User-perceived Information Visualization Method in Human Body Acupoint System

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Abstract. Information visualization is a trend and research hotspot in various fields. This paper constructs a user-perceived information visualization framework and applies it to the human acupoint system. A user-perceptual visualization method of three-layer architecture is proposed. A unified storage method and access interface are provided in the data unified layer to effectively manage data information. Then, in the user perception layer, the K-means clustering method is used to generate the expected interface of the system, which reduces the processing tasks of the subsequent visualization process. The visual implementation layer forms an actual interface for interface design such as interaction, navigation, and the like of the content of the intended interface. Finally, an application example of the acupoint system is given, which proves that the method can complete the visualization from the source data to the actual interface.

1. Introduction

Information visualization was first proposed by Stuart K. Card, Jock D. Mackinlay and George G. Robertson in 1989 to study the visual presentation of large-scale non-numeric information resources. On this basis, Card et al. summarized the process of information visualization and first proposed an architecture to describe information visualization[1].

We first abstract an information visualization process on Card's reference architecture and introduce user perception based on user information. A general information visualization framework based on user perception is proposed. Then, a user-perceived visualization method based on the human acupoint system is constructed under the universal visualization framework. Based on the source information, the method unifies the storage form and access method of the data information contained in the system, and combines the user's perception to generate the expected interface by K-means algorithm. Finally, the actual interface is generated through the visualization process[2].

2. User-perceived Visualization Framework

As shown in figure 1, the general model for visualizing information based on user perception is divided into five parts: visual data module, visual structure mapping module, visual graphic mapping module, visual interface module, and user module[3].

The module forms an interaction between the modules by performing visual transformation, and the model is dynamically adjustable. The basic process is as follows:

(1) Visual data module

Raw data information is cluttered, and various types of data are intertwined from which we can not quickly obtain valid and required information. The visual data module classifies and aligns the
scattered data to generate a corresponding data set. The data set has a preliminary unified collection form compared with the original data.

Figure 1. User-perceived visualization framework.

(2) Visual structure mapping module
Although the data stored in the dataset has a two-dimensional storage form, but the data is independent of each other, and the visualization will be independent and lack of logic. In fact, each piece of data needs to maintain its meaning through multiple relationships, and we attribute these relationships to attribute relationships and mapping relationships[4]. The visual structure mapping module links and matches the relationship information to achieve information fusion.

(3) Visual graphics mapping module
The process of visual graph mapping is to select a reasonable visual channel for different information characteristics from the constructed source information database and to visual encode, and generate visual elements. Visual coding is the core of information visualization. It is a technology to establish the mapping relationship between data and graphic elements. Visual coding consists of geometric markers and visual channels. Geometric markers are points, lines, faces, and bodies, while visual channels are different features that display geometric markers, such as position, shape, color, etc.

(4) Visual interface module
The process of functional design, content design, interaction design and navigation design for the generated visual elements is called visual interface layout, which is the core task of the visual interface module. The functional design is based on explicit and implicit functions of system and the functions that the user demand. The two functions are matched, and the functions with consistency are filtered out to become the main body of the functional design. There is implicit logic in the interaction. Different interaction order and degree of interaction affects the entire interaction process. The purpose of the navigation design is to normalize the interaction and to provide interactive guidance for the user.

(5) User module
The user module and the visual interface module are two-way. During the interaction process, the user has some suggestions on the friendliness of the interface, the layout and the fit of the usage habits, and these contradictions are returned to the visual interface module as user feedback.

(6) user-perceived collaborative processing
User-perceived collaborative processing is based on the characteristics of the user's needs, and the visualization process is improved and adjusted. In the internal scope, the user's personal information and interest preferences are mined to form the user's demand points. In the external scope, the
visualization process is collaboratively processed in combination with user information and demand conditions. The process is as follows:

Process 1 is data pre-processing. By introducing user perception, the required attributes and mapping relationships are determined in advance, and the processing of other redundant information and relationships is avoided, also the volume of the data space is reduced. The process 2 of generating the expected interface is the most important user-perceived process. The expected interface is determined by user's needs in the user module to determine the content information that each interface needs to present. And the user has an expected effect on a system in each process of interaction, and there is information associated with these effects. Process 3 is hierarchical processing, the visual elements generated by the information content in the same interface are processed hierarchically to ensure the orderly design of the interface.

3. User-perceived Visualization Method in Human Acupoint System

Basing on Unity 3D software, we designed the human acupoint visualization system to achieve positioning from disease to specific acupoints\[5\]. Therefore, under the general framework, we propose a visualization method based on user perception in the acupoint system for the specific object of the human acupoint system. The architecture is as shown in the figure 2:

After the source information base is formed in the data unified layer, a unified storage form and an access interface of the data are established. In the user perception layer, the related information is searched according to the user's requirement conditions, and the K-means clustering method is used to generate the expected interface. Finally, in the visual implementation layer, the information is called and the actual interface is visualized to complete the design and implementation of the entire system.

![Figure 2. User-perceived Information Visualization Framework in Acupoint System.](image-url)

3.1. Unified Form of Visual Data

The acupoint system involves a large amount of data information. A source information database is formed after the user's perception of the disease and acupoint information structure processing. There are not only texts and other information in the library, but also non-traditional models and animation information\[6\]. This information is usually stored in a relatively scattered manner in different places, so it is necessary to manage these data information in a unified form.

(1) Structure processing of data

We extracted the most concerned about the disease and acupoints by analyzing the daily habits of the public, taking oral ulcers for example as shown in table 1. The processing of information such as acupoints is similar to this method.
Table 1. Disease information.

| Disease Name | Cause                                                                 | Symptom                                                                                                                                                                                                                                                                                                                                 | Acupoints | Precautions |
|--------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|
| Oral ulcer   | Topical trauma, mental stress, food, drugs, malnutrition, changes in hormone levels, and vitamin or trace element deficiency | The surface of the ulcer is covered with gray or yellow pseudomembrane, the surrounding mucosa is red and slightly swollen, and the local burning of the ulcer is obvious.                                                                                                                                                               | Yanggu    | Avoid eating spicy, fried, rough and hard and grinded objects |
|              |                                                                      |                                                                                                                                                                                                                                                                                                                                    | Neiting   |             |

(2) Unified storage architecture

The data that the system can use includes disease information, acupoint information and so on. For the system, unstructured data should be reduced as much as possible. We use the unified storage architecture shown in figure 3 to implement a more unified storage method for data information.

Disease and acupoint information are stored in the MySQL database after structural processing. The picture and audio information belong to unstructured data. Although it can be stored by converting binary, the encoding and decoding process is time consuming, so we use indirect storage. It is realized by storing the URL path of the file in the database. Considering that the Unity itself has a more convenient way to store model and animation information, they are stored in the Unity.

(3) Unified access interface

The system needs to access the data during the visualization process. Since the MySQL database and the Unity repository are included in the unified storage architecture, there are two access methods. As shown in figure 4, we provide a unified access interface to handle different access requests. By judging the type of access information, if it belongs to structured data, use the ADO.NET access method, otherwise use the Unity script method.

The unified access interface of the data realizes the unified call of the data resources, and provides an efficient and unified method for the call of the data information in visualization.

3.2. User-perceived Expected Interface

For the object of the acupoint system, we regard the process of generating the expected interface in process 2 as the main process of user-perceived collaborative processing. The process sets the expected content of the interface according to the user's need for the use of the acupoint system. Therefore, we consider the user's daily thinking habits of understanding the disease in life, mining detailed user demand conditions, and matching the related information that satisfies it. We propose 11 demand conditions as shown in Figure 5, and give corresponding association information.
Because the user's demand conditions are far and near in psychological distance, we divide the psychological distance into the near-field phase, the mid-field phase and the far-field phase. “What kind of disease”, “what disease”, “where is the acupuncture point” are set as the starting point of the near field, midfield, and far field, and we set the psychological distance to 1, 2, 3. The psychological distance of other transition conditions is between the value of the two fields. Information depth refers to the general cognitive level of the content contained in the information. We set the information depth according to the following rules. The main information has the lowest depth, and the attribute relationship information is deeper than the main information, and the mapping relationship information is one level higher than the attribute relationship. The picture information in the attribute information is deeper than the text information level. The model and animation information as a three-dimensional information has a deeper depth than the two-dimensional information.

The psychological distance has a greater influence on the expected interface than the information depth, so the value is larger. The psychological distance and the information depth is taken as the horizontal axis and vertical axis, and the scatter diagram shown in the figure 6 is formed.

We use the K-means clustering method to help us determine the division of the expected interface. We set the expected number of interfaces to 5, that is, the number of clusters K in K-means is 5, and the training set is the coordinate points corresponding to 11 demand conditions. We randomly select 5 points as the starting point, after several iterations it forms the clustering result as shown in the figure 7, but the clustering result needs to be corrected according to people's habits and logic. The name of the disease as the main information of the illness needs to be shown together with the disease, the cause, etc. So, the common disease is used as the interface 2, and the disease name is classified into the interface 3. Similarly, the relevant acupoint information as a mapping is a progressive point of the
interaction, so it needs to be placed before the acupoint interface. The local adjustment based on the clustering result finally generates the user expected interface as shown in the figure 8.

4. Application Instance
We designed the human body acupoint system in Unity 3D according to the above user-perceived visualization method. The actual part of operation interface is shown in figure 9.

![Figure 9. Expected interface](image)

Figure 9. Expected interface

Figure a is the home page of the system, and it provides different ways to query. Figure b is a common disease interface, through the sliding bar and other ways to achieve visual interaction of information. Figure c is the disease detailed information interface, including symptoms, causes, massage points and other information. The system combines the user's needs and usage habits to make a reasonable layout of the interface information and interactive controls, and facilitates the user to read and understand through visual methods such as text color features and picture descriptions. Also, it provides navigation buttons such as return button to enhance the user experience.

5. Conclusion
This paper proposes a user-perceived general information visualization framework. It introduces the visualization process and the user-perceived processing method, and improves the visualization efficiency through the introduction of user perception. Then, based on the framework, the human acupoint visualization system is designed. The user's demand condition is mined and the K-means method is used to generate the expected interface in the user perception process, making the visualization result more in line with the needs of users. The method can fully reflect the user-centric concept of the product, conforming the current and future information visualization development trend.

6. References
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