Visualization Technology For The Financial Decision Models Of DSS

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Abstract: According to the research of visualization technology and the theory, concept and methodology of decision support system, this paper presents a new design method of DSS based on visualization technology. This new method is the foundation for developing the financial decision support system based on visualization technology. This paper describes the developing process of the financial DSS based on visualization technology. The problems have been solved that are how to realize the visualization of financial decision models and their related data, and how to build financial decision models. The method of analysis and design generated from the process of the system realization offers a new method for developing different kinds of the DSS based on visualization technology.

Key-Words: DSS, Visualization technology, FDSS, Financial decision models, Visualization module, Web application

1 Introduction

In recent years, the research and development of all kinds of information system based on visualization technology, such as the research of GIS visualization, research on the application of visualization in the MIS, research on the application of visualization in Data Mining, and research on the application and method of the information visualization, etc [1-5], have become the popular spot of the IT academic circle, which have impelled and promoted the alternation of the information visualization on the existed information technology (for instance, MIS, DSS, ERP and so on). Therefore, the application of visualization technology in all different kinds of areas has developed rapidly and become more and more popular.

On the other hand, the theory, concept and methodology of DSS established in 1980 are also quoted in or inherited to the follow-up theories such as Data Warehouse and ERP. For instance, the concept and method of Data Mining, which is the important component in the theory of Data Warehouse, are the typical cases of inheriting the model of DSS theory and its application in the management decision; the application of the methods for ERP theory can also be considered as the modification of the application of model base for DSS theories. Thus we can say that the theory and concept of DSS and its methodology are full of impacts [6].

On the basis of classical DSS theory, this paper presents new theories, concepts and methods of DSS based on visualization technology. Moreover, a financial decision support system based on visualization technology has been developed grounded on new theories, concepts and methods of DSS based on visualization technology. One of the key technical problems remained in the development of the financial decision support system based on visualization technology is how to realize the visualization of the financial decision models and their related data; while another
accounts for the building of the models. Finally, the relative theories, concepts and methods set forth in the paper during the analysis and design of the financial decision support system based on visualization technology has resolved the problems of how to realize the visualization of the financial decision models and their related data and to build the financial decision models, and finished the development of the financial decision support system based on visualization technology. Therefore, the work made in the paper, to some extent, has theoretical instructions and practical references to the development of the theory, concept and methodology of the DSS based on visualization technology.

2 Relative Theories and Technologies of the Financial Decision Support System (FDSS) Based on Visualization Technology

2.1 Information Visualization Technology

Visualization, also called as the Visualization in Scientific Computing, which was defined as follows in a report published by US NSF in 1981, that was, “As a computing method, visualization transforms the symbols or data into intuitionistic geometric figures so that it will be convenient for the researchers to watch its simulating and computing process. Visualization also includes the image synthesis, which means it is a tool for interpreting the image data input into the computer and creating the images from the complicated multi-dimension data.”

The data visualization technology, some of which were developed for particular applications, while others were of universal applicability, was described according to the images formed by Data Set. Generally, visualization technology can be divided into four steps, that is, “data preprocessing”, “mapping”, “protract” and “display”. [7]

2.1.1 Data Preprocessing

The visualization module input the analog data and experiment/measurement data from the computers. Moreover, the transfer of the data from the database is also included. The objects treated by the visualization include “symbol”, “structure”, “image” and “signal”. The creation and acquisition of the objects such as the original symbols, structures, images and signals belong to the tasks of scientists or engineers who are engaged in the computing and experiment of the science and engineering; while the tasks of transforming the data into visible graphical (image) information are left for those engaged in the application of the visualization in the scientific computing, who cooperate with the scientists engaged in the fundamental researches or engineering researches and use visualization tools to realize and finish the process of transforming the invisible objects into the visible images. The following two parts shall be usually included for the original data processing:

1. Original Data Preprocessing and Storage

The following operations are usually needed in processing of the original data for the visualization: a. Data format and its standardization; b. Data transformation technology; c. Data compression and decompression.

The data processed through the above-mentioned operations will possibly have bigger data capacity and be stored with the standardized data transformation format. The scientific data storage and transformation formats/structures such as HDF, CDF, NetC-DF and so on have been put forward by the organizations such as NASA from US National Supercomputer Center. The formats are usually of the feature of self-description and prone to storage and reading, so they are widely used in the mode computing of oceanographic and meteorological environment and large-scale numerical value computing, etc.

2. Data Processing toward the Visualization Method

The further transformation of the original data is
necessary for different kinds of visualization methods and contents to meet the needs of visualization. For instance, the preprocessing of three-dimensional filtering, re-sampling, three-dimensional image division, and marginal test to the original CT images are needed for the three-dimensional re-establishment of medical images. The operations transformation processing to the original data mainly include: a. Data standardization processing; b. Filtering processing; c. Smoothness processing; d. reseau re-division; e. coordinates modification; f. geometrical modification; g. linearity modification; h. division and marginal test; i. feature test, enhancement and pick-up; j. Lookup table operation and feature mapping; etc.

2.1.2 Mapping
The mapping module can fulfill the function of transforming the numerical data into geometrical data, so what the function of mapping really fulfills is then function of data modeling, which is the core of visualization. The data types processed by the visualization will vary with the application areas. Therefore, different mapping technologies shall be adopted for different types of application data. The regular methods include:
(1) Using the identifiable variable to validate the radices of dimension;
(2) Using the scaling and offset to match the scale;
(3) Using the derivative value (residuals and logs) to emphasize the transformation;
(4) Using the projection to compress the information and acquire the statistics;
(5) Using the random dithering to differentiate the superposition;
(6) Using the multi-view to deal with the high-dimension information;
(7) Using the effective gridding keyword or label to help the understanding.

2.1.3 Protract
The protract function shall fulfill the process of transforming the geometric data into images. In the computer graphics, the scan imaging includes two parts; that is, accurate graphical expression of the object and proper physical description of the illumination effect in the scene.

The accurate graphical expression of the object includes the geometric form modeling technology, scanning transformation technology, anti-alias technology and hidden face removal technology. However, these technologies shall be usually synthesized for the full accurate graphical expression. Meanwhile, the needs of the clients for the figures shall also be considered, so the graphical shall be modeled neither too simply nor too complicatedly.

The reflection, transparency, surface texture and shadow of the light belong to the illumination effect, which is expressed by the imolation model that describes the candela of all points on the surface. Since it is a complicate course to build illumination effect model for the visible objects, most of the software adopts the simplified illumination model which is deducted by the physical formula of the surface candela.

2.1.4 Display
The function of the display module is to output the image data created by the protract module subject to the designated requirements of the users. Similar as the GUI technology, the display module’s corresponding software layers provide the drivers of all kinds of equipment. In addition to fulfill the task of image-information output, the display module also transfers the feedback information of the users to other layers so that the interactive task will be fulfilled. The interactive function is one of the important guidelines of the visualization since much visualization requires of modifying the mapping relationships dynamically and zooming the view through the change of the traversal data, etc.

2.2 The Structure of DSS Based on Model Base
In the early 1980s, the structure of DSS based on model base which was given by Sprague (illustrated as Fig.1). Of which, the model base and its management system(MBMS) was the core of analyzing and solving the problems, whose main functions were to model, solve and administrate the operations of storage, run, control and so on; database and its management system(DBMS) was the memory part of DSS, whose main functions were to collect and store all kinds of data which was needed for running the decision models; while dialogue generating management system(DGMS) was the user interface of DSS, whose main functions were to understand and input the questions of the users (decision-makers), output the solutions and link the model base management system and database management system.

3 Analysis and Design of FDSS Based on Visualization Technology

3.1 Financial Decision Models

There are several kinds of financial decision models, for instance, financial forecast models, financial planning models, financial analysis models and investment models, etc. The math. forms of most financial decision models are statistics models.

Just as Fig.2 shows, the model base is one of the important components of FDSS. Since the FDSS applied here takes the financial decision support as the application background, financial decision models are the logic (computing) basis of the model base of FDSS. We have designed two realization methods of financial decision model base. 1) Method of general statistics software package: Take the statistics models (functions) which are included in the general statistics software package as the main body of financial decision model base and install it to the application server; compile the interface program of the statistics models (functions) which are included in the running and management of general software statistics software package to take it as the important components of model base management system of FDSS. 2) For the financial decision models which are not included in the general statistics software package, programming it if FDSS needs and add it to the financial decision model base.
3.2 Components of Visualization-Based FDSS

Compared with Fig.1, Fig.2 has added the visualization modules of financial decision model and data visualization model.

3.2.1 The Visualization Module of Financial Decision Models

The visualization of financial decision models was implemented through the following two parts in compliance with the features of the financial decision model:

(1) Output visualization of financial decision model: The financial decision model shall be output with a particular meaning. Since the math form of financial decision model gives priority to the statistics models, the design of model output interface will provide the analysis equation of the model first; and then, the variable of the analysis equation will be transformed to one or two models, which will output the value (function) of the analysis equation in the form of plane curve or 3D curved surface, separately.

(2) Interactant: The users will be allowed to change the input value of every variable of the financial decision model through operating the model in order to observe the change of the model output. [8-9]

3.2.2 The Visualization Module of Data

There are several methods of data visualization, which vary with the purposes of data analysis. The methods mainly include:

(1) Discrete-point graph, which can help to analyze data clustering and observe the distributing to find if there is any odd point.

(2) Discrete-point matrix, which is the extension of the function of discrete-point figure and can describe the distributing of multi-dimension data.

(3) Parallel coordinate system is a way of expressing multi-dimension data. If the data is of n dimension, there will be n parallels. Every point will be described with a broken line, the point of intersection between which and the coordinate axis shows the value of the point in this dimension.

(4) Multi-angle patrol implements the preceding transformation to the data continuously and display dynamically. What is reflected to the computer’ screen represents the projection of the data in some two-dimension. Its advantage exists in being able to observe the data dynamically from different angles.

(5) The saturation brush is a technology put forward to emphasize the expressive force of data visualization. It provides little brightness (almost dark) to each data point; however, the forward data points in the data-concentrated area are of high brightness, and those in the data-scattered area are of little. Therefore, the distributing of the data will be concluded according to the change of the brightness. [10-11]

In one word, according to the features of the financial decision support system, the data visualization methods chosen for its visualization module include discrete-point graph, parallel coordinate system and multi-angle patrol.

During the process of analyzing and designing FDSS based on visualization technology, we have combined two mainstream methods in the software engineering; that is, structured method and object-oriented method. Since the main body of FDSS is model (model base), we can assume every model of FDSS Based on Visualization Technology as the object (or main body of the object) first. Then, a genius (object) will be abstracted out of some kind of model. According to the DSS theory put forward by Sprague, the data in the DSS database is mainly used for running the model, so the main attribute (group) of the object (model) designed in the FDSS is equivalent to the corresponding data (group). Since the technology is quite dependent on the products of relational database now, the structured method is adopted in the analysis and design of FDSS database and its management.
system. [12]

4 Implementation of FDSS Based on Visualization Technology

The development process of the application of DSS also reveals the development track of information system architecture, software, hardware and networks communications to us, for instance, PC-based DSS and DSS based on C/S architecture, etc. Therefore, the now-popular Web application environment shall be taken into consideration naturally when designing DSS here. Today’s information systems usually take three-layer architecture applied in Web as the physical architecture, the implementation of FDSS based on visualization technology is no exception.

4.1 The Three-Layer Architecture of Web Application

Fig.3 illustrates the three-layer architecture applied in Web. The main function of presentation (Web Server) is to provide input and output interfaces (Web interface) for Internet users; that of logic (Application Server) is to deal with all kinds of application logic; while that of data service (Data Server) is to carry out several operations to the database according to the instruction of logic and take charge of the regular management of database. Just as Fig.3 shows, the workflow of the three-layer architecture applied in Web is generally subject to the mode of [Input data --> Expression layer --> Logic layer --> Data layer --> Logic layer --> Expression layer --> Output data ]. Furthermore, Fig.4 illustrates the topology structure of FDSS based on visualization technology.

4.2 The Running Environment of FDSS based on Visualization Technology

After reviewing all kinds of Web-based application techniques, we provided the basic framework of FDSS based on visualization technology realization technique: The FDSS user interface in the Web Server (including visualization module of financial
decision model and data) was programmed by XML (and visualization program tool or environment); FDSS model base and its management system were installed in the Application Server, and the interface programs between model base management system and Web Server, Application Server and Web Server, Application Server and Data Server, separately, were programmed by Java; while FDSS database and its management system chose the Oracle Relational Database of strong functions.

Therefore, FDSS based on visualization technology running environment was set up based on XML+Java+Oracle technique framework of strong functions and compatibilities, which was the typical B/S three-layer structure.

4.3 Implementation of FDSS based on visualization technology

B/S three-layer architecture and XML+Java+Oracle technique framework show the clear technique route of implementing FDSS based on visualization technology. The main programming workload during the process of developing FDSS based on visualization technology include: 1) plenty of Web user interface description (including visualization module of financial decision model and data); 2) FDSS model base and its management system; that was, the establishment of financial decision models and model base, running and management of the interface program (user interface description of the models and transferring of models, etc) of the models (function) included in the software package; 3) the interface programs among all the servers of B/S three-layer structure.

Since FDSS based on visualization technology was based on the application system of Web, we had also designed the Web data collector (data collecting application program) which was specialized for assisting to run the financial decision models. For instance, in the case that we run a market forecast mode and need to input the goods’ relative forecast data; if the data stored in FDSS database is not enough to support the running of the model, we can recur to Web data collector to search for the data concerned with the model on the Internet space (The collector has the function of iterating and filtering the application data: It can support the users to filter the data if the acquired data for the search is too much and miscellaneous; after several times of iterating and filtering, the users can acquire application data as their will.) Therefore, the data collecting program is one of the characteristics of FDSS system, which meet the needs of acquiring domain data in a wider area for DSS to solve the semi-structured decision problems.

4.4 Examples of the Visualization Interface of FDSS based on visualization technology

The market forecast module (interface) of FDSS based on visualization technology illustrated in Fig.5 can support the output of all kinds of data and graphs for the market-forecast financial decision model, and the users (decision-makers) can input the data concerned with the market forecast (semi-structured) in the window.

![Fig.5 The market forecast module (interface) of FDSS based on visualization technology](image)

5 Conclusions

On the basis of a deeper research on the theories, concepts and the methodology of visualization technology and DSS, this paper presents some new theories, concepts and methods of FDSS based on
visualization technology. Moreover, a FDSS based on visualization technology has been developed based upon these new theories, concepts and methods. In the process of developing FDSS based on visualization technology, the paper also has resolved the problems of how to realize the financial decision models, the visualization of relative data and establishment of financial decision model, etc. Finally, the task of developing FDSS based on visualization technology has also been fulfilled.

The FDSS based on visualization technology, which is the typical case of synthesized application of DSS technology, visualization technology, Web technology and relational database technology in the field of financial management, has a wide popularization and application prospect in its design concept and implementation method. For instance, FDSS website built on the Internet can provide all kinds of financial decision support services to the enterprises; meanwhile, FDSS based on visualization technology can also be connected with the enterprises’ MIS, Data Warehouse, ERP and so on and produce higher IT application techniques which support the enterprises’ management decision so that FDSS based on visualization technology can deepen the application trend of IT techniques in the enterprises.

References: