The Research of GPS Localization and Map-Matching Method

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***Abstract*—Map-Matching,integrate the vehicle positioning data with digital road network,is an important posotioning technique in the vehicle navigation and positioning system. Map-Matching as software technology,which can improve the positioning accuracy without increasing too much cost in equipments,is widely used in many systems.The paper is concentrated on data proessing and Map-Matching in vehicle navigation system.Data processing includes the resolution algorithm of the GPS data,with combination of principle of coordinate transformation,changing the coordinate.As to the map-matching part,for Map-Matching algorithm,a new maping method is adopted according to angle when driving,the algorithm is programmed and realized in Visual Basic 6.0.Consequently,highly matching precise and more fast matching velocity are obtained.**

Keywords-Global Positioning System; Map-Matching;Data processing;Vehicle Location&Navigation system(VLNS)

I. THE GPS LOCALIZATION PRINCIPLE AND THE POSITION ERROR ANALYZE

A. The principle of GPS

The GPS receiver receives in the ground located at the space at least 4 GPS localization satellite signals(electromagnetic wave).According to the time difference which from the positioning signal to the GPS receiver, the GPS receiver may calculate the accurate distance from satellite. Also because the GPS localization satellite in the space position is known, therefore may adopt the formula, converting the location and the distance into when GPS receiver is in the ground (longitude 、 latitude、 elevation and so on).

B. THE ERROR ANALYZES OF THE GPS

Through analyzing the basic principle of the GPS, the pseudo distance observation quantity's main error source has 3 aspects:

1)Aero space vehicle part: including satellite ephemeris error and satellite clock deviation;

2)Signal dissemination part: including ionized layer propagation delay of electric wave signal, tropospheric propagation detention and multi-diameter effect;

3)Subscriber system part: including user receiver measuring error and user counting error;

C. GPS SIGNAL PROCESSING FLOW

The GPS signal processing flow is this:first disintegrating the data which the GPS receiver outputs,gaining the WGS-84 coordinate(longitude and latitude), then after the coordinate transformation its transformation in the coordinate system which uses actually to us, transforming again after the Gaussprojection transforming it into the place coordinates,then uses some algorithm match to the map.

II. DATA PROCESSING OF VEHICLES LOCALIZATION

The GPS receiver will output a data every other 1 second, what outputs is the NMEA0183 form data, in these data has contained position coordinates, speed, direction, time and validity of GPS locating point. When the GPS signal expires or not available, the receiver will regard the output data marker as the invalid data, making the data pretreatment before the map-matching,rejecting unusual data, thus guaranteeing match accuracy.After the data processed,it may send to GPS map-matching module as the data origin of the map-matching.

A. The Realization of GPS Receiving Data Analysis Algorithm

After GPS receiver gathering data, needs to carry on the partition interception to the locate statement，carrying on the data analysis,to obtain the information of accurate longitude, the latitude,running speed ,the time and so on.

The data analyses algorithm's flow chart(figure 1) is as follows：

The data interception algorithm's flow chart(figure 2) is as follows:

III. MAP-MATCHING

The basic idea of map-matching is by matching the GPS track of vehicles and the road section object of the vectorization in the map,seeking for vehicles current path, and projecting GPS positioning point to the path.Such,on one hand provided the vehicles demonstrated on the electronic map,caused the vehicles won't deviate the path when demonstrating because of the positioning error; on the other hand by projecting enables the vehicles location data only to remain GPS error in radial component of the vehicles route, in order to improve the positioning accuracy.

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A. The Design and Realize of the Map-Matching Algorithm

The paper designed an integration map-matching algorithm,different road section uses the different matching algorithm. On the general straight line path which the change of the angle is low,using the historical path inference matching algorithm; in the turning which the change of the angle is high and the complex crossroads,using curve fitting matching algorithm.

B. The Step of Algorithm Realize

Step 1: Through the GPS receiver to receive data, carrying on screening to the data, deleting invalid information point. Then from received data stream to read out the latitude and longitude information of locating point point by point, through the corresponding coordinate to transform again, taking the final locating point information to prepare the next step analysis processing;

Step 2:Fixing candidate road section of the locating point,and taking this spot as a center , making a circle by certain length, to ask the vertical projection distance d from the point to all the road section in the circle, the choice is away from certain threshold value the road section as the candidate road section, and calculates various road sections slope value k_0 according to the road section head and tail vertex coordinate.

Step 3:According to the curve fitting principle to carry on the multinomial curve fitting to the locating point. This algorithm uses twice the multinomial to carry on the curve fitting,each time selects the first two,the next two and the location point altogether 5 points to carry on fitting, can get a smooth curve of good description history walk path, simultaneously acts according to 5 observation points the place coordinates to extract the fitted curve the slope:

$$K=\frac{-\sum_{i=1}^{5}x_i\sum_{i=1}^{5}y_i+5\sum_{i=1}^{5}x_iy_i}{5\sum_{i=1}^{5}x_i^{2}-(\sum_{i=1}^{5}x_i)^{2}} \quad (1)$$

In the formula, x、y expresses GPS locating point place coordinates. Principle which matches by the map, only need pay attention to k, k reflects the vehicles general travel direction, in the scope of the measuring error permits, this article thought that the road sections is acceptable when the angle is less than 30° between it and track;

Step 4:According to fitted curve slope k and candidate road section slope k_0,to judge what kind of matching algorithm to select; when the intersection angle is within 30° ,electing historical path inference matching algorithm; otherwise to select curve fitting matching algorithm, then turn to step 5;

Step 5:The cost function of curve fitting matching algorithm:

$$S = p_1 \frac{\arctan(k)-\arctan(k_0)}{\pi/6}+p_2\frac{d}{60} \quad (2)$$

This article chooses S to take the minimum value the road section for the vehicles current travel road section, after having determined the vehicles current travel road section, will use map matching algorithm which based on the position point to project to this road section.p_1 and p_2 may act according to the actual situation adjustment, we choose p_1 =0.6, p_2=0.4.

IV. Experimental Result And Discussion

Table 1 has given three kinds of map-matching algorithm data which in the match accuracy and the match time,the data is the average value which we have tested 10 times.

TABLE I. THREE MATCHING ALGORITHM CARRY ON THE MATCH TO 100 GPS LOCATING POINTS PERFORMANCE DATA

Match Method	Match Accuracy	Match Time (second)
Historical path inference match	95%	37.00
Curve fitting match	99%	40.27
Integration map-matching algorithm	97%	38.56

We may see from the table , integration map-matching algorithm can obtain well in the match accuracy and the quicker match speed. This algorithm has overcome the mistake chain-reaction malpractice which to a certain extent the historical path inference match easy to appear;at the same time, because the new algorithm has used the high real-time history path inference matching algorithm on the rectiunear figure path, reduced the algorithm complexity, thus enhanced immediacy of the entire algorithm.

V. Peroration

In the intelligence transportation system, the vehicles positioning and navigation system is an extremely important part, it not only provides the convenience for the user journey, thus effective solving traffic jam, environmental pollution and so on a series of transportation question, and has led the correlation technique fast development, such as GPS whole world satellite positioning system, GIS geographic information system, MapInfo and electronic map and so on. Moreover, this research, although has made certain practical progress: the map- matching algorithm has obtained the high match precision and the quick match

speed, but still had the place which the need further consummates. Describes as follows:in the paper uses the corresponding matching algorithm separately through the change of angle size. In the later research, we may further consider the division of GPS locating point, thus may select the more concrete branch matching algorithm to distinguish the vehicle is on the overpass or under the overpass and so on, in order to obtain the higher match precision and the quicker match speed.

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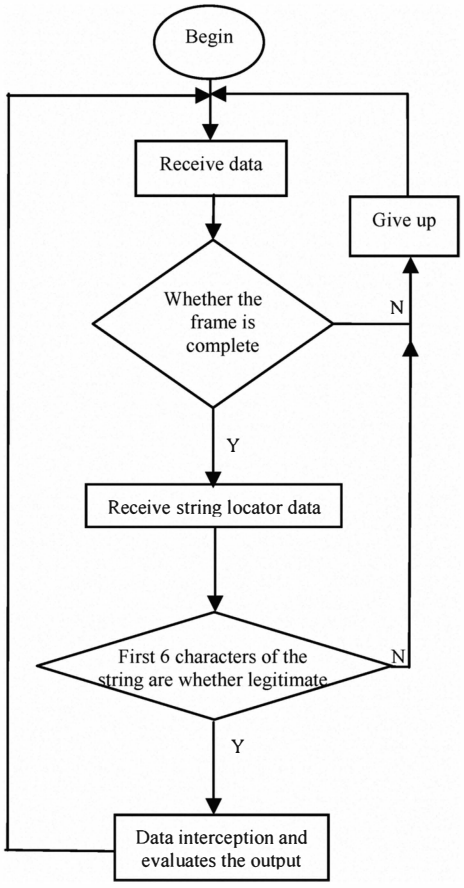

Figure 1. Flow Chart of Data Analyses Algorithm

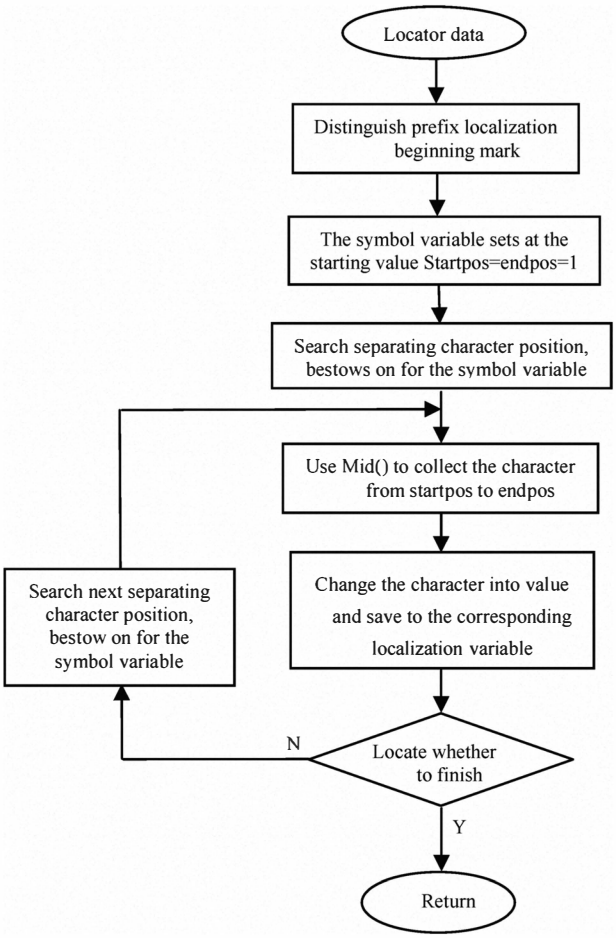

Figure 2. Flow Chart of Data Interception Algorithm