An e-Map Navigation System with Visualized Landmark Information

Dai-Yi Wang, Chang-Kai Hsu and Ming-Tsung Lai

***Abstract*—In this paper, a new e-Map navigation system is designed to provide users with regional navigation services. It provided users keyword search, multiple classification search, and region search, so that users' need for diversified searches can be satisfied. Besides, this system applies chromatology to visualize search results, using colors to present landmarks and different degrees of chroma to describe landmark information. It is expected that through improvement of the system design and the information retrieval interface, user's search cost can be reduced and better navigation services can be provided in a more efficient manner.**

***Index Terms*—e-map, landmarks, navigation, visualization.**

I. Introduction

Information visualization enables users to quickly and easily understand features and concepts contained in the information [1], [2]. Map is a visualized product. Using symbols, lines, and simple graphics, a map is drawn to express the spatial information of a region or a landmark. Users can move and browse the map to have a quick understanding of the overall development of the region. In recent years, e-map systems have been developed toward not only providing geographic information but also integrating life information, such as real estate sale or rental information, and traffic conditions. Integration of these services with e-map can enhance practicality of e-Maps and bring much convenience to users.

On conventional maps, a landmark is defined as a symbol of a building. However, on an e-map, a landmark can be a building, a dessert vendor, an event location or even a person's whereabouts. The definition of landmark has become very broad depending on the focus of users' interest. Moreover, information carried with the landmark has also been expanded. Not only location of the landmark, many other messages, including the name and opening hours of a store, user satisfaction with this store, and etc. can all be included. However, if this e-map system is expected to provide much more extensive information, how to facilitate information retrieval and use will be a critical issue, which is the focus of this research.

Information retrieval helps users extract information of interest from a huge information database [3]. So far, most of the web-based e-map systems have allowed users to search landmarks using any keyword of store name or address. However, users sometimes will explore a region without any specific landmark in mind. For instance, Professor Wang, who is scheduled to attend a meeting in University A, wants to know the distribution of stores around this university and find the area where restaurants are densely located in advance. Unfamiliar with this region, he may not be able to provide an accurate keyword in the search.

Some systems provide the function of classification search, allowing users to move the map to the area of interest and select the type of stores they want to view. However, almost all of these websites do not provide multiple choices in classification search. If Professor Wang wants to know where he can dine and buy books, he needs to search the database twice, and if he moves the map, he needs to check the class again to retrieve new landmarks.

In addition to the information retrieval method, the current e-map systems also have problems with the display of retrieved landmarks. The information which needs to be displayed involves landmark and its content information. In the present, common landmark content information includes landmark name (symbolic data), opening hours (symbolic data) and customer rating (numerical data) of each landmark. In current e-map systems, different types of landmarks are presented with different icons, and users can click on each icon to view the entire landmark information on a separate window. The landmark information is usually in the text format. This kind of separate display of graphics and text may cause burden and obstruction to user's recognition [4].

Moreover, the current landmark icons can only help users recognize the location of each landmark. An excessive number of landmark icons on an e-map are likely to cause the clustering phenomenon, making it hard for users to recognize the target landmark and distinguish it from others. As shown in Fig. 1, if multiple landmarks are close or even overlapping, users only see the landmark on the top and cannot easily find the landmarks on the bottom. Text-based portals usually display search results in a list or on several pages to avoid excessive concentration of information. However, if the same strategy is applied to e-map systems, users may not identify the spatial relationships between landmarks.

Therefore, in this study, a new e-map system design is proposed to provide users with a more efficient navigation service and allow them to explore landmarks with a sense of direction from a huge database [5]. This system needs to be equipped with diversified and flexible retrieval methods, so as to satisfy demands in various contexts. In addition to text description, the important landmark information is also

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D. Y. Wang is with the Department of Computer Science and Communication Engineering, Providence University, Taichung 43301, Taiwan (e-mail: dywang@pu.edu.tw).

C. K. Hsu is with the HyWeb Tech. Co., Ltd., Hsinchu 300, Taiwan.

M. T. Lai is with the Department of Computer Science and Information Management, Providence University, Taichung 43301, Taiwan

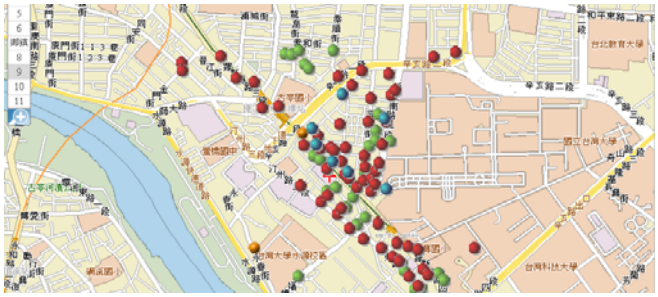

Fig. 1 The clustering phenomenon of landmarks

presented with different visualization techniques depending on data features. Various kinds of analysis charts of landmark information are further provided to give users an overview of the regional information and also enhance efficiency of information recognition.

II. System Analysis and Design

The framework of the e-map navigation system with visualized landmark information is proposed as shown in Fig. 2. The system information is stored in the map image database and landmark information database. The proposed system organizes life-related landmarks by theme and class in a hierarchical manner. For instance, the theme of educational institutions includes school, library, museum, and cultural center, and the landmark of Providence University belongs to educational institution/school.

In the navigation service, the system provides the landmark search function to assist users to search for expected landmark. The data analysis function enables users to statistically analyze landmarks within a specific region to obtain global information of the region. The above results will be presented through the information display module. Besides, users can add or delete landmark information, and the added landmark information can be shared with other e-map users. The landmark search module, data analysis module, and information display module are respectively explained as follows:

A. Landmark search module

This module allows users to define search criteria by three methods.

1) Keyword search

Mainly used when users have a certain degree of understanding about the target landmark (such as the partial name of a store) to obtain spatial location of the target landmark.

2) Classification search

Landmarks are classified into several hierarchies for users to explore landmarks in a specified region by classification, such as to search for coffee shops (class) in the class of restaurant (theme). The system is designed to satisfy users' need for multiple choices of search criteria, such as to search for a region where has coffee shops and book stores nearby Providence University. Besides, when the viewing area is moved, the system can automatically re-execute the classification search command to achieve instant retrieval on move.

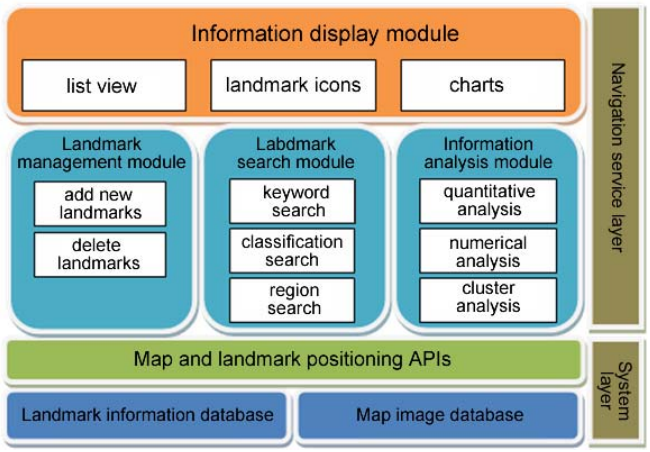

Fig. 2 The framework of the proposed system

3) Region search

Users explore landmarks in a region specified via dragging map and selecting an area by mouse. For instance, users can use this retrieval method to have an overview of all the stores and distribution of each type around Providence University.

B. Data analysis module

This module analyzes landmarks satisfying the defined retrieval criteria to propose statistic information.

1) Quantitative analysis

The amount of landmarks in each class is estimated to understand the distribution of each class of landmarks, such as the number of coffee shops or convenience stores around Providence University.

2) Numerical analysis

The numerical data of each landmark, such as customer satisfaction with a store or sale price of a house, are analyzed to help users understand the difference between landmarks.

3) Cluster analysis

The numerical data of each class of landmarks are analyzed to help users understand the difference between landmark classes, such as the ratings for coffee shops and convenience stores around Providence University.

C. Information display module

The system displays not only geographic information but also landmarks that satisfy defined criteria and the related information of these landmarks. Three display styles are proposed: list view, landmark icons, and charts.

1) Display by list

Names of landmarks are listed. When users select any landmark on the list, the system will instantly move the map to the area where the selected landmark is located at the center for users to perform regional retrieval. Besides, the landmarks that satisfy the defined criteria are classified by city/county in hierarchy so as to help users understand the distribution of landmarks in a particular city/county (Fig. 3).

2) Display of landmark icons

Landmark icons are displayed on the map with different colors to denote symbolic information, such as landmark class, and different degrees of chroma to denote numerical information, such as customer satisfaction. Users can quickly identify a single landmark and even obtain comparative information of landmarks in a specific region.

Fig. 3 Information display by list module

Colors play an extremely important role in information communication [6], and utilization of color hue can bring different perceptions [7]. Therefore, if different types of landmark icons are presented in different colors, they can be more impressive to users. For instance, yakiniku restaurants or hospitals can be displayed in red hue.

Considering the high sensitivity of human eyes to chroma, numerical data of landmark information (such as customer satisfaction with stores and house price) are converted into degree of chroma of landmark icons. Higher numerical values will derive a degree of chroma near 100, while lower values derive a lower degree of chroma. Therefore, if a number of landmarks are clustering, users can still quickly find landmarks with higher numerical values. Besides, overlapping icons when presented in different degrees of chroma can concentrate users' visual attention to find the important area.

3) Display by charts

Landmark information is analyzed and presented in radar chart, pie chart, and histogram chart.

III. System Implementation

In the implementation of previous e-map systems, transmission of massive map images would reduce the display speed of web pages. Thanks to the mature technology of Web 2.0, this system uses Asynchronous JavaScript and XML (AJAX) technology to transmit data between systems modules. AJAX allows users to continue having interactions with the browser while requesting data from the web server. Therefore, access of map information and retrieval of landmarks can be smoother and more efficient, and the operations of the e-map system can also be more flexible. In this system, the AJAX technology is adopted to efficiently perform the data transmission between systems modules, and the flowchart is shown in Fig.4.

Based on the above system analysis and design principle, an e-map navigation system that can provide life-related information is implemented. Map image database is provided by OleM@p Inc., stores the map data of Taiwan. OleM@p Inc. also provides UrMap APIs for programmers to develop e-map systems. The mainly functions of UrMap APIs are to access map images and locate the landmarks by their longitude and latitude.

The landmark information database is established by authors. The landmarks contained in the system include public institutions, schools, restaurants, and etc. Landmark class decided the color hue of landmark icon, and customer satisfaction decided the chroma degree of icon.

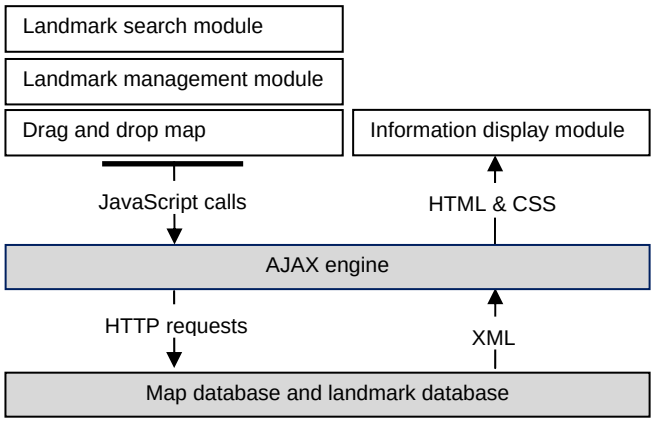

Fig. 4 AJAX request for e-Map navigation

Fig. 5 System interface

The implemented system interface is shown in Fig. 5. The right side shows the viewable area of the map, which users can drag to change the viewing area. Other functions on the system interface are detailed as follows:

A. Animated tutorials of various retrieval methods are available. If users need any assistance during operation, they can view the tutorial, drag the timeline or close the animation.
B. Keyword search interface. Users can input any keyword of the name or address of the target landmark as a search criterion.
C. Classification search interface. Users can change the theme to select landmark classes. Landmarks of the selected classes will be presented on the e-map.
D. Regional search interface. Users can click on the map and drag a rectangular area. All landmark information within this specified area will be immediately displayed on the map.
E. Hierarchical text information display interface. The retrieved results are classified by city/county, so users can select the city/county to see all the landmarks satisfying the defined criteria within this city/county.
F. Text information listing interface. Landmarks satisfying the criteria in classification search and regional search within the viewing area are listed.

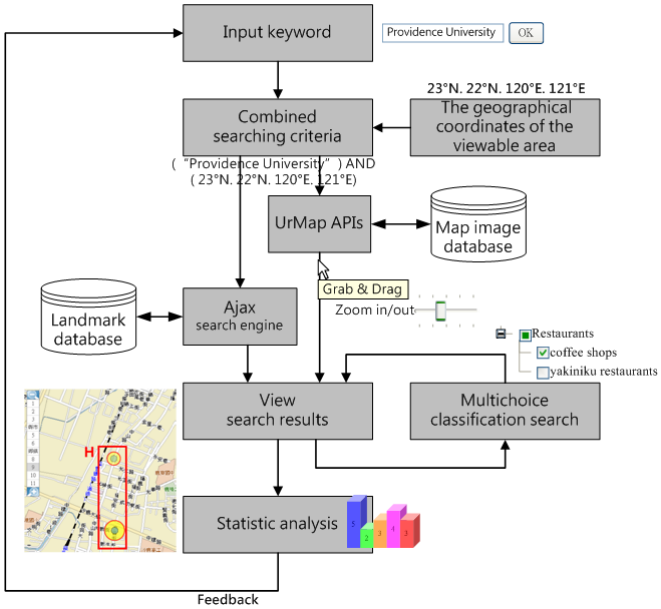

Fig. 6 The operation flowchart of an application scenario

G. Statistic chart display interface.
H. Different classes of landmarks are presented in different colors, and customer satisfaction is presented with icons in different degrees of chroma.

The following is a scenario of e-Map navigation: Dr. Wang, who will attend a meeting in Providence University, wants to find the area where she is convenient to dine and buy books around this university. Therefore, she inputs "Providence University" in the textbox (keyword search), and drags the map to view the area around Providence University. Via classification search interface, she clicks the coffee shops and book stores checkboxes to make multiple selections, and finding the area where coffee shops and book stores are densely located. After observing the highlight-colored landmark icons, she can easily determine which stores are satisfied with her options and highly recommended by other users. The operation flowchart is as shown in Fig. 6.

IV. Conclusion

In this paper, an e-map with visualized landmark information was proposed, and AJAX technology was applied to accelerate display efficiency. This system allowed users to explore a region in naïve search (with no idea about the target landmark) or primed search (with idea about the target landmark) [8]. In future e-map systems, information of special offers of stores can be integrated and applied to group purchase service, and the sell price of houses can be applied to house sale services.

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