THE UPDATING OF MAP DATABASE WITH GPS AND RS TECHNOLOGY

Wu Jin-hua[1] Zou Yijiang[2] Liu Rong[3]
[1]Dept. of Territorial Science and Engineering, Xi'an Chang An University
No.6 Yanta Road, Xi'an 710054
Tel: 86-029-5585068, Fax: 86-029-5585068,E-mail: wjh.z@263.net
[2]Xi'an Research Institute of Surveying and Mapping
No.1 Mid-Yanta Road, Xi'an 710054
Tel: 86-029-5533091, Fax: 86-029-5525310, E-mail: zyj.sj@263.net
[3]East China Geological Institute
FuZhou JiangXi 344000
Tel: 86-0794-8258022, Fax: 86-0794-8258022, E-mail: lr@ecgi.jx.cn

Abstract This paper states the necessary of updating the database and it's technical approach. The theory of updating and the fundamental principle of implementation are discussed.

1. Introduction

The data in map database mostly roots in the digitizing of paper map, air and satellite photograph. The updating of map database ought to perform in case the database of this scale has been set up. If the database built doesn't be updated in time, it influence the modernity and authority of the data in the map database, meanwhile, it also influence the usage in supplement and manufacture of surveying and mapping.

It is well-known that map is consisted of nature feature and cultural feature. The nature feature presents the objective things in nature, such as water, geomorphology, soil and vegetation feature. The cultural feature indicates the social and economic phenomena and it's distributing, character and relation, namely the objects which are built on the surface of earth by human, such as transportation network, settlement, boundary and economic sign etc. There are obvious difference between the natural feature and cultural feature. There is no distinct change for the natural feature in a long time except artificial destruction, for instance, geomorphology retains it's configuration basically except artificial destruction. The cultural feature that includes transportation network, settlement, boundary and so on will be changed every other period of time. Therefore, when updating the map database, we must make a difference between the nature feature and the cultural feature. The nature feature is attached importance to update.

It is an active topic to discuss updating theory and basic method of map database in the cartography at all times. A lot of articles with different

learning view have been published in many publications. At present, two most advanced methods have been used for updating map database, one is the spatial RS technology and another is the GPS technology.

The updating method by spatial RS technology is the main direction in the world now. Haploid aerial datum was adopted in map surveying and map revision in the past. With the development and advancement of RS technology, there are more and more the methods of catching RS datum. In recent years, we considered that there is a good geometric relation and resolution of SPOT, IRS, small satellite, SAR image. So utilizing these data to update map database not only could broaden the source of datum, but also could economize the expenditure, improve the efficiency and shorten the cycle.

Updating map database by GPS is a rising technique in recent years, it was supported and accepted by lots of countries at once when it appeared. Now many countries have been using GPS for updating their map database. The cultural feature is always located in the district where the population is multitudinous and the transportation network is advanced. The transportation feature especially suits for updating by vehicle or handhold GPS. Updating the cultural feature by utilizing this technique is a method of high accuracy, fast speed and economic value.

Therefore, according to the condition in China, Using GPS technology to update the cultural feature (especially transportation feature) is the suitable method, but some large settlement (such as a city) or some hot districts are suitable to use RS technology. The two technologies ought to supply and combine each other.

2. The theory of updating and the fundamental principle of implementation

2.1 Updating by GPS technology

At present, there are two kinds of satellite position systems that were applied on the world, namely GPS and GLONASS. It has been proved that the positional result with combinational GPS/GLONASS is obviously better than that with single GPS or GLONASS. The combinational GPS/GLONASS can observe satellites to 48, consequently increased the dependability and the positional accuracy. On account of we can obtain the data that comes from two kinds of satellite systems and SA’s influence in GLONASS is nonexistence, so the SA’s influence in GPS can be decreased by special processing. Therefore the combinational GPS/GLONASS technology gets attention and application on the home and abroad. Owing to the consuming little money, spending short time, repeating usage and solving practical problems, it has become a rising technology. According to the general technology, updating 1:250000 map database with

combinational GPS/GLONASS is divided into three parts. Number one is field surveying by combinational GPS/GLONASS. Number two is data processing. Number three is to update map database.

2.1.1 Field Surveying

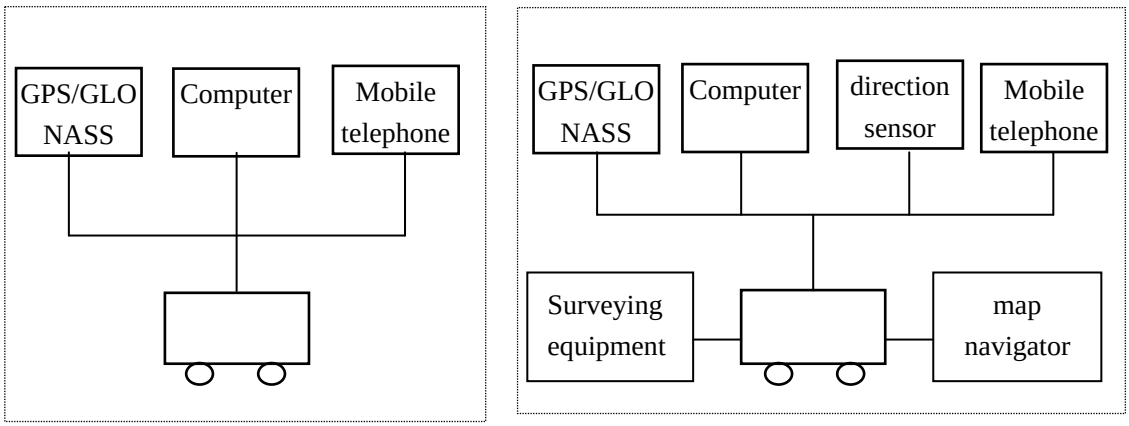
2.1.1.1 Disposing the difference station of GPS/GLONASS

Field surveying with combinational GPS/GLONASS is key step of map database updating. To obtain the attribute and coordinate data for updating, the positional accuracy meeting the requirement is very important in this step. There are many factors to affect positional accuracy by combinational GPS/GLONASS. Obviously, the positional accuracy by single GPS or GLONASS can't meet the requirement of the map database updating. The difference of GPS/GLONASS can remove all kinds of effects and raise the positional accuracy of real time by combinational GPS/GLONASS in a large margin.

The development for difference of GPS/GLONASS is quite rapid. It needs two GPS/GLONASS receivers. One as a fixed station is placed on a known surveying control point or an anchor point calculated from it. Another as a moved station is placed on vehicle to make dynamic surveying for the cultural feature in map. Each GPS/GLONASS receivers can obtain pseudorange and phase data. The accuracy is 4 or 5 meter if Each GPS/GLONASS receivers obtain pseudorange data and make difference processing. The accuracy is 1 or 10 centimeter if Each GPS/GLONASS receivers obtain phase data and make difference processing. So the process for difference of GPS/GLONASS can arrive at the aim of updating map database.

The fixed station is placed on a known surveying control point or an anchor point calculated from it. The moved station is placed on a vehicle and begins to survey the cultural features needed updating within the range where R is radius. In order to ensure the data processing's accuracy, R must be less than 200 KM. If R is bigger than 200 KM, we must move the fixed station from the primary surveying control point to a new one, then the moved station surveys another area. Because the buffer of GPS/GLONASS receiver is limited, the data in GPS/GLONASS receiver must be transferred to a portable computer after completing each area's surveying in order to make difference processing later. The mobile telephones collocated on fixed and moved stations are used for communication between them, but not to use for setting up the data communication chain. The map navigator on moved station is very useful. It has two functions: one is navigation, namely putting the digital map of surveying area into navigator in order to show the direction and location, meanwhile, to mark the surveyed cultural features with symbol. Another is to input the attribute value, namely notes

the attribute value of surveyed cultural features. The coordinate data in GPS/GLONASS receiver and the attribute data in map navigator are linked to the coordinate data and attribute data of surveyed cultural feature by matching with the only time parameter. The direction sensor and survey equipment are used for blindness processing of GPS/GLONASS. Disposing the difference station of GPS/GLONASS is showed as fellow:



fixed station moved station

Fig.1 chart of the difference station of GPS/GLONASS

2.1.1.2 The coordinate value by GPS/GLONASS difference surveying

The principle of difference position is stated as follows:

The observation equation of observed GPS/GLONASS of pseudorange and phase data is:

$$P = \rho + c(dT - dt) + \Delta\rho_I + \Delta\rho_T + \varepsilon_{SA} + V_1 \quad (1)$$

$$\lambda(\varphi + N) = \rho + c(dT - dt) - \Delta\rho_I + \Delta\rho_T + \varepsilon_{SA} + V_2 \quad (2)$$

The result of difference to (1) and (2) is:

$$\Delta\nabla P = \Delta\nabla\rho + V_1 \quad (3)$$

$$\Delta\nabla\varphi = (\Delta\nabla\rho + \Delta\nabla N)/\lambda + V_2 \quad (4)$$

To pseudorange and phase data of GLONASS, the result is:

$$\triangle\nabla P' = \triangle\nabla P' + V1' \quad (5)$$

$$\triangle\nabla\phi = (\triangle\nabla P' + \triangle\nabla N')/\lambda' + V2' \quad (6)$$

The equation of (3) and (5) is equation of pseudorange surveying for GPS and GLONASS. The equation of (4) and (6) is equation of phase surveying for GPS and GLONASS..

2.1.2 Data processing

2.1.2.1 Data preprocessing

The data preprocessing refers to how to transfer the positional coordinate date with combinational GPS/GLONASS to accepted coordinate value in map database. The basic principle of processing 、、 is: the coordinates system by GPS/GLONASS position is WGS-84, it's coordinate value is expressed with Xw、Yw、Zw. The coordinates system used for map database is older Beijing 54 coordinates system and it's coordinate value is expressed with Xo、Yo、Zo. The coordinates system within map is geographic coordinates system and it's value is expressed with Xg、Yg、Zg. The steps of coordinate transformation are: Transferring the WGS-84 to the older Beijing 54 coordinates system, then the older Beijing 54 coordinates system is transferred to geographic coordinates system. When all of the coordinate transformation have completed, we'll obtain the geographic coordinate value of required cultural feature. At the same time, the files of attribute data are formed. The process is to obtain the attribute value of cultural feature by map navigator, to form the files about attribute data, to form the cultural feature's geographic coordinate of different maps finally according to map and to use the map number as the naming rule.

2.1.2.2 Overlapping editorship and topology processing

Overlapping editorship and topology processing must be performed to the files of coordinate data and attribute date. The basic processes of performance are: Firstly, after data preprocessing, the files of updated geographic coordinate data and attribute data in a certain map number will be obtained. Secondly, the required updated coordinate and attribute data are selected from database based on the developed software about "Multi-scale map database system based on Client/Server" by Xi'an Research Institute of Surveying and Mapping. Thirdly, in order to form background map, the coordinate data and attribute data of the map number are inputted into the tool of map data overlapping and generalization editorship processing, then the required updated data is putted into this tool. Overlapping display is formed as the background map on screen. Because the scale of updated map data is different with original map scale, it needs to be processed by utilizing the methods of choice, simplify, generalization and displacement. Fourthly, the standard data files that can enter database and possess spatial topology relation are obtained by automatic topology processing.

2.1.3 Updating database

Updating database is the last step of operation. The result of map database updating will be got in this step. Therefore, it is very important step to possess the software of database updating and operate map database. It is delight that Xi'an Research Institute of Surveying and Mapping had developed the operational software successfully, which is "Multi-scale map

database system based on Client/Server". The software is provided with function of updating map database, it's operational processes are to input the standard data files for map database and to automatic update the original data in database during the processes.

2.2 Updating by RS technology

Updating by RS technology is an important part of map database updating, it's major function is to obtain the latest topographic data from air and space photograph and RS datum, which serves for updating the data in map database. Updating map database by RS technology is divided to three parts from entire technical method, the first is RS surveying map, the second is data processing, and the third is updating map database.

Because the methods of RS data updating are varieties and the rip degree for large production is different, it needs to study specially. In order to meet an emergency, this paper only discusses the ripe single photograph updating system based on multi-digital RS image. The other methods of RS data updating are feasible so long as they have the same data format outputted.

2.2.1 RS surveying

There is a series of strict principles and methods in RS surveying, and it needn't to be discussed in this paper. The function of RS surveying is to update the map database by utilizing the latest space and air photographs.

2.2.2 Data processing

2.2.2.1 Data preprocessing

The single photograph updating system of multi-digital RS image is a digital updating system which developing rapidly. In recent years, people accumulated more practical experience on processing images of SPOT, IRS, small satellite and so on.

The single photograph updating system of multi-digital RS image is to show the Orthoimagery of revision surveyed on screen, to overlap the same area's older topographic map on it and to select the changed geographic feature through comparing the information of them. The contents selected are attribute data and coordinate date. The method makes it has good real time and can meet rapid demands. Its structure is showed as fellow:

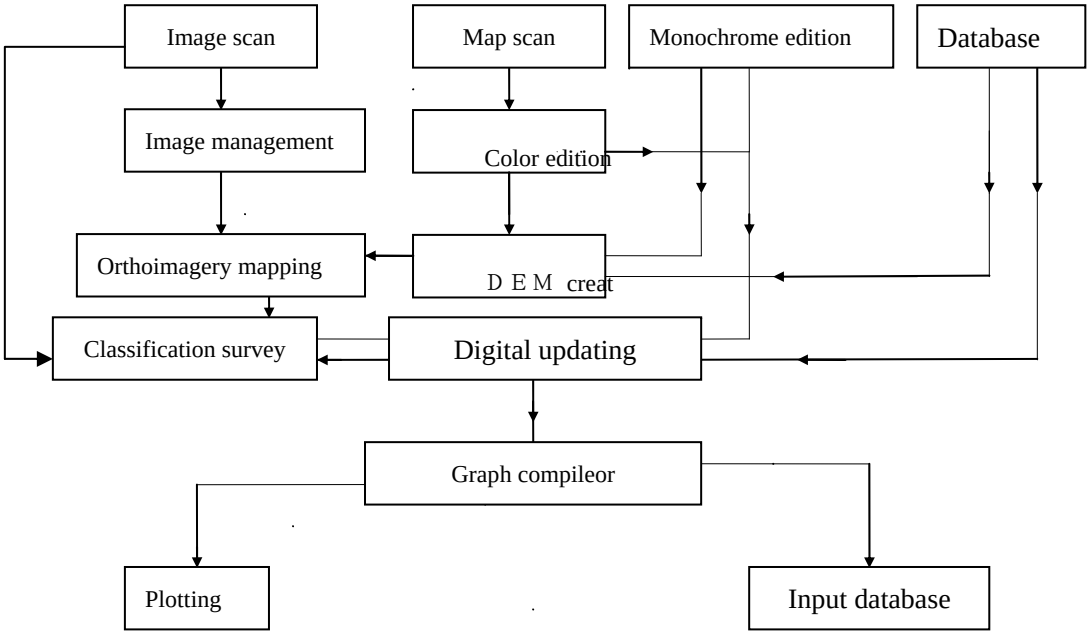


Fig.2 the structure chart of RS updating

2.2.2.2 Overlapping editorship and topology processing

The process of overlapping editorship and topology processing is equal to principle of updating by GPS technology. It is no necessary to repeat.

2.2.3 Updating database

The process of Updating database is equal to principle of updating by GPS technology. It is no necessary to repeat.

3. Conclusion

The three processes of updating map database with spatial RS and GPS technology are field surveying, data processing and database updating. All of them have possessed the condition on each aspect and are feasible too. With developing of the hardware and software system of map database updating, it will change the modernity of map database and improve the practicability of its. Meanwhile, the method of map database updating suitable for the situation of our country is explored, and can use it for map database updating of other scales.

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