

A Study on the Establishment of Population GIS

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Abstract

The recent household registration and population management in the police substation is lack of geographic information support. This causes some difficulties in population management and limited the application of the existing population data. The former GISs are mainly built based on vector data format and this makes the system establishment very costly and system maintenance difficulty. From the study and requirements of the population management in local police substation, this paper presents an idea to design and build the population GIS for police substation based on the raster image. It introduces the system design, system architecture, proposes the method to build the geographic and population data bases and their maintenance. Finally, we summarize the characteristics of the system. It proved to be a cheaper and efficient way to establish a GIS in the local level.

Keyword Household Registration, Population GIS, Geographic Units, Raster Image

1 INTRODUCTION

Since 1986, the household registration information of 620 Million persons has input into the Population Information Management System in Public Security Ministry of China and basically formed a 5 level of network structure from ministry, provincial bureau, city bureau, sub-bureau to police substation. The daily operation of population related data are now finished based on computer. The efficiency of population information management is greatly improved. The system covered the whole country and included every person in China will be established in the next few years.

Although the Population Information Management System has realized the computerized information management and the techniques are greatly improved compared with the tradition handwork methods, the system is still lack of spatial nature. For the population data, it bears the natural, social and spatial characteristics. For a system that is completely reflects the population nature and because the population is very closely related to the spatial distribution, the spatial aspect is very necessary. By use of Geographic Information System (GIS) technique which integrate the population data and spatial data, the value of existing data will be greatly enhanced and the application fields will be greatly broadened. For example:

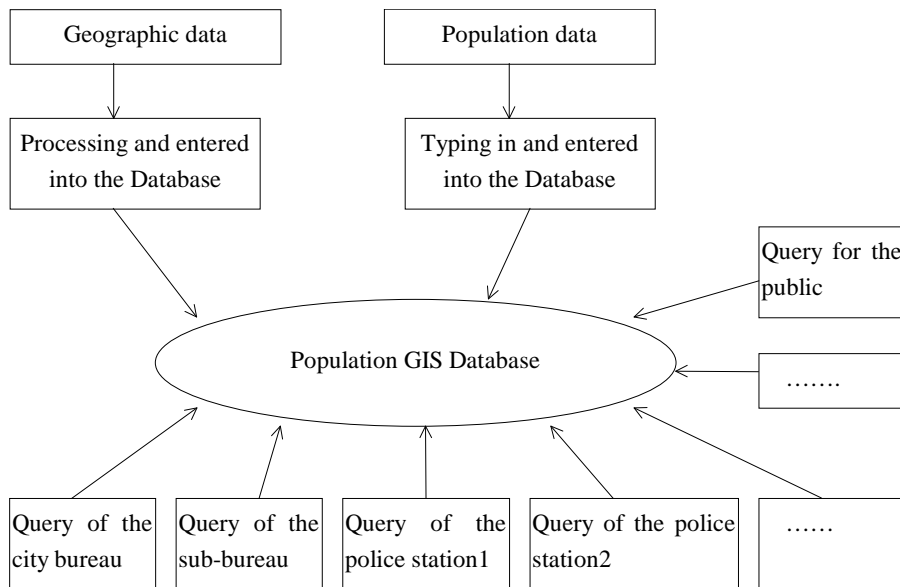
- (1) Taking full advantage of geographic information, the police substation can analyze the household and secure situation completely and accurately.
- (2) Based on the topography, transportation network, park and population information, such as age, sex, occupation, etc., the reasonable counter measures for public security will be worked out.
- (3) The detailed information about population spatial distribution can be used for dealing with the accident, proposal of safekeeping, solving a case, pursuing a criminal.
- (4) Because the population data is updated daily, it can be used as an important source for urban planning, transportation planning, utility allocation, policy making of household registration transfer.
- (5) Information about population spatial distribution, such as education, occupation, marriage status, sex,

age and stature, can be used for decision making of marketing.

2 DESIGN OF POPULATION GEOGRAPHIC INFORMATION SYSTEM

2.1 Work structure of the system

The databases of population GIS include spatial data base and population database. The population data is divided into internal and external data according to its usage and confidential status. The internal data can be accessed by the police substation, sub-bureau of public security and bureau of public security through ISDN or telephone line while external data can be used for the public through telephone line or by floppy disk and CD. Figure 1 shows the work structure of the system.



(Figure 1 Work Structure of the Population GIS)

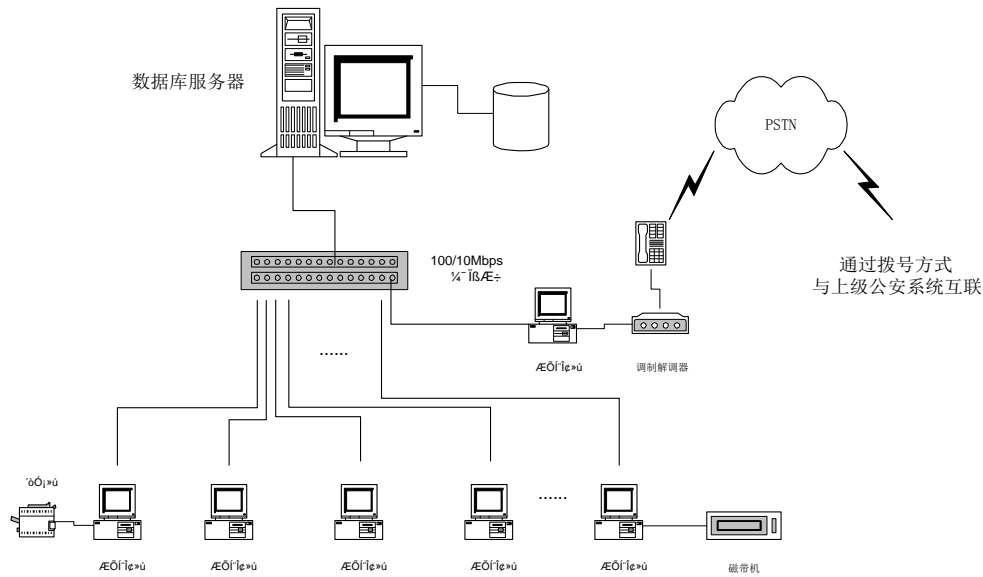
2.2 The hardware and software of the system

The minimum requirement of the system is 486DX PC with 16 MB memory, 600x800 resolution and Windows 95/98 or Windows NT4.0x operation system. It is better to adopt PC with Pentium processor, 32-MB memory and 1024x768 resolution. The all computers in the police substation are form a local area network and the server has a higher configuration. The LAN is connected with outside through ISDN or telephone line. The structure of the system is shown in Figure 2.

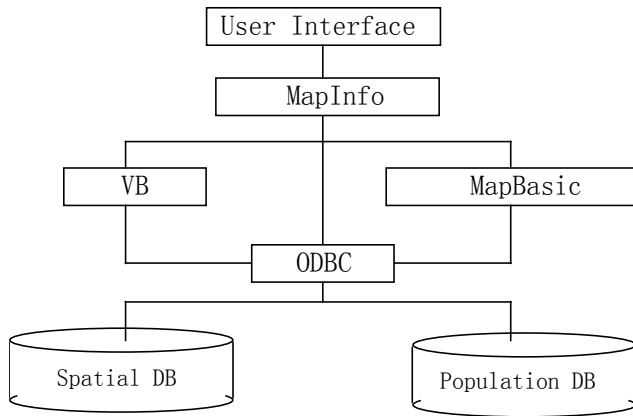
The software of the system is developed by MapBasic provided by MapInfo and Visual Basic. The spatial database and population database are connected dynamically through ODBC (Figure 3).

2.3 Data flow of the system

The geographic database of the system includes image, geographic name, address and boundary of police district, which are obtained from aerial photo, map and field survey. The aerial photo is ortho-rectified and forms the geographic basis of the system. The population data includes permanent residence, temporarily residence, security management and vehicle management. After the system is built up, the data can be retrieved, statistically and spatially analyzed. The results are output by the mean of map, figure and table. The data flow of the system is shown in Figure 4.



(Figure 2 Hardware and Network Structure of the System)



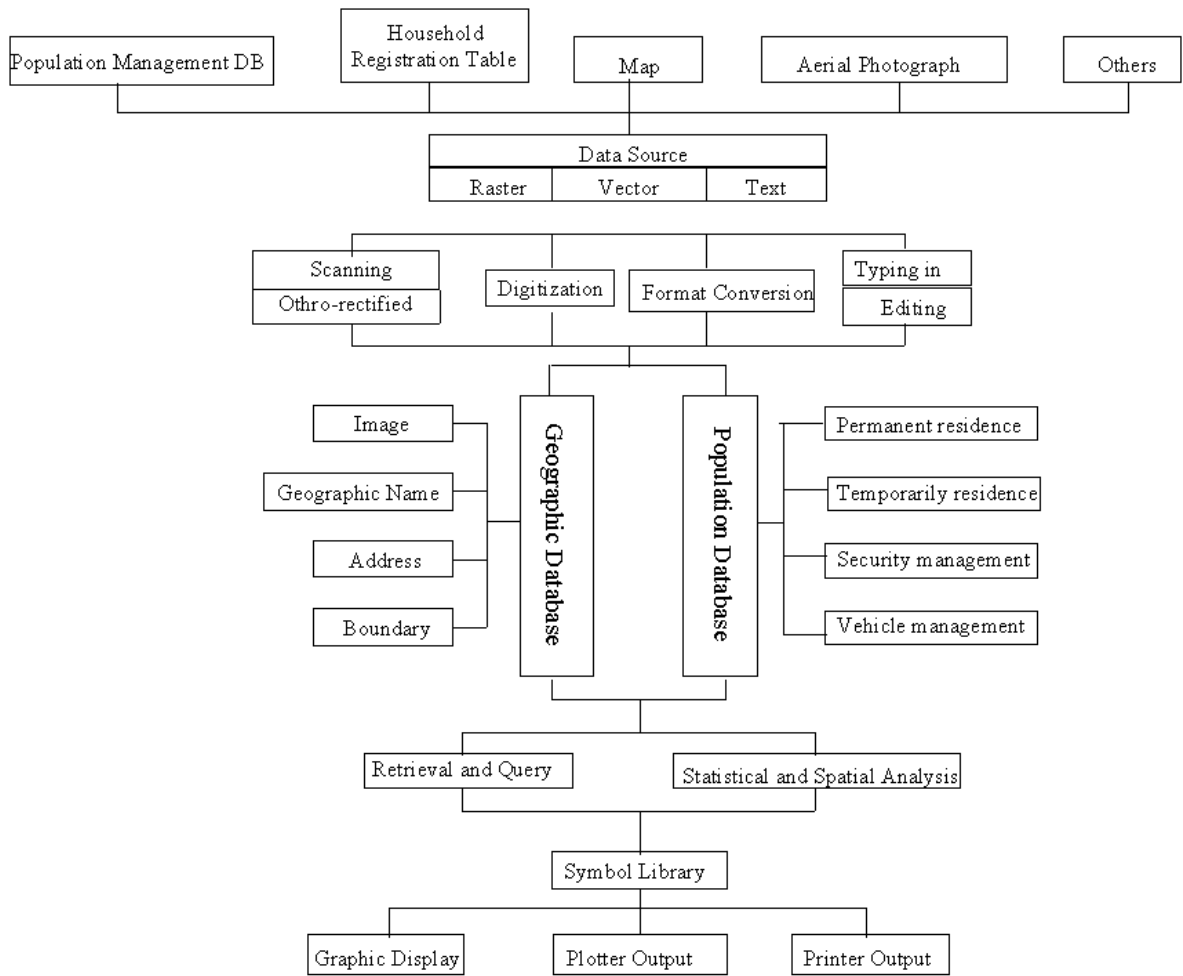
(Figure 3 Software Structure of the System)

2.4 The main functions of the system

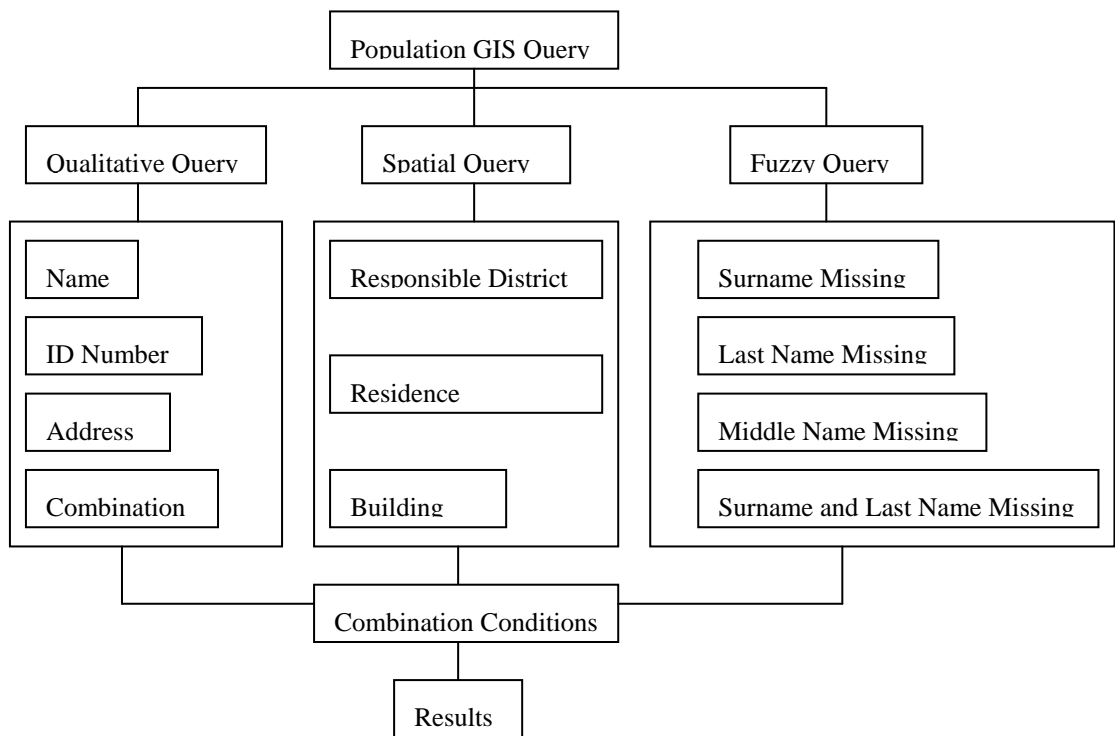
Upon the requirement of the police substation, the functions of the system are as follows:

- Production of security management map
- Marking of police thematic information
- Query of single feature or multi-features
- Spatial union and split of statistic region
- Overlay analysis and mapping of social-economic information
- Updating of geographic and population data
- Maintenance of the database

At present, the most frequently used tool in police substation is query of the population data. The system has the query functions such as qualitative query, spatial query and fuzzy query. The query structure is shown as figure 5.



(Figure 4 Data Flow of the System)



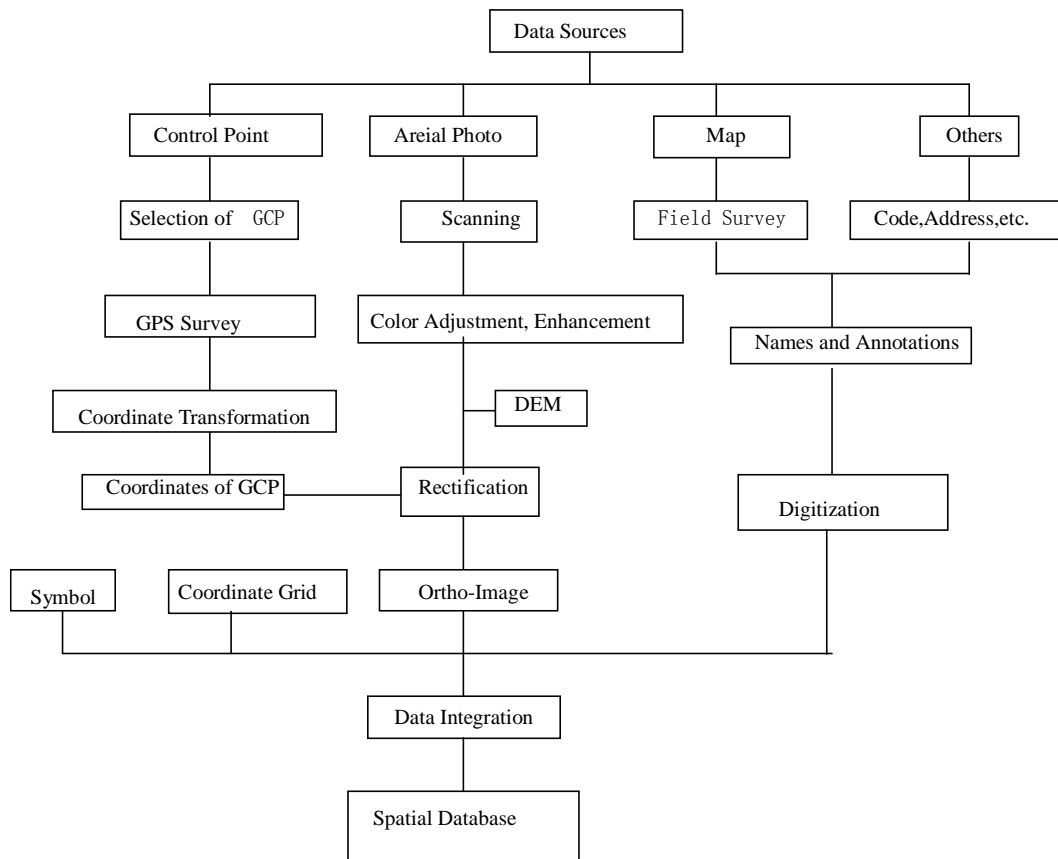
(Figure 5 Query Methods of the System)

3 ESTABLISHMENT AND MAINTENANCE OF THE DATABASES

3.1 Establishment and updating of the spatial database

The main steps of spatial database establishment are: collection of material, field survey, GPS positioning of control points, image processing, map digitization, classification and coding of geographic unit, annotation, integration of databases.

The flow chart of the spatial database establishment is shown on figure 6.



(Figure 6 Establishment of Spatial Database)

The frequently changing of population data makes the currency of spatial data a major aspect. Easily updating of the spatial data at a lower cost is an important factor to ensure the system's running in a local police substation. Because the system uses image as a basic geographic data, it makes the maintenance of the system more feasible. The methods of the system updating are as follows:

- Substitution of old images

In china, the major city will have a new aerial photograph at 5 years on an average. When a new image come, the old aerial photo will be replaced by a new one of the whole area after the image processing.

- Updating by scanned map

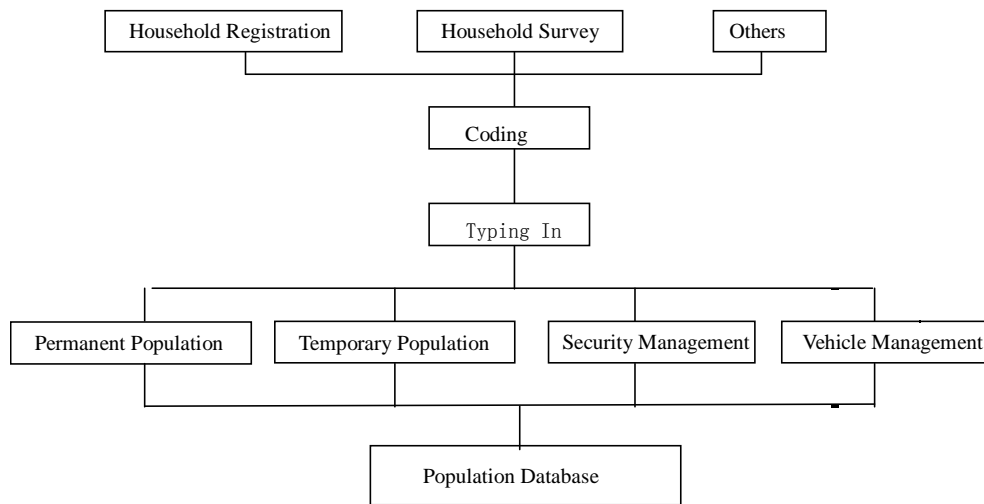
When a part of the area has dramatically change, such as a new built-up area, a planning map from the city planning division will be scanned and rectified and a part of the area will be updated.

- GPS survey

When an important part of the area needed updating, GPS will be employed to collect the new features. At that case, the spatial information will be transformed to raster format.

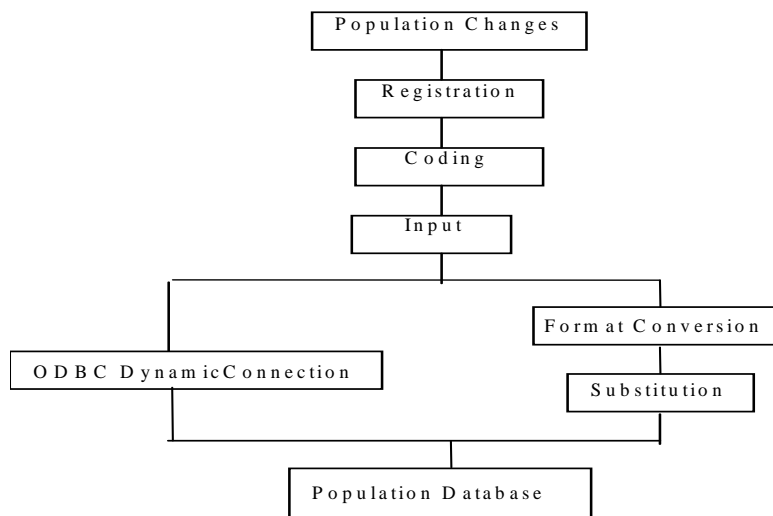
3.2 Establishment and updating of the population database

The establishment of population database includes the following steps: household registration, household survey, coding, typing in, data checking. The flow chart is shown in figure 7.



(Figure 7 Establishment of Population Database)

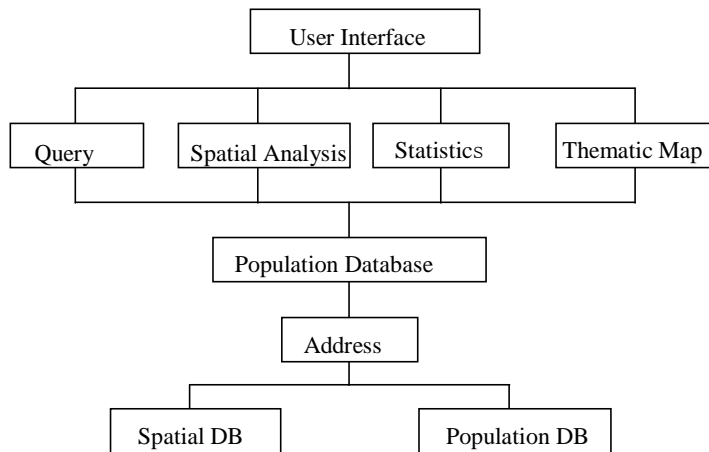
The population data is changing every day. The updating of the population database is shown in figure 8.



(Figure 8 Updating of Population Database)

3.3 Integration of spatial and population database

As the large scale aerial photo can distinguish different building and every building has a unique address, a single building is treated as the minimum geographic unit and its address is used for integration of spatial and population data. The integration method is shown in figure 9.



(Figure 9 Integration of Spatial Database and Population Database)

4 CHARACTERISTICS OF THE SYSTEM

4.1 GIS designed based on raster images as the main data sources

The GIS can use vector or raster format geographic data. Establishment of a spatial database in vector format is cost much more than spatial database in raster format and its maintenance is much more difficult. For a local police station, it is not a feasible way to build a GIS of vector format now in China. Comparing with the vector data, the raster image from aerial photograph and high resolution remotely sensed image has several advantages: abundance of information, easy input and updating, good in currency and low cost for database establishment and maintenance. At this time, sophisticated spatial analysis which is the merit of vector GIS mostly with topological structure is not urgently needed. A GIS based on raster image is a suitable way for police office in a local level.

4.2 The minimum geographic unit to integrate population data

The population census, household registration and population sample survey are the main method to collect the population, social and economic data. In china, these methods don't use geographic information as support, reference and control. They use administrative region system to divide statistic unit. Because the political boundary is often changed, such as union, split of the political unit, and people migrate within a city and across the country more often than before, existence of some defects in recent methods of population data collection and management is obvious:

- a) Difficult to ensure data accuracy and integrity;
- b) Difficult to compare population between different period;
- c) Difficult to aggregate population to meet different uses;
- d) Limited applications, especially population spatial applications.

A stable geographic unit to integrate population data with spatial data is needed. In this system, we use a single building as a minimum geographic unit. Its address is used as a key to integrate population with spatial data.

4.3 Spatial query and analysis

The raster image is stored in the computer as gray scale and can not represent the complicated relationship between the spatial objects. Therefore, it is not suitable for the spatial query and analysis. In the system, we use the point in every building of image to match the population data. For the query, a query frame is determined by the system for area with different population characteristics, for example, the query frame is 100Mx100M in normal built-up area and 20Mx20M in densely populated area. This can make sure that when the user click on

the building in the image, the system can search the corresponding point within a certain tolerance.

5 CONCLUSIONS

1. This paper present a method to build the population GIS in local police station based on the aerial photo image. It cost less and has a short cycle of system establishment. It is suitable for the operation in many administrative offices at a local level. With the advantage of high-resolution satellite image, it will provide us an economic way to build and maintain that kind of GIS with little function of spatial analysis.

2. The system uses the address as a key to integrate population data with spatial data. The same method can be used to integrate spatial data with many social and economic data and build other professional GIS.

3. The integration of population data with spatial data will broaden the usage of exiting population in police office. For example, it can be used in the utility site selection, marketing and transportation planning, etc.

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