Unification and Harmonization in True Color Image City Map

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Abstract  True color image city map is a sort of new-style map which combines the high resolution image and map symbols and shows both advantages in visualization. At the same time, the map unification and harmonization should be taken into account during the design process, since some visual conflicts appear when map symbols overlaid on the true color image. The objective of this research is to explore the rules in the process of true color image city map design based on chromatic and aesthetic knowledge. At the end, taking the Image Atlas of Guangzhou as an example, image color adjustment, road network presentation, and symbol designing issues will be discussed in the application.

Keywords  true color image; city map; map design; unification; harmonization

CLC number  P283.1; P299

Introduction

Nowadays, in the GIS-context, multi-source data become popular in map design, since other data, remote sensing image for example, can supply a gap in traditional map expression. True color image city map is developed in this trend. It uses aerial photograph or high resolution satellite image as background, added to some map symbols and annotations, such as the road networks and borderlines, to present the true city landscape and important geographic entities. Compared with the general city map, it has more vivid background information, more diverse geographic elements and some other advantages[^1]. However, some traditional design rules and methods are not suitable for this new type map any longer. Exploration is necessary to address the conflicts which appear during the data fusion. This paper only discusses the visualization problem in the map design process in the chromatic and aesthetic point of view.

1  Information gain in data fusion

1.1  Expression enhancement

The integration of the image and map is an effective way to help map users to gain more information by enhancing the geospatial expression. For one thing, the information on general city maps is usually extracted and expressed in abstract way. Generalization of map contents sometimes will limit the cognition of geo-space and on-demand cartography is impossible carried out on static maps[^2]. Whereas based on the legible and vivid true color satellite image or aerial photograph, various city landscapes, such as the natural beauty spot, forest park, urban green space.

[^1]: Reference
[^2]: Reference
will be displayed vividly and intuitively. The information keeps great consistency with the cognition about the real world. For another, either high resolution image or aerial photograph is still inefficient in identifying some important but tiny entities, and some invisible boundaries as well, no matter how satisfying resolution of image will be. However, map symbols could supply this gap.

1.2 Multi-dimensional information

The cognition to the geographic space is multidimensional and multileveled\(^3\). Aerial photograph on one hand could give veracious and intuitionistic information of the earth surface, but on the another hand has no capability of showing phenomena below the ground surface. In modern cities, subways, tunnels and some other underground architecture have turned into the significant part of traffic system. Travelers in the city may not only concern about the subway network and the route direction, but also want to know the relative position between the exits of underground and street. In the true color image city map, map symbols could easily be displayed in line form and point form present subway route and exits respectively. Besides, in addition to the geographical existing boundary, the flat\(^4\) which is closely related to cities, for instance, the administrative district, is also demanded to express combined by line elements.

1.3 Information classification and processing

Aerial photograph or high resolution satellite image without interpretation and cartographical process will not be an effective city map: ① coordinate system should be added to the image; ② on account of lacking attribute information, it is required to categorize the image information and distinguish different sorts of geo-objects by symbols of different colors or fonts; ③ generalization is still of importance to extract useful information for map users. Take road networks, the framework of every city, for an example, it is necessary to be classified into various kinds and ranks, and then applying multifarious symbols. In practice, the road width in the basic reference maps and the true color image should both be considered. In this case, the short and narrow street in residential zone or insignificant district could be abandoned; contrarily, the roads, which are the city framework or located in important zones but are narrowed owing to the shooting angle of image, should be aggrandized.

2 Basic rules of unification and harmonization

The basic aim of fusing image and map is to serve the map cognizance, therefore the regularity of cognizance must be studied before the fusion process and map design. The cognition and reasoning to city in the geographic space relies on the markers, routes, nodes, regions and boundaries\(^5\), of which the marks play important roles in space cognition and navigation. Although annotations and map symbols are able to act as marks in the true color image city map, road networks which are regarded as the linking markers will make the space cognizance and navigation in a more clear way. Accordingly both the marked geo-objects and road networks must be symbolized so as to establish the connectivity of the map symbols serving the cognizance.

During the fusion of the image and map symbols, three main aspects should be paid attention.

Firstly, the relation of visual levels between image layer and map symbol layer. Map elements being in the same visual field will form several visual levels in a way of adopting different expression methods. The important layer lies above whereas the relative subordinate one lies beneath; they are consistent and will not interfere with each other, it is an important characteristic of the present-day map. True color image city map provides a window for us to understand the real visage of cities, which is convenient for reading and addressing. Consequently, in the map users’ visual field, the thematic contents such as traffic infrastructure, departments, residential area, should be lay on the upper level, whereas the image, which serves as background and geographic reference, is generally in the lower level. There are two steps in processing aerial photograph or high resolution satellite image: ① rectifying the chromatic aberration partially in each image which were caused by the weather condition and so forth; ② adjusting the color of the mosaic image, including the brightness, saturation and tonality.
Secondly, the road networks and background image should be distinguished under harmonization condition. The map designer should try to symbolize the road networks and make them the obvious framework of cities while inosculating with surrounding image appropriately. In present, some published image city atlases provide valuable reference. In Image City Atlas of Shenzhen, road networks were picked-up solely to the first level using solid lines in bright yellow, which formed the clear framework\(^3\). In Image City Atlas of Shanghai(Center City Zones), road networks were processed to be semi-transparent. It appears harmony with the background image and looks more natural. In Image City Atlas of Lanzhou, road networks were not symbolized, only the road addresses were labeled. These disperse annotations could result in reading difficulty and missing the navigation function of the road network. At the same time, when highlighting the cloverleaf junction and overhead highway, which are main infrastructure of the modern cities, the cognition effect and harmonization must also be fully considered.

Last but not least, the design of map symbols and annotations in the image city map is quite different from that in the general city map. Generally speaking, the background of traditional city map is rather simple, just filling certain light color. Therefore designers always use geometrical symbols or artistic symbols to enhance the expressive power and artistry of city maps. Various Bertin visual variables in different forms, configurations and color combinations will be applied in this traditional design process. However, giving the image as background, designers should consider the following issues: ① image must give prior to symbol and annotation layers in visual levels. ② symbols should not cover too much of the image information; ③ the color of annotations must be observable but too many sorts of color are unfavorable.

3 Case study

In the following paragraphs three main design schemes will be described in the case study of the Image City Atlas of Guangzhou(Atlas in short): ① adjusting the relation of whole visual levels by exerting diversification of the map color in color phase, brightness and saturation perspectives; ② designing road networks symbols by utilizing the derivative visual feeling of color, such as advancing and receding, dilatability and contractibility, the cognizance based on the background and so forth; ③ utilizing the color to perfect and systematize the classification and gradation of map elements during symbols and annotations design\(^6\).

3.1 Image preprocessing

The original aerial photographs of Atlas are of vivid colors, great contrast and high resolution. Fig.1(a) shows a piece of typical area in the city centre. This raw aerial photograph is of clod hue, vegetation appearing dark green and buildings also in dark colors. The histogram showed in Fig.2(a) describes the color characteristics of this original aerial photograph.

Fig.1 Original image and image after preprocessing

Fig.2 RGB histogram of images

Since the colors of this original aerial photograph are unfit for background layer, firstly the hue being some cold could be slightly adjusted to be neutral or some warm. The city will look brighter and sunnier with some warm hue, but what is to be mentioned is that the color of vegetation, green, must be preserved. Then the photo should be put to a subordinate visual level by reducing its saturation while increasing its brightness. In respect that the contrast between the bright part and shadow of buildings in original photo is too striking, the contrast and resolution of image should be adjusted appropriately. After adjusting the hue, reducing the saturation, increasing the brightness, decreasing the contrast and some other manipulation, a new image with quietly elegant color and slight contrast is showed...
in Fig.(b). The histogram showed in Fig.2(b) describing the color characteristics of the aerial photograph after preprocessing. This comparison proves that the preprocessing is fit for the image background layer and in favor of the design of other symbols.

3.2 Symbols of road network design

The road networks are not suitable to fill with excessively saturated color as they cover relatively large area though they are in line form. Moreover, the roads surface and residential area in the aerial photograph are in the same caesious, hereby the symbol of road networks in transparent white or cold cyan looks harmony with background image and this color design also makes other symbol design easier. In the experiments, we found that it is satisfying when the color of roads is in semi-transparent purple which appears nearly white as a result of the interference of background color (usually because of the residential area in light cyan). Furthermore, the road networks and background image will be separated by the white sideline. Fig.3 shows three kinds of results, of which the combination of transparent roads and image is most natural and the whole road networks are more holistic (Fig.3 (b)).

![Fig.3 Symbol designing of road network](image)

The yellow line symbols with certain transparency will make overhead highways more striking and prominent. Meanwhile, according to the chromatic principle, the highways in the color of yellow at upper level will look like to be advancing. These transparent symbols will not be able to transfer information any more after the overlay, but the style of them keep the same, and it is more natural and clearer (Fig.4).

![Fig.4 Symbol designing of viaduct](image)

3.3 Point symbols and annotations design

Atlas adopt the following schemes in the point symbols and annotations design: ① a large amounts of small rounded symbols are designed to locate entities with annotations, such as government offices, enterprises, hotels, markets and the like. This simple design can avoid overlaying too much space on image. ② Other important geographic entities such as underground exits, gasoline stations and parking pots, distributed widely, are not provided with demonstrative annotations. Therefore, these entities would better to be presented by symbols that are of simple structure, impressive symbolism and small area. ③ In order to give prior to annotations in the visual levels and make it convenient for readers to obtain attribute information, annotations are always in bright red, fuchsine, cyan and some other thunder-and-lightning colors. The annotations can be separated from the background image using white solid sidelines. ④ Annotations which address large area entities such as region, residential zones and parks adopt the font of official script or wei bei whose stroke is relatively wide, moreover, they could be decorated with reverse white typeface.

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