System Development of Making an Image Map Based on Google Earth

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Abstract. With the advent of the information age, the establishment of high-precision, low-cost digital image maps are increasingly more important for surveying and mapping engineering, land management, forestry, and marine monitoring. Combining real remote sensing imagery with computer science and technology to produce an intuitive and clear digital image map has become a trend in the development of GIS systems today, but professional image data is expensive to purchase, resulting in greatly improving system development cost. Therefore, this paper proposes a new method based on Google Earth and GIS technology to develop a system for application.

The system mainly includes geographic information collection (according to remote sensing image acquisition), geographic information storage and management (using database technology) and digital map production three Module. The key technologies of the system are the establishment of regional geographic model, attribute data management, the establishment of information database and information query and analysis.

The system can provide digital image maps with high efficiency and low production, and establish the database to realize the timely exchange and sharing of geographic data. Compared with the traditional drawing method, the system reduces the cost of development, and improves the authenticity, intuitiveness and practicability of the GIS system; and compared with MapInfo and ArcView, the system is easier to operate and to draw efficiently without professional image data. The digital image map made by the system can save a lot of manpower, material and financial resources after the actual production, which improve the work efficiency and reduce work intensity, and also provide theoretical and technical guidance for the current surveying curriculum teaching.

1. Introduction

With the advent of the information age, the establishment of real and intuitive digital geospatial information is becoming increasingly important for urban planning, environmental monitoring and
transportation management, emergency rescue services, socioeconomic development, and defense and military construction [1]. The vector digital maps presented in various traditional geographic information systems in the past only represent simple and primitive elements such as points, lines, and areas to represent key and required feature information, and use text for simple labeling and description. Information is abstract. The display is not intuitive and the readability is poor. Using real remote sensing image pictures as the background display and adding text, symbols, line segments and other primitives to supplement the description of the feature information can greatly improve the authenticity and practicality of the geographic information system and can better meet the actual needs of engineering construction.

The new geographic information technology has a great influence on surveying and mapping engineering [2]. The process of information collection and processing has basically achieved scientization, automation, and standardization; data storage and management have become faster and more convenient; data transmission and sharing have begun to become a breeze, abandoning traditional drawing transmission. Meanwhile, the formation of the Internet can make multiple users to execute different operations on the same map, which improves the efficiency. Therefore, modern surveying and mapping technology has a greater impact on the development of surveying and mapping. Topographic maps of various scales are used at each stage of engineering survey and design [3]. With the development of aerial surveying and remote sensing technology, high-definition Orthophoto Maps and satellite images are favored by surveying designers because of their intuitiveness and timeliness [4]. However, but its high cost also makes it unacceptable for general engineering units. The purpose of developing "System Development of Making an Image Map Based on Google Earth" is to hope that the system can provide digital maps with higher economic value and lower production costs for the design and planning of surveying and mapping engineering construction projects, and partially make up for the some shortcomings in the collection of geographic information, to solve the problem of location accuracy in engineering construction more accurately [5].

2. Google Earth and Image Map

2.1. Google Earth
Google Earth is a computer program that renders a 3D representation of Earth based primarily on satellite imagery [6]. The program maps the Earth by superimposing satellite images, aerial photography, and GIS data onto a 3D globe, allowing users to see cities and landscapes from various angles [7]. Users can explore the globe by entering addresses and coordinates, or by using a keyboard or mouse. The program can also be downloaded on a smartphone or tablet, using a touch screen or stylus to navigate. Users may use the program to add their own data using Keyhole Markup Language and upload them through various sources, such as forums or blogs. Google Earth is able to show various kinds of images overlaid on the surface of the earth and is also a Web Map Service client. Recently Google has revealed that Google Earth now covers more than 98 percent of the world, and has captured 10 million miles of Street View imagery, a distance that could circle the globe more than 400 times [8].

2.2. Image Map
Image map is a kind of map with ground remote sensing image. It is a map that directly reflects the
geographical characteristics and spatial distribution of cartographic objects by using certain map symbols and notes through geometric correction, projection transformation and scale domestication through aerial or satellite remote sensing images [9]. The image map combines the advantages of both aerial photographs and line topographic maps. It not only contains the rich content information of aerial photographs, but also guarantees the topographic map's decoration and geometric accuracy [10].

The development of image maps is closely related to the development of aerial photography, aerial surveying technology and aerospace technology. Aerial photogrammetry has gone from analogue measurement in the 1930s to analytical photogrammetry in the 1970s; digital photogrammetry has risen in the late 1980s and has developed into the current stage of all-digital photogrammetry. The core technology benefits from the development of computer technology, communication technology, aviation (sky) remote sensing technology and digital image theory technology. Due to the high-tech infiltration of "3S" (GPS, RS, GIS technology), the image map is full of legendary gorgeous colors.

3. System Construction Process

3.1. Overall System Idea

The construction of this project is based on RS, GIS technology and computer application technology to assist in the indoor collection of geographic information, and build a computer-assisted system to manage geographic information, by establishing a database and using digital maps as an operating platform to achieve timely exchange of geographic information and data sharing [11].

The system development is based on Google Earth imagery. It mainly includes geographic information collection (according to remote sensing image acquisition), geographic information storage and management (using database technology) and digital map production. The realization of the geographic information collection function is completed based on Google Earth's 3D image and the measured surveying feature points (obtaining 3D coordinates and input attribute values). The function of geographic information storage and management is to record the relevant data of the collected feature points in a data table for easy output. At the same time, it can also provide drawing data sources for drawing software such as CASS. The digital map making function is to make a digital map (drawing points, lines, areas) based on the collected feature points.

3.1.1. Implementation of Information System Management. The information management system realizes information resource sharing through computer technology, establishes a table space in the database, and creates related information tables such as basic information tables and geographic location tables according to application requirements. The main function of the system is to display the geographic location of the collection point and related engineering information. Therefore, the main contents of the system construction are as follows:

(1) Geographic Information Collection
(2) Geographic Information Storage and Management
(3) Digital map making
(4) Daily information management and maintenance functions (edit, modify, output, etc.)

Achieving the above goals involves the application of "3S" technology, the collection of geographic information, the establishment of databases, and software production. The system's key technologies
involve the establishment of regional geographic models and the management of attribute data, as well as the establishment of information databases and information query and analysis. The relational tables in the database mainly include geographic location tables and geographic attribute tables, as shown in table 1 and 2. The two tables are linked by sequence number fields.

| Table 1. Geographical sheet. |
|-----------------------------|
| Serial number | Coding | Abscissa(Y) | Vertical(X) | Elevation(H) |
| …… | …… | …… | …… | …… |
| …… | …… | …… | …… | …… |

| Table 2. Geographic attribute sheet. |
|-----------------------------|
| Serial number | Name | Attribute | Attribute2 | …… | Attribute n |
| …… | …… | …… | …… | …… | …… |

3.1.2. “3S” Technology Application. This system is based on Google Earth and is an application system developed based on GIS technology. GPS and RS technologies will also be involved in the collection of information. The key point of system development is to collect geographic locations according to Google Earth remote sensing images and realize management and application of geographic information by GIS technology.

The geographic information system has a strong function of spatial information analysis. The geographic information system can be used to quantitatively describe the spatial elements in the construction area collected according to Google Earth remote sensing images and other methods with points, lines, polygons, and polygons (such as figures 1).

Figure 1. Regional remote sensing image.

Such a digital map management system can:

A. Efficiently display map information, create charts of visual geographic information, and provide related information services.

B. Interactive drawing tools for creating graphics in maps. Enter static and dynamic geographic
objects, symbols and georeferencing information layers. Realize information query and statistical analysis. The geographic information system is used as a platform to realize the management and query display of the construction goals in the area.

C. Import standard GIS data layers offline (add new layers).

D. Information query, query real-time and historical data. Based on the geographic information system platform, the results can be further combined with remote sensing applications to mark the results on an electronic map and display the results graphically in the form of reports and charts.

E. The system leaves a certain margin on the basis of application services, which can be used to integrate other information services.

3.1.3. System Architecture Design. 1. The goal of building

Provide information exchange and data sharing through system construction. Based on the database application, describing the management objects in the database, developing a unified and standardized record encoding, classify the basic encoding according to the required file type, and use the basic encoding to make one-level, two-level to multi-level encoding design according to the application function. Finally, all system retrieval functions can be realized through the coding system.

Combined with geographic information system to realize the interaction of query data and geographic information, business information is made clearer through intuitive location information (geographic information) reflection.

2. The main functions of the system

The system consists of multiple pages to facilitate the application of multiple functions. The specially designed code management module table is used to manage each function page in the database, which is convenient for users. The main functions of the system are as follows.

A. Geographic Information Collection

The feature points are determined by moving the cursor (as shown in figure 2) or image movement. Click the cursor to obtain the 3D coordinates of the feature points and record them in the data table. The data in the data table can be output as a dat file in the format required by CASS software. The geographic information (data) and attribute data in this file can be used to make digital maps.

![Figure 2. Feature point collection of remote sensing image.](image)

The above process is similar to the detail survey process in the surveying practice. The point surveying operated with the electronic total station during the practice is also to obtain the three-dimensional coordinates of the survey point and store it in the instrument. After the surveying, the data in the electronic total station is exported to the computer [12]. You get the data file. This system has a
very intuitive effect for teachers to explain to students how to survey and map terrain (identify feature points). The overall description of surveying is more visual than in the field, and it can be in many aspects and cases. In addition, you can use remote sensing images to browse geographic information to achieve comprehensive observation and seamless operation of 3D images—zoom in, zoom out, pan, rotate, etc.

B. Geographic Information Storage and Management

A variety of geographic information data can be entered into the system. The data entered includes multiple forms of data, such as text, pictures, audiovisual materials, etc., and the system automatically stores and manages them in categories.

You can edit (add, modify, organize, delete) various data in the system according to authorized permissions.

You can query various information in the database and association relationship according to various conditions and user requirements, to achieve simple aggregation, classification, filtering, sorting and other functions.

According to the authorization authority, the original data and query result data can be output in different formats, that is printing and storing new files.

C. Digital map making

The coordinate information of the points collected by the remote sensing image can be stored in the database, and the geographic information can be represented graphically in the map to realize the location data collection and attribute data editing of the primitive.

You can browse the geographic location of the area of interest and the surrounding geographic environment to understand the geographic environment, such as terrain conditions, features, etc. Achieving seamless operation of the map (zoom in, zoom out, pan, etc.)

You can query geographic information (object location and its attributes) according to specified conditions, and visually express it in various forms such as text and images.

It can edit digital maps, add and delete geographical objects, update attribute data, and change the style of map symbols.

D. The combination of engineering project information and GIS information management

Combining engineering project information with geographic information (map) display makes engineering information more intuitive and easier to read.

3.2. Implementation of System Construction

According to the principle of step-by-step implementation, openness and compatibility, the system meets the requirements of practicability and continuity. It uses advanced and reliable software and hardware facilities, and uses database technology to implement comprehensive data management and information sharing. It takes advantage of geographic information system technology to provide Analyze and synthesize a comprehensive information service system for infrastructure. Emphasis is placed on the combination of technology and management, the combination of advancedness and practicability, the combination of versatility and safety, the combination of reliability and operability, and the system production adopts a modular design. The construction process is as follows:

(1) Schema design

With reference to the existing technology and equipment, combined with domestic and foreign
related technologies, the project team held a seminar and proposed a corresponding design scheme.

(2) System production

The system production is to write code to form software. The production of this system involves GIS technology, and the production is completed using control technology.

(3) System debugging

After the preliminary completion of the system, the simulation data will be used for system debugging, and the system will be tested in the pilot project management after the system is stable.

3.3. Implementation of Main Functions

After the system is completed, it should have the following main functions:

1. Settings of the system login interface

   After the system starts, as shown in figure 3.

![Figure 3. Operating system.](image)

2. Geographic information collection function

   Geographic information can be collected in a single point or in batches. The method of single-point acquisition has been described previously and is not repeated here.

   The method of batch acquisition is mainly designed for acquiring image maps. Since Google Earth does not provide free data downloads, the method researchers use here is to obtain a piece of satellite image by copying the screen. The basic principle is that when Google Earth browses the area of interest at an appropriate scale, and then displays a screenshot of the screen. For the designated screenshot area, the system software can automatically calculate and divide into blocks according to the set area size. After the screenshot is completed, the serial numbered divided satellite images are obtained. The specific operation method is as follows:

   First, select the coordinate difference (longitude and latitude difference) between the area to be collected and a given collection point. The system will calculate the position of each point to be collected according to the given parameters (longitude and latitude difference), as shown in the figure 4 and then point by point.
The collection of method is that after the system loads the Google Earth image, the Google Earth image is first moved to the center position coordinate as the acquisition point coordinate (generate a KML file with a given L, B or X, Y and run to achieve the purpose), and then intercept Google Earth image (screen copy) of this area, a key parameter to be determined in this process is to determine the height of the screenshot. Taking the screen resolution of a computer monitor set to 1024 × 768 as an example, when the height of the screenshot is 500m, the screen display area is 270m, and about 318 pixels per meter can be calculated. This kind of screenshot accuracy is used to form a 1: 110,000 image. It can meet the requirements. Of course, the high-definition images provided by Google Earth are various, including Quick Bird images with 0.6m resolution, Ikonos images with 1m resolution, SPOT images with 2.5m resolution, and so on. The resolution of the image itself is the key to determining sharpness. Reducing the height of the screenshot without limit does not necessarily improve the sharpness of the screenshot. Therefore, a simple method for determining the height of the screenshot is to reduce the observation height for the screenshot area until the image can no longer be clear and becomes slightly blurred, that is, the observation height at this time can be used as the screenshot height. Image positioning can use this sentence

```csharp
App_GE.SetCameraParams(YY, XX, H, EARTHLib.AltitudeModeGE.AbsoluteAltitudeGE, Scale_Height, 0, 0, 5)
```

Scale_Height is the height of the area observed in the screenshot, which can be set arbitrarily by us.

Secondly, after the image acquisition is completed, the image registration problem must be solved. When taking a screenshot, a high-resolution satellite image map of the screenshot area can be obtained after acquiring more than four registration points registration images at the same time. The registration points are usually collected at the four corners and center points of the photo, as shown in figure 5. The coordinates are WGS84 coordinates in decimal format. Simply by the projection conversion from the WGS84 ellipsoid to the 1980 Xi'an ellipsoid, the 1980 Xi'an coordinates of the four corner points of the picture can be obtained.

![Figure 4. Location of batch points.](image)
After installing MapInfo desktop map system, you can directly open this file to browse the image map.

3. Information storage function

Information storage is to store the collected geospatial location information (coordinates) to the corresponding location of the data.
3.4. Experimental Results (Partial Results)

There are still many difficult areas in China, especially some mountainous areas that have not been covered by large-scale topographic maps. This situation is far from meeting the requirements in the process of engineering survey design and construction. The large-scale planar image obtained by using the above method, combined with the medium-scale topographic map or DEM, can greatly compensate for the shortcomings of no large-scale topographic map. In this experiment, we used the above method to conduct experiments in a mountainous area in Zhejiang Province. We collected multiple points of data as shown in Figure 8, and used this to make a satellite image. From the results of the sampling inspection, the error of plane coordinate is less than 0.0036\textdegree. Such a result can bring great convenience to the construction of the project and play an important role in optimizing the design.

| ID | L       | B       | H       |
|----|---------|---------|---------|
| 1  | 120.832668 | 28.732253 | 81.081  |
| 2  | 120.835585 | 28.732253 | 82.350  |
| 3  | 120.827668 | 28.732253 | 121.162 |
| 4  | 120.829752 | 28.732253 | 79.593  |
| 5  | 120.835029 | 28.732253 | 81.610  |
| 6  | 120.838085 | 28.732253 | 149.007 |
| 7  | 120.834891 | 28.732253 | 81.812  |
| 8  | 120.827807 | 28.732253 | 116.915 |
| 9  | 120.831418 | 28.732253 | 79.638  |

The experimental area is selected as a rectangular area, and the area is divided into several small areas according to the set values of longitude and latitude differences (see figure 4, the blue box range is the selected area). In each area, we can see the locations of several points were collected, and the data storage form is shown in Table 3. All the points collected in the area are plotted on the map, as shown in figure 8.

![Image registration map](image-url)
4. Conclusion

4.1. Social and Economic Benefits of Project Results

(1) Social benefit

The development of this product not only plays an important role in engineering planning, but also greatly aids the teaching of future measurement courses, especially the field training of measurement courses. This effect has a greater impact on students' better understanding of surveying and mapping knowledge and mastering of surveying and mapping skills than in the past. The level of students' knowledge mastery has a direct impact on the production of social benefits. In addition, after the system is converted into a drawing tool for actual production, it can save a lot of manpower, material resources and financial resources, improve work efficiency, reduce work intensity, shorten work time, and enable operators to work with pleasure.

(2) Economic benefits

According to the function of the system, a digital map with a certain accuracy (our preliminary study is that it can meet the point coordinate error \(<0.000010\)) can be made, and this map can fully meet the requirements of planning and design in water conservancy construction. Therefore, using this system to complete the corresponding work, because Google Earth remote sensing images are free, you can save a lot of human, material and financial resources.

4.2. Research shortcomings

After the product trial operation, the product still has the following deficiencies:

1. The products produced by the system have strong regional differences in accuracy assurance. For example, the accuracy of mountain areas is lower than that of plain areas.

2. The system operation is only partially automated and requires more manual intervention to complete the information collection.

3. The operationality of the produced maps needs to be further strengthened.
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