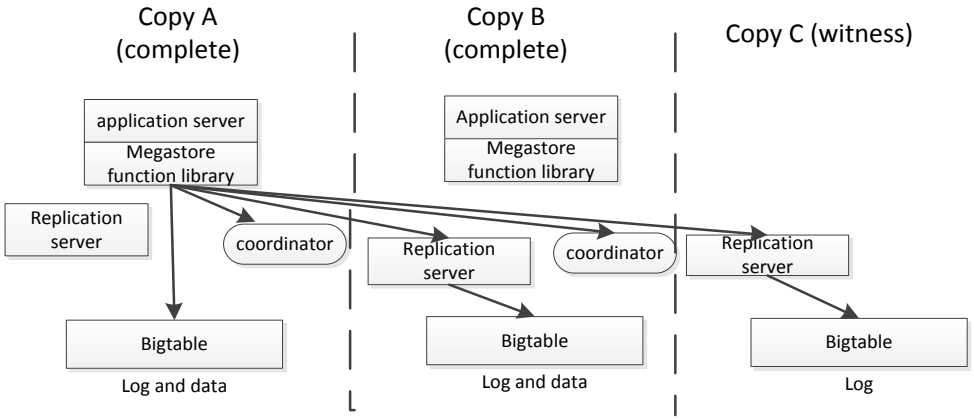


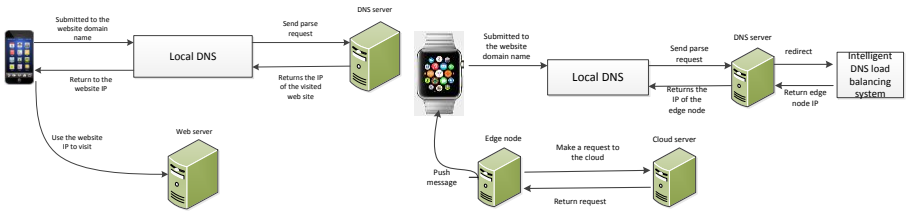
Figure 4. System Architecture of Cloud Platform Storage

There are three kinds of copies in the HMegastore system, namely, complete copy, read-only copy and witness copy. The complete copy Bigtable stores the complete log and data, read-only copy reads recently a consistent data, and witness copy participates in voting when Paxos algorithm cannot produce a resolution during the implementation process.

4.2 Message Push Service Module

Android mobile network is established based on cloud computing platform, and what different from the traditional health care platform is that it developed four special features. This is also the characteristics of the system.

As shown in Figure 5 (a), the traditional health care system is based on B/S mode, the client submits the application information to the server, and then the server sends the message to the client. The server cannot send messages to the client without application. Moreover, the client needs to dynamically monitor the WEB server, and keep the connection with the server. This approach will cause that mobile devices frequently open wireless communication module which is a great waste of electricity.



(a) (b)

Figure 5. System Structure Diagram

In order to solve the problems existing in the traditional B/S mode, using CPNS (cloud messaging service) to replace the dynamic request service [11] in the traditional CMTHC system.As shown in Figure 5 (b), the first time, the message service enables users to get access to the latest medical information and to obtain feedback on the problem.Compared with figure 5 (a), CPNS system increases the intelligent DNS load balancing system in the DNS server, set up the cloud server's proxy server in the front of the cloud server, that is, edge node.When the DNS server resolves the domain name, intelligent DNS load

balancing system perform a redirection process andthen return to the edge of the node IP.After cloud server getting the edge node IP, the message is sent to the edge node, the cloud server waits for the return code of the edge node.Edge node sends the message to the mobile terminal at the first time. If the push was successful, the edge node returns to the cloud server"Push success", if push fails, the edge node returns to the cloud server"Push failed".

4.3. Map Service Module

In order to complete the treatment of children with paroxysmal diseases, it is necessary to find a nearby hospitaland plan optimal path conveniently and rapidly, then the map navigation service modulewas developed. This module uses the "Baidu map" platform to set up the development environment, making use of the built-in function of "Android system API", the map service module has the function of positioning,navigation and recommendation.

Compared with other positioning methods, this module allows users to choose different positioning methods by detecting the user scenarios, that is, WiFi positioning, GPS positioning and the integration of the two methods. This dynamic method can effectively balance the relationship between power consumption and positioning accuracy. At the same time, the map database is deployed on the cloud platform, Android mobile terminal using WEB services to communicate with the cloud platform, cloud platform returns the results of the query. Map data is provided by Baidu maps, database records in detail the base station of mobile terminal and the location of the WiFi access point. The recorded information also includes the identification code of base station, the MAC address of the WiFi access point, and the relationship between the coordinates and the location. The user terminal can detect the WiFi access point and obtain the information of the base station, and then upload the information through the communication module, and lastly, compare with the information of the database. Its structure is shown in figure 6:

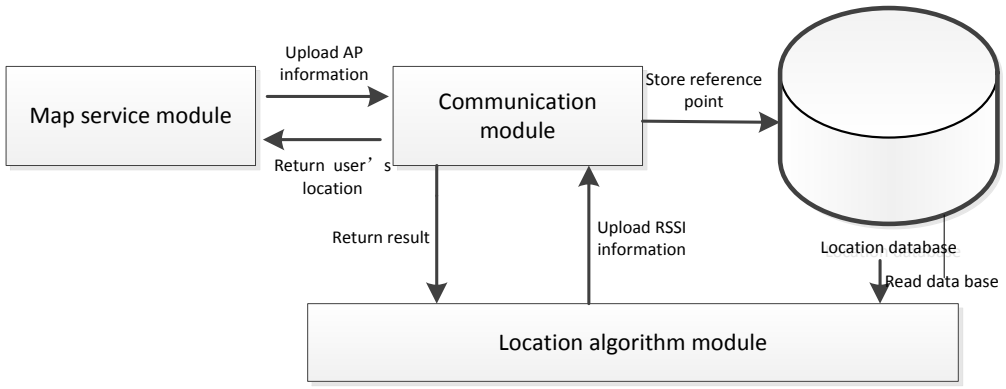


Figure 6. Function Structure Chart

4.4. A Map Matching Method based on Fuzzy Logic

Based on the section4.3, after the user searchingnearby hospital, this module will choose an optimal path to arrive at the hospital.In order to allow users to accurately track the path planning, the path matching of the map is essential.

4.4.1 Distance from Point to Line

If the point to the line segment where the linear projection on the line，thedefinition of distance from point to line vertical length or the shortest distance to the two endpoints.This definition is suitable for the straight line segment and the line segment.

The distance here is the Euclidean distance of two-dimensional plane, that is:

$$d = \|X^2 + Y^2\| = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad (1)$$

4.4.2 Line Matching

If a curve is divided into any number of arbitrary proportion, and the segmentation point falls on the other curve, the two curves match strictly.This is also suitable for line matching. The basic idea of line matching is to calculate the average distance d and the average distance error δ between the shape point in a line and the other reference line.With the reciprocal of the mean distance as evaluation index, the matching degree of the two lines is evaluated.Average distance is used to evaluate the closeness of the two broken lines, if the average distance is small, the matching degree is high, otherwise matching degree is low. If the average distance error is small, the shape similarity of the two lines is high. That is to say matching degree is high, otherwise the matching degree is low.Assuming that the line1 has n shape points,their distance to the line2 is$d_1, d_2 \ldots d_n$,the average distance between the line1 and the line2 is:

$$d = \frac{1}{n}\sum_{i=1}^{n} d_i \quad (2)$$

Mean distance error δ is:

$$\delta = \sqrt{\frac{\sum_{i=1}^{n}(d_i - d)^2}{n-1}} \quad (3)$$

The matching quality index of broken line1 and line2 is defined as:

$$\lambda = \omega_d / d + \omega_\delta / \delta \quad (4)$$

ω_d and ω_φ are the proportion that average distance and the average distance error in the evaluation index system,$\omega_d + \omega_\varphi = 1$.

4.4.3 Determination of Error Region

According to the principle of map matching, the first step is to determine the error region of the vehicle position, which contains a certain probability of the current location of the vehicle, this is usually defined by a probabilistic criterion.According to statistical theory, the positioning error ellipse can be derived as follows:

$$a = \hat{\delta}_0 \sqrt{\frac{1}{2}(\delta_x^2 + \delta_y^2) + \sqrt{(\delta_x^2 - \delta_y^2) + 4\delta_{xy}^2}} \quad (5)$$

$$b = \hat{\delta}_0 \sqrt{\frac{1}{2}(\delta_x^2 - \delta_y^2) - \sqrt{(\delta_x^2 - \delta_y^2) + 4\delta_{xy}^2}} \quad (6)$$

$$\Phi = \frac{\Pi}{2} - \frac{1}{2}\arctan\left(\frac{2\delta_{xy}}{\delta_x^2 - \delta_y^2}\right) \quad (7)$$

Among them,$\delta_x$and $\delta_y$are the standard deviation of the East and the north that electronic map system output;$\delta_{xy}$is covariance;a is the long half axis of the error ellipse, and b is a short half axis of the ellipse;$\Phi$is the angle between the ellipse long axis and the direction of the north.$\delta_0$is the posterior variance of unit weight, which is also called the expansion factor.Ellipse center is the current vehicle position.The measurement error is assumed to obey the standard normal distribution, and the standard ellipse$(\delta_0 = 1)$ corresponds to the confidence region of the 39%.In the case of 2D,$\delta_0 = 2.15$can gain

95% credibility.

4.5 Map aided location algorithm

Path analysis is one of the contents of spatial analysis, and it is one of the most basic functions of the navigation system.The core is to solve the optimal path.The optimal path is a path that satisfies some optimization conditions in the road network, such as the shortest distance, the lowest transportation cost and so on.It is of great practical significance to find the optimal path between two points on the map, for example, to reduce energy consumption and shorten the journey time.Finding the optimal path through the path analysis will bring huge economic benefits.

Map aided location algorithm aims to obtain the shortest distance in road network.Finding the shortest path is a special problem in the optimal path.After obtaining theroad that user will walk from the start point to the target hospital.As shown in figure 7.Section R is the most likely road that the users will walk.The user's current location point is $P(x_p,y_p)$ .The distance between the point and the section R is $d=\sqrt{(x_r-x)^2+(y_r-y)^2},(x_r,y_r)$ is in the line where the line segment is located.According to the nearest neighbor rule,d should get the minimum value,min (d) is the intersection of R and its normal.Points$p_t(x_t,y_t)$ can be obtained according to the equation of two straight lines:

$$p_t=\begin{pmatrix}x_t\\y_t\end{pmatrix}=\begin{pmatrix}\left(x_a tg^2\partial+\left(y_p-y_a\right)tg\partial+x_p\right)\Big/\left(1+tg^2\partial\right)\\\left(y_p tg^2\partial+\left(x_p-x_a\right)tg\partial+y_a\right)\Big/\left(1+tg^2\partial\right)\end{pmatrix} \tag{8}$$

Among them , $tg\partial=\dfrac{y_b-y_a}{x_b-x_a}$

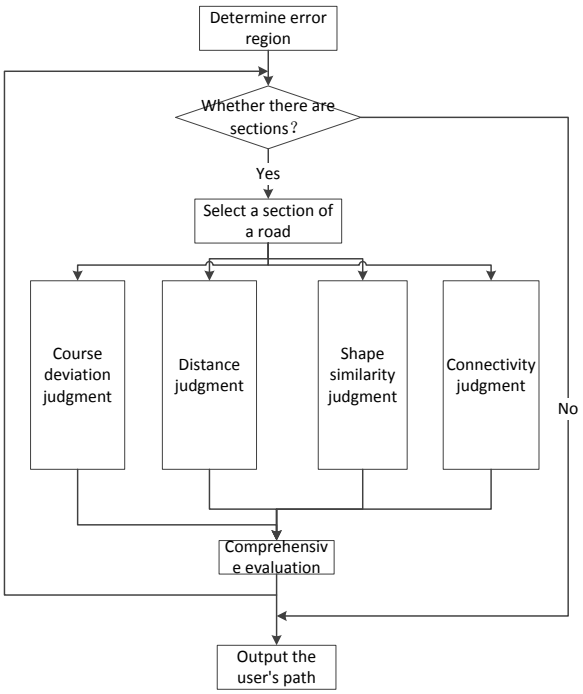


Figure 7. Map Matching Algorithm based on Fuzzy Logic

According to definition that distance from point to line segment, we should determine whether the point $p_t(x_t,y_t)$is on the road R,if it's not on the road, take the nearest end of

the road.

(1) If $x_a > x_b$and $x_t > x_a$,or $x_a < x_b$and $x_t < x_a$,then $p_t = A = (x_a, y_a)$;

(2) If $x_b > x_a$and $x_t > x_b$,or $x_b < x_a$and $x_t < x_b$,then $p_t = B = (x_b, y_b)$;

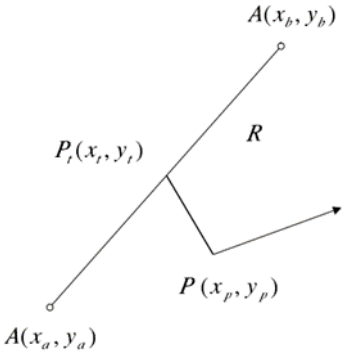


Figure 8. Map Aided Location Algorithm

Point p_t is thelocation of the user's current position after the map matching in the electronic map.The user position can be matched with the road in the electronic map, and the user positioning error is defined in the radial direction of the user's walking path, thereby ensuring that the user accurately reach the desired hospital.

5. Conclusions

Based on the current domestic and foreign research status, this paper analyzes the development trend of mobile medical industry. With the advantages of cloud computing and big data platform, combined with the new technology of health management, cloud platform and Internet, the integrated system of children's health care based on mobile Internet is designed and constructed. At the same time, functional planning of the system, the overall design and implementation of the program are given. Guardians have access to understand children's health, disease prevention and health knowledge through the new platform, and view the filing of child health card, get online guide from doctors. The system docks with hospital information system and residents' health card. The system changes the traditional way of medical treatment, and provides a new idea and a feasible plan for the future medical plan.

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Authors

Zhou-Lianru. She is a director of the nursing and her main research direction is the medical information. She works at the Hebei children's Hospital Information Bureau.Address is No.116 Meiji street, Shijiazhuang City, Hebei Province.