3D Visualization Framework based on MVC for In-Situ OLAP
Knowledge/Information Interpretation

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Abstract: - This paper introduces a framework for a 3D visualization working space in which users can efficiently manipulate components associated with information/knowledge. This space with 3D graphical interfaces for knowledge/information navigation is geared on a framework based on MVC (Model-View-Controller) which has been implemented in WPF (Windows Presentation Foundation). This 3D space is integrated with an OLAP tool to provide graphical presentation of such complex business data. Eventually, the integrated system can provide humans with huge benefits in making fast and intuitive interpretations of information.

Key-Words: - 3D Chart, 3D Visualization, eCube Operation, Human Interaction, MVC, OLAP

1 Introduction

As graphics hardware and graphics tools for PCs have developed very rapidly, a 3D visualization concept became very popular in many fields such as process control [1] and scientific data analysis [2-4]. Also, 3D visualization techniques for mobile environments [5-7] have been developing with the advent of mobile devices such as smart phones and tablet PCs.

The concepts of 3D visualization were considered about two decades ago. In particular, a data visualization in business areas has been focused on [8] 1) utilizing the human visual recognition system to extract specific information from data, 2) providing a summarized view of complex data, 3) identifying structures, patterns, trends, anomalies, and relationships in data, and 4) navigating and identifying areas of specific interest. As the complexity of business data has been increasing recently, 3D visualization becomes very important. Now, business software naturally requires more comprehensive and intuitive approaches to present and navigate the analyzed data to exploit an ocean of information. Thus, graphical presentation techniques have been attractive research topics for academic and mission critical product issues for the vendors. However, most available business software can only support 2D or partially limited 3D charts as a graphical presentation of information so far with limited human interaction capabilities. Computer graphics expertise and very large business data manipulation expertise have not been successfully combined to produce efficient graphical interface for modern business data.

This work introduces a framework for a 3D visualization space in which users can efficiently manipulate components representing data sets, statistics, knowledge information, 3D maps, 2D images and so on. This space with 3D graphical interfaces for knowledge/information navigation is geared on a framework based on MVC (Model-View-Controller) which has been implemented in WPF (Windows Presentation Foundation). This 3D space is integrated with an OLAP tool to support graphical presentation of such complex business data.

2 Visualization and Interface for OLAP

2.1 MVC based Visualization

This work is based on MVC (Model-View-Controller) for 3D visualization. The model concept is introduced to represent and manage the targeted information that users selected from the huge data for their own purposes. The targeted information can be a subset of raw data, statistics information, or knowledge information. The model can

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be written in XML (Extensible Markup Language) which is a standard language for efficient communication between two or more modes. When the state of a model is changed by a controller, its associated views should be refreshed in the view mode. Figure 1 presents a sample of the model’s script written in XML. The XML script consists of 1) definition of 3D graphical environment, 2) structure of view modes, 3) interaction syntaxes, and 4) file names of real information associated with each view mode.

The view consists of an XML interpreter and a 3D graphical renderer which deals with the given model information. The basic structure of 3D graphical environments is pre-defined, and general information of dynamic structures is in the model. Figure 2 presents the view of the 3D graphical environment corresponding to the given model written in XML shown in Figure 1.

The controller is associated with users’ interaction on the 3D visualization space. It receives users’ responses in the view mode whenever any interactions happen on any components in the 3D space. And then it instructs the model to perform actions based on the interaction.

2.2 3D Interface for eCube Operation

The eCube is a 3D information representation which consists of two selected attributes of the given database and the measurement for them. Users can manipulate this eCube by selection, navigation and zooming in/out. Figure 3 shows an example showing how to select eCube elements through manipulation of a 3D graphical cube.

![Fig. 1: Example of a model’s script written in XML](image1)

![Fig. 2: Example of 3D graphical view corresponding to the model’s script shown in Figure 1](image2)

![Fig. 3: Four steps for eCube operation in the 3D graphical environment](image3)

3 Integration of OLAP System with 3D Visualization Framework

This section presents an integration of an OLAP system (called “eCubeStudio”[9]) with new visualization techniques to upgrade the OLAP product in terms of human interface and visualization for fast and intuitive interpretation of information and knowledge in business fields. The upgraded OLAP system includes two extra...
functions which are 1) a human interface for eCube operation and 2) a 3D working space view as shown in Figure 4.

Fig. 4: Diagram of the upgraded OLAP system

### 3.1 Traditional OLAP System

An OLAP system manipulates multidimensional data models, conceptualized as cubes, to facilitate facts, measures and dimensions. A measure consists of numerical facts, stored in a fact table, such as revenue, number of customers, or profit. Each measure has a set of descriptive values called dimensions. A simple example of a cube would be a store’s sales data. An aggregated monetary sales amount is a measure. Locations and Date would be dimensions. A sales amount history on a specific location can be easily analyzed in this cube. There could be any number of dimensions attached to a cube. A typical number of dimensions for a large corporation range from several hundred to several thousand. A dimension can have multiple levels, for example country-state-city, so that specifically chosen measure values can be analyzed by selecting a specific combination of dimension levels. Dimension levels consist of a hierarchy. Users can drill-down or roll-up through the hierarchy to control the granularity of focused data.

One most important aspect of OLAP analysis is its superior performance. Complex queries on an OLAP cube can generate an answer around 1% of time for the same query on relational database.[10,11] An internal mechanism that achieves such performance is the use of aggregations, which are built from the fact table by an altering hierarchy of specific dimensions and aggregating up data along these dimensions. The number of possible aggregations is determined by every possible combination of dimension hierarchies.

### 3.2 eCube Operation in OLAP

eCube operation functions can be manipulated in a 3D working space which helps users to understand the operation easily. If a dimension of the eCube is associated with region information, the function can provide their geographical information such as maps of the Korean peninsula and its provinces in surrounding environments shown in Figure 5.

Fig. 5: 3D visualization for eCube operation

### 3.3 3D Working Space in OLAP

This space has been implemented in the MVC based framework. Figure 6 presents an example of the visualized chart report. If the report includes
geographical data, the view of 3D graphical environment shows a 3D map generated from region information of report data. Then, each region shows discriminative height which coincides with measure data of each region.

To view the model of the eCube, real data sets used for business tasks of major financial institutions in Korea are applied to presentation on this visualization space. Figure 7 presents an ER-D (Entry Relationship Diagram) of the database used for data analysis and visualization.

![ER-D Diagram](image)

Fig. 7: ER-D of the database used for validation

4 Conclusion and Future Works
This paper presented a preliminary work of a 3D visualization framework for an OLAP system. A prototype system has been implemented and validated with real data sets used for business tasks of major financial institutions located in Korea. In order to commercialize this system, it should be considered in terms of testing, validation, and certification services for vendors.

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