Seamless Expression of Active Traffic Safety Mobile Map Based on Location

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Abstract. Currently, the expression of mobile-map is incomplete and discontinuous, and users in different places have different needs for map information. In this issue, a seamless expression of mobile map based on location is proposed. The implementation of this technique is based on ArcGIS Server and mobile terminal develop kit. Firstly, this paper proposes a main progress of seamless expression of mobile map, and analyzes the architecture of the server and the client respectively. Then we introduce the publishment technique based on ArcGIS Server. We also give frame design and data-optimizing tactic of release based on the specific data. Finally, we take the urban traffic zone as an example to achieve the implementation of seamless expression algorithm of the map in the mobile terminal.

Keywords. ArcGIS Server, Map Cache, IOS, Seamless Expression

1. Introduction

In the mobile Internet era, with the development of computer technology, GIS and smart phones, car navigation, portable navigation devices (PND) and otherr intelligent terminals, mobile location-based services (LBS) become more and more popular in our daily life. LBS technique gives a prospect of spatial information services, that is, when a user has interaction with the real world models, at different times, in different locations, this model will dynamically provide different information services to different users [1]. In daily life, with a variety of socio-economic activities, more than 80% of the information pertains to the geographic location of the characteristics of spatial information, users are more eager to get the service information around them. And mobile map can effectively promote the development of LBS industry by collecting diverse spatial information in one

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carrier. As a result, many mobile operators have greater interest in and increased their investment into mobile Internet.

In 2010, the domestic company Navinfo, AutoNavi, and some other navigation electronic map production companies went public one after another. At the same time, Chinese public version of the National Geographic Information Public Service Platform - "Tiandi Map" website has officially opened services [2]. In technical applications, Google, Microsoft, Apple and other companies have launched global products for mobile and Internet map and update regularly. And the leading enterprise on geographic information industry ESRI also introduced mobile platform development components for these three companies, and took the lead in providing the ability to support cloud computing on the ArcGIS 10 platform. These companies quickly occupied a large part of the global online map service market [3]. Thus, on the second quarter of 2012, the accumulated account number on China's mobile map client market has reached 229 million, a quarter-on-quarter increase of 33.0%, and a year-on-year increase of 206.0%. Some local Mobile Map products such as Baidu Maps, Mapbar and Sogou Map achieved a growth rate of more than 60% [4]. However, the current mainstream mobile terminal navigation map products such as google, Baidu, AutoNavi, Mapbar, Sogou and Kay Rucker expand their business in aspects of map dimensions, additional function, related life services and are of expression deficiencies such as incomplete mobile map, discontinuous expression insufficient mining of the potential value of the position information for the map expression, and also lack of the demand analysis of mobile users on the map.

Therefore, this paper proposes a method which integrates different scale map data, carry out dynamic seamless switching and make integrated analysis since the smart mobile client could obtain real-time position information based on the dimentional feature of city electronic map and analysis of the user's need for the map according to the location. Thus, this method could continuously display details on the region of interest at different levels based on the real-time location of the user, and it also provides further details of different adaptive digital maps from the global overview to the local level of detail.

2. Mobile location technologies and the demand for spatial information in LBS

2.1. Mobile positioning technology framework

Since space positioning technique is not only the foundation to achieve LBS, but also evident advantages over traditional GIS (Desktop GIS, Web GIS).

Real-time location information obtained can provide a series information services in people's lives on "Where are you" (spatial information), "Whom are you with" (society information) and "What resources are nearby" (query information) [5].

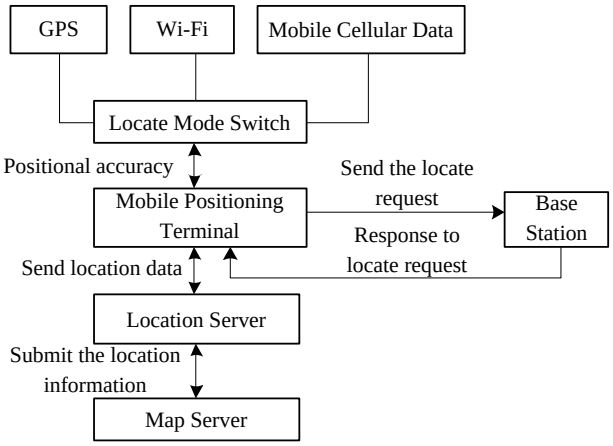

Figure1. The framework of mobile terminal positioning

Currently the positioning techniques of smart phone terminals are mainly of three kinds: GPS, mobile wireless cellular, WIFI. GPS is based on satellite positioning technology, mobile wireless cellular and Wi-Fi are based on network positioning. Which mode the terminal chooses depends on the positioning accuracy. As is shown in Fig.1, the mobile positioning procedure can be described as following: firstly, the mobile terminal makes a request to the surrounding base station, then the base station responds to this request and the terminal could obtain the latitude and longitude coordinates. Secondly, the user terminal transmits the positioning data to the map server, including latitude and longitude, and at the same time, submits this information to the location server. Finally, based on latitude and longitude, the map server calculates the user's current location and sends map results, pictures, text to the specific user.

2.2. Demand for spatial information of LBS

Spatial information refers to many related information in the geographic area, such as buildings and roads in the region, as well as locations of the region and what kind of service it can provide in the area, etc [6]. LBS can provide spatial location-based information services for mobile (physical and logical moving) object by using the GIS technology, spatial positioning technology and network communication technology in the mobile computing environment, heterogeneous environments [7]. The main objective of LBS technology is to make the user access to geographic information services based on location at anytime and anywhere. Therefore, the massive

wealth spatial information is an important part of LBS. It provides the positioning framework foundation and real-time dynamic information carrier for LBS, so it is an essential information platform for LBS.

3. Seamless expression of the mobile map based on the location

3.1. Technology architecture of mobile map expression

The core of mobile terminals is to provide human-computer interaction interface, browsing the map display and query. Its data sources mainly include three aspects. The first is the data file that comes with the mobile terminal, including map data and common attribute data. The second is the data obtained from the server through the wireless network. The third is the data collected by the mobile terminal which generally is the coordinate position data.

The map representation of mobile terminal is achieved through the static map service technology of slicing technology, namely using the map slicing technique to establish the image of pyramid in advance. The technical route is shown in Fig.2.

First of all, analyze the original vector data, design the mapping scheme, then make a series of data processing, include projected coordinate system transformation, conversion of data structure format, spatial adjustment ,etc. After being composited, the data will be symbolized and optimized for better display of map according to the principle of mapping and the need of browsing. And the map data conduct the conversion from vector to multigrade raster. Slicing it by the setted scale, we can obtain multiple scales raster images. Then we store it in the database or folder in the server-side according to certain rules. Clients only need to specify the data source, the server will be able to calculate the needed sliced map to display and go on its stitching and indexing process according to the geographical coordinates range of current client requests. At last, it could be sent to the client for display, forming a complete map.This process make sure the display expression of the map data on the mobile phone from the server side.

3.2. The framework of server

ArcGIS server is an enterprise solutions based on Web GIS, providing an efficient platform for creating and managing the GIS applications based on Server. ArcGIS Server is built based on core ArcObjects component library,

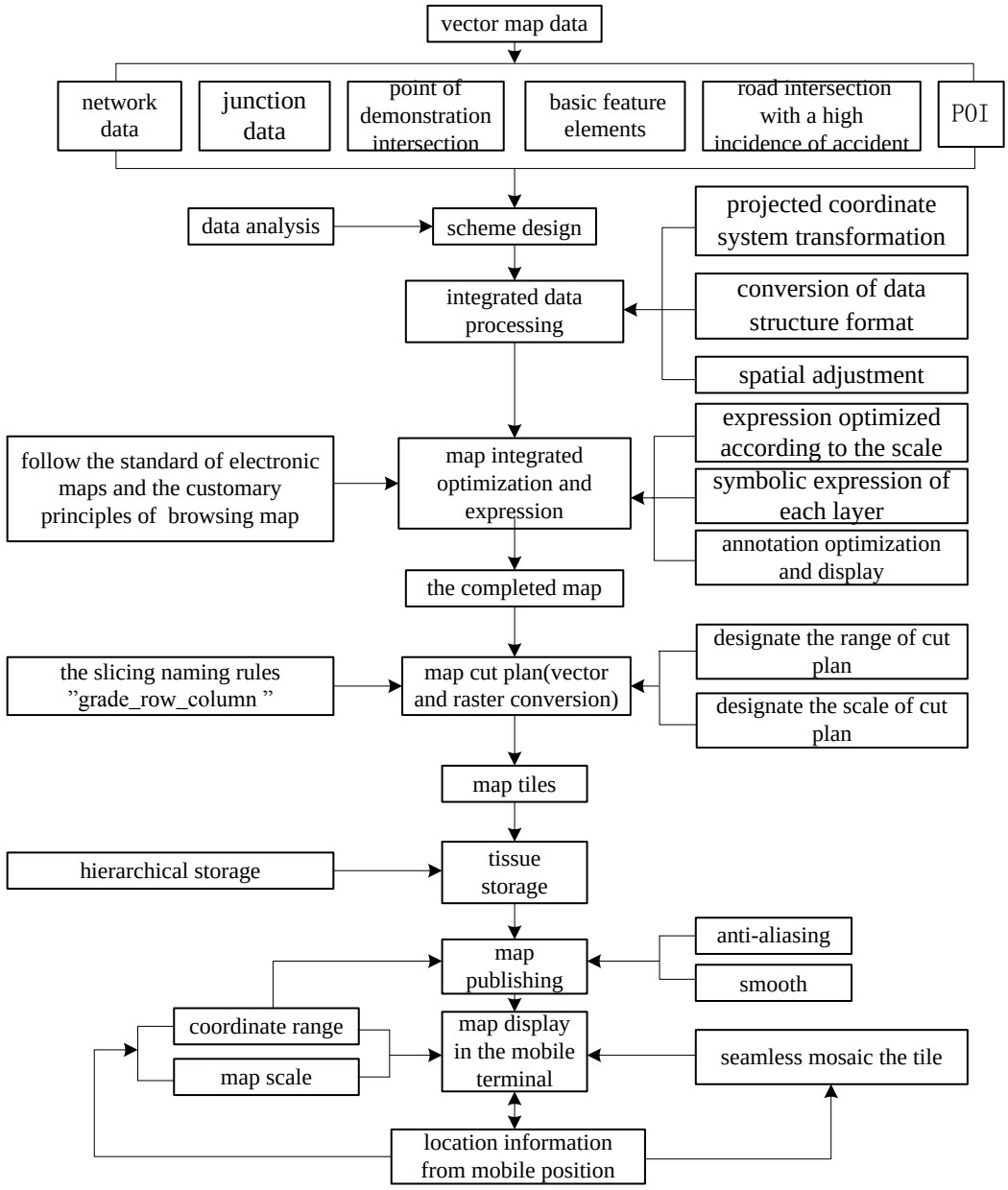

Figure2. The overall technology route of the map tiles publish

3.3. The framework of server

ArcGIS server is an enterprise solutions based on Web GIS, providing an efficient platform for creating and managing the GIS applications based on Server. ArcGIS Server is built based on core ArcObjects component library,

combining GIS and network technology, which are two powerful technology, and then complete global networking and spatial analysis and processing. Since ArcGIS 10.1 for Server, using the ArcGIS Server site architecture instead of the previous SOM-SOCs architecture. They're mainly composed by the GIS Server, Web Adaptor, Web Server and Data Server, and they may be selectively distributed on different machines and work to increase the computing power.

3.4. Mobile client application architecture map

ESRI ArcGIS API for ios is the latest launch for Apple OS API. The API is Objective-C library. The library can be embedded in an iphone or ipad application using ArcGIS map, and implement business applications based on ArcGIS. After the map service is published, ArcGIS Server REST provides calls interface to realize the function of GIS. Each map service and every operation has its corresponding address. If it is map service, open the virtual pages that published map layers, projection and other basic information can be retrieved. If it is operation, the function parameters and return values which related to the operation can be retrieved[8]. The relationship between the various parts is shown in Fig.3.

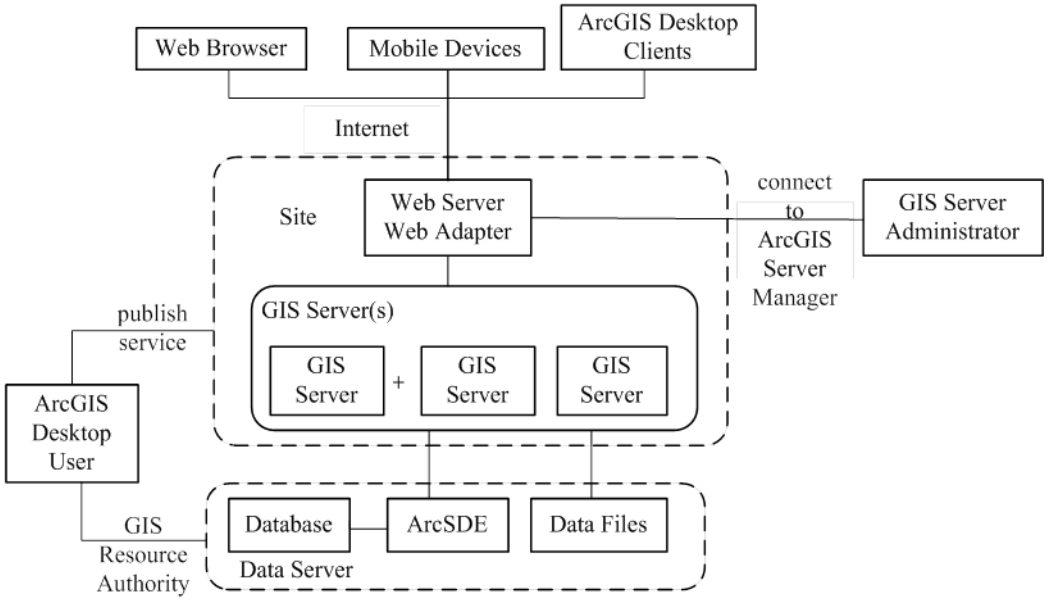

Figure 3. The framework of server

4. Multi-scale expression and caching techniques of mobile map

4.1. Multi-scale representation of electronic map

The establishment of city multi-scale electronic map is not only to meet the demand of government, but also to meet the demand of the companies, the public and every industry in society for their spatial information and thematic information. Multi-scale expression of electronic map is implemented by graded layers and the selection of elements content. Layers grading refer to "Public platform of geographic information service Data specification for electronic map", it adopts pyramid hierarchical uniform rules and the layers ratio (i.e. tile ground resolution) is fixed. Thus the display pyramids layers of tile dimensions is determined [9], as is shown in Tab.1. Selection method of elements content is based on the relevant specification, firstly selected by classification (an important feature has high selection priority), and then selected by key-elements. And the content of the elements should be increased as the scale increases. However, on a smaller scale levels the surface appearance need to be considered, so it should not be placed too many elements [10]. On the scale of all levels prominent represent important buildings surface, water surface, surface vegetation, road lines, the iconic feature and associated annotation.

Table1. The map layer classification

Level	Corresponding country platform level	Ground resolution(m/pixel)	Display scale
0	9	305.75	1:1155583.42
1	10	152.87	1:577791.71
2	11	76.44	1:288895.85
3	12	38.22	1:2144447.93
4	13	19.11	1:72223.96
5	14	9.55	1:36111.98
6	15	4.78	1:18055.99
7	16	2.39	1:9028
8	17	1.19	1:4514
9	18	0.6	1:2257

4.2. Electronic map caching strategies

Since, massive map data are managed by the server, there is inevitable delay between the client's request and the server's response. So it is difficult to meet the needs of users instantly. Therefore, in order to ensure the display speed on mobile side, fluency and good visual effects of electronic map, electronic maps pre-caching is very important, i.e. pre-built pyramid tiles. The layer of tiles refers to the raster image which is cut to a plurality of lines and columns in accordance with the vector map size and format within a certain range set, according to the zoom level or scale [11]. Each layer fea-

ture of the geographic scope represented by the same, and scale becomes smaller gradually from bottom to top. Typically there are two times level relationship between adjacent layers.

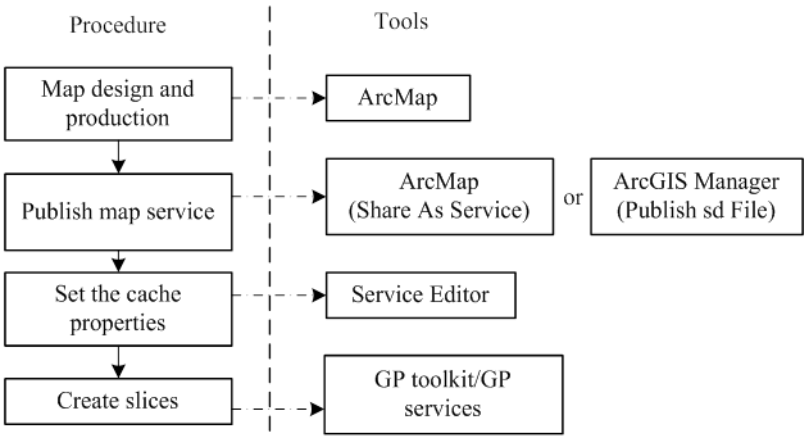

Figure 4. Build the map cache

The creation of a map cache is shown in Fig.4. After completing the illustration of the electronic maps in ArcMap, a map service can be published. There are two ways to publish the service, one is making a good electronic map directly to a shared service, the other is to release packaged sd files in ArcGIS server manager. Publishing process needs to set the cache property, including cutting map scale, scope, storage format, slice width and height, whether antialiasing, DPI (Dots Per Inch) and so on. Anti-aliasing will be used in order to ensure linear elements' smoothness of the published map. Geoprocessing(GP) service can be called after settings to complete the creation of a map cache. This work is always implemented on the server side. The server generates space service data and makes effective management in order to facilitate the mobile terminal to call the appropriate scope and level pictures, and to realize fast browsing.

5. The application of mobile map in the urban traffic active safety

5.1. The urban traffic basic spatial data

The instance is the demonstration application to the urban traffic active safety in Pudong district of Shanghai, the specific scope includes: Huangpu river to the east, within outer ring road, including outer ring road tunnel, Xiangyin road tunnel, Dalian road tunnel, Xinjian road tunnel, etc and Yangpu bridge, Lupu bridge, Nanpu bridge, etc. Based on the urban traffic

active safety demand for spatial information, the spatial data of this area is mainly made up of basic road network, point of interest, demonstration crossroads data, data of road intersection with a high incidence of accident and other basic terrain factors, as shown in the Tab.2. The entire map data not only includes the user travel basic information provided by the ordinary electronic maps ,but also contains professional traffic elements of the providing service intersection, such as the traffic signs, the traffic lights[12]and the mark lines, etc.

Table2. The urban traffic data features

	Category	Name	Description
Basic electronic map	Point elements	Accident monitoring stations	Road accident monitoring
		Service road intersection	Selection of 10 service road intersection
		Dangerous road intersection	Road intersection with a high incidence of accident
		Scenic	Famous tourist attractions
		Important landmarks	Government agencies
		Life service POI	Gas station,supermarket,etc
	Line elements	Road network	The center line of each grade road network
		Dangerous road	Ramp ,approach bridge,etc
	Polygon elements	The park green space	Urban green space
		Buildings	Block ,commercial buildings,etc
		Drainage	River ,lake,etc
		Administrative areas	Administrative division lines
Service road intersection map	Point elements	Arrowhead	Reflect the way Banks function in detail，indicate the specific function of indicating lane
		Traffic lights	Indicate traffic laws
	Line elements	Crosswalk	Indicate pedestrian croaawalk
		Shield wire	Located in the middle of the road，to play the role of a segregation to traffic
		Stop line	Vehicle stop mark
		Double amber lines	Isolation to traffic
		White full line、White Dotted line	Discriminate different lanes of the synthetic traffic，the former cannot be spanned，the latter can be spanned
		The road red line、the road green line、the road edge line	The lines associated with road design data
	Polygon elements	Green belts	To play the role of a segregation to traffic and virescence
		Safety island	The safety area for pedestrians crossing the road

5.2. Map publishment and optimization in demonstration area

This case of application is based on the requirement that provides location service online concerning active traffic safety to the urban vehicles. And the case aims at providing the traffic environment information of the front road to the drivers to prevent traffic accident that may happen. With the help of

this application, users can get the information of the front road in advance, and then change the driving behavior in time. The server of this application will provide the service of traffic information published with ArcGIS Server. And the application on the mobile terminal is a kind of C/S structure based on ArcGIS Runtime SDK for ios.

The server of the application includes three parts: web server, database server, and map server. The web server is constructed with nginx and connects with database server and map server based on Ruby on Rails structure. The database server that consists of Oracle database can connect to the map server and transmit mass of data to it dynamically by using ArcSDE. The map server is used to publish geographical map and a series of GIS function. It can even be used to edit the map. This kind of application structure will improve the efficiency of map publish effectively. The structure of servers is shown in Figure 5.

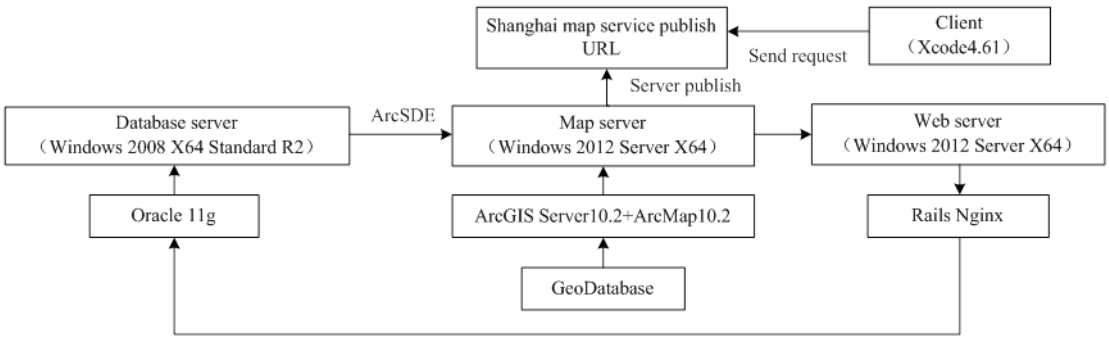

Figure 5. The server deployment mode of the Shanghai map release

In addition, the other way to optimize map server publishment is establishing the cache of the map beforehand. The database server doesn't store map data anymore, but stores the regular pyramid of tile data. The tile data makes the server so efficient that the server can transmit the map to mobile terminal nearly without calculation, and so do the terminal while displaying the map. The tile map can improve the transmit efficiency between the server and the terminal when compared with dynamic map. In addition, the tile map can be modified in advance and optimize the effect of display as much as possible.

5.3. Implementation of seamless expression based on IOS

The key to the seamless expression of map at a mobile terminal is to finish seamless switching among different levels of the cache map, judging by location. The main algorithm is shown in Fig.6. ArcGIS Server published 10 levels of cache map. The first nine layers are the ordinary road navigation

display layers, and the tenth layer is the detailed intersection containing road drainage information in the service area. In the design, the service area is a 100 m radius circle with the intersection as the center. When a user enters the region, the location acquired by the mobile intersection held in the user will fall in the area, and the largest map hierarchy is level 9. When the user is not in the area, the largest map hierarchy is level 8, and display-level control is performed by getting terminal map scale. The effect of the final two map displayed on an iphone is shown in Figure 7.

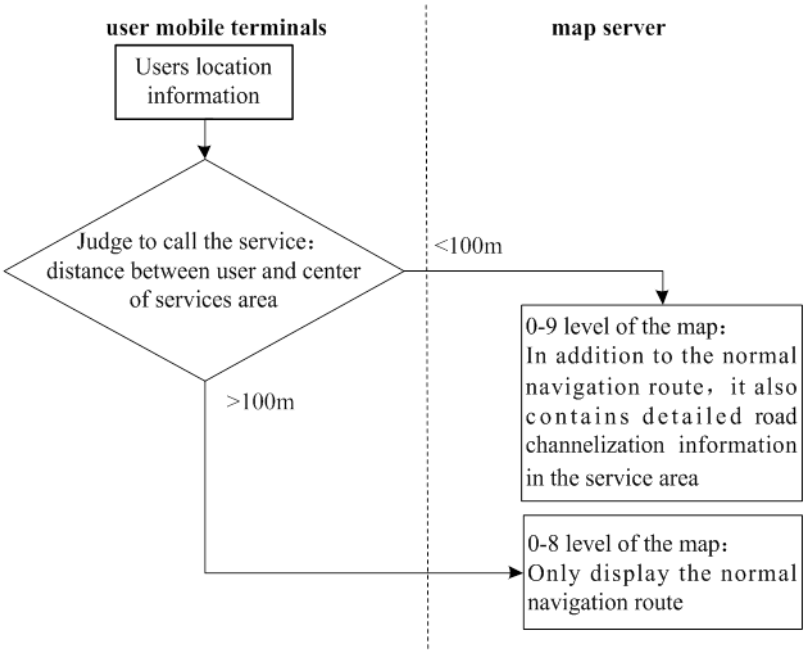

Figure 6. Map seamless switching algorithm based on the location

5.4. Feasibility analysis

In this paper, the achievement of seamless expression of mobile map method is based on the existing navigation softwares such as Baidu, Autonavi, etc. It is to be innovative by the effective integration of geographic information. From the aspect of theory and technology, this paper put forward a complete technical solution from the data processing, digital mapping, map publishment to the achievement in the mobile terminal. The method has been tested and achieved on iphone. In terms of data availability, in order to test the accuracy of the map data, we select a series of control points in road network. Then we use a GPS receiver to field measurements, with the distance between the map point and the actual point of about 3m. For the

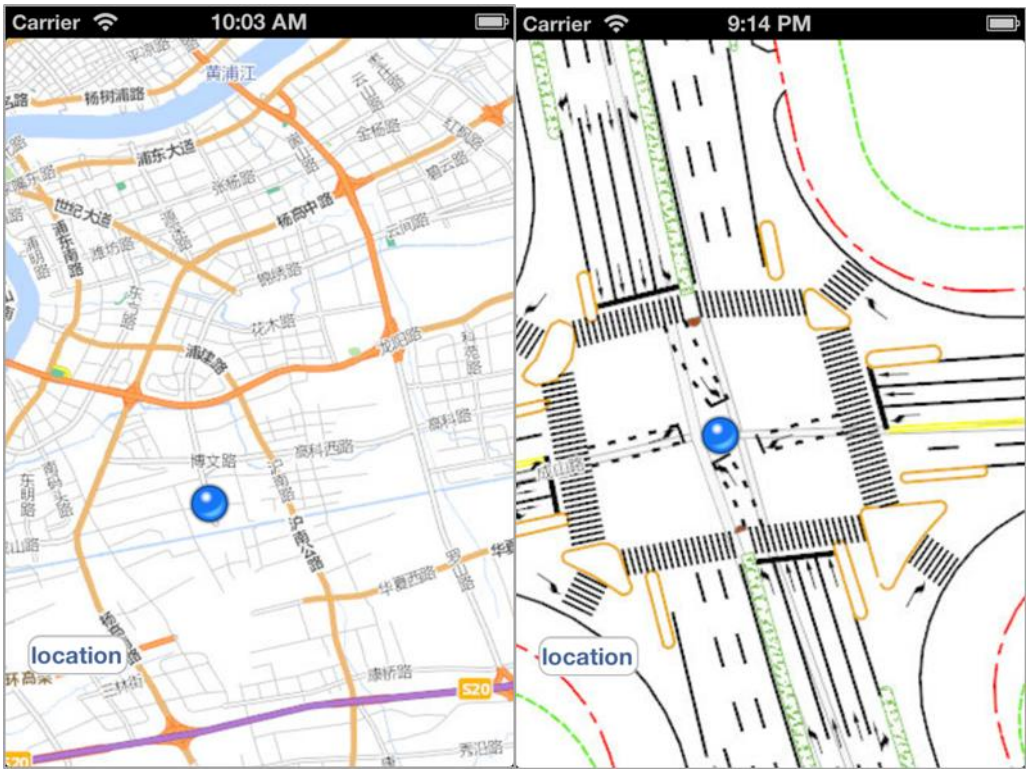

Figure 7. The effect map of road network and junction in the iphone

channelization intersection, we take the same method to measurement, the error is about 3 cm, and it met the required accuracy of the map. Therefore, the method of this paper could provide a good data foundation for high precision navigation and “car-to-car” collision warning services in future work.

6. Conclusion

This paper, based on the development components for the ios mobile terminal offered by ESRI corporation and ArcGIS Server,, realizes the seamless expression of the map on the mobile terminal by calling REST service. Since the REST structure supports caching mechanism, it can call the use of URL address and has made it much easier to develop mobile map and improve the development efficiency to a certain extent. Server distributed deployment plan design, making a large amount of data classification management, can effectively solve the network congestion problem caused by a large number of concurrent access, shorten the access time and improve the overall efficiency. After the map cached on the server, the switching between different scale maps on the mobile terminal can also be much smoother. So, when the user`s location changes, the map can change its

richness according to the users' needs, allowing users to obtain more abundant visual experience.

The method provided in this paper is effective with the aid of the geographical position advantage and provides a new train of thought and feasible technical solutions for the realization of the map navigation. But the realization of the follow-up service of mobile map did not elaborate further, which remains to further study.

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