Multi-gigabyte Multimedia Collections Using Qis Visualization Spreadsheet

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요약

Qis 이미지 스프레드쉬트(Qis Image Spreadsheet) 환경은 멀티기가 바이트-다차원 멀티 미디어 데이터집합(multi-dimensional multimedia datasets)들의 비쥬얼라이제이션(visualization) 을 수행 하는데 매우 효과적이다. Qis는 프레임 스택(framestack)을 이용하여 많은 양의 멀티 미디어 데 이터들을 집약적으로 압축하고 3차 원 구조로 빠르게 구성할 수 있을 뿐 아니라 효 과적으로 관리할 수 있다. 과학분야의 다양한 실험을 통해서도, Qis가 각 프레임 (frame)의 빠른 랜더링(rendering), 2-D 및 3-D그래픽 디스플레이, 다차원 데이터집합의 분석 등을 수 행할 수 있는 우수한 상호작용 비쥬얼 툴 (interactive visual browsing tool)임을 입증 하였다.

Abstract

The Qis visualizational spreadsheet environment is shown to be extremely effective in supporting the visualization of multi-gigabyte multi-dimensional data sets. The Qis has a novel framestack that is the 3-D arrangement of spreadsheet elements. It enables the visualization spreadsheet to effectively manage, rapidly organize, and compactly encapsulate multi-dimensional data sets for visualization. Using several experiments with scientific users, the Qis has been demonstrated to be a highly interactive visual browsing tool for the analysis of multidimensional data, displaying 2-D · 3-D graphics, and rendering in each frame of the spreadsheet.

I. Introduction

Human Computer Interaction (HCI) involves the study of how to appropriately design, implement, and deploy interactive computer systems in task specific settings or the study of how computers affect individuals, organizations, and society. The dialog between human and computer or computational systems(such as the Internet or GRID) enriches the communication of information[1]. HCI encompasses not only ease of use and performance metrics but also develops more effective interaction techniques for supporting user tasks, providing better access to information, and creating more powerful tools of communication. Specially, the importance of information visualization, one type of HCI, domain is critically important today as more original sources of information becomes digital and diverse and people have access to larger and more sources of information[1]. In this

paper, we extend information visualization research by considering an information visualization spreadsheet framework that includes operators and synchronized interactions across a diverse range of information sources. We discuss properties of this framework and use it to characterize techniques for managing, organizing and interacting with a variety of different data sets for information visualization.

Over the past several decades, there is continuing interest in developing new tools for image browsing, querying, animations, and rendering. One class of tools for image manipulation has been to extend the concept of spreadsheets and linked windows from the textual domain to multimedia domain. Recent research involving imagery exploitation has been motivated by a variety of application such as browsing of photos, entertainment special effects, medical diagnosis and treatment, visual sciences, and scientific research such as remote sensing, and astronomy. Imagery exploitation tools based on spreadsheet theory include Spreadsheets for images in which cell render data [2], the Photobook content-based image query tool [3], a graphical financial spreadsheet [4], information visualization spreadsheet using an operator and organizing for a range of data sets [5,6,7], a visualization spreadsheet for exploring parameter space [8], the Distributed Image SpreadSheet (DISS) for collaborative remote-based visualization [9] that extends earlier work on the Interactive Image SpreadSheet (IISS) [10], an interactive visualization approach for science computations and animation [11,12,13], and browsing tools for

clustering digital photographs [14,15]. All of these applications for exploring large data sets and complex visualizations exploit the spreadsheet paradigm for organizing input/output using a two-dimensional tabular layout for display, operator-based proceedings to create new data sets, and utilizes operator-based processing to create new data sets and maintains inter-cell dependencies.

The Qis is a portable platform independent version of the DISS and IISS with enhancements for collaborative organization of large multimedia data collections and interactive out-of-core manipulation of very large data sets. Each cell facilitates structurally managing and inter-comparing visualization among different data sets. The Qis tool for imagery exploitation is used to effectively manage, easily organize, and compactly encapsulate multi-dimensional data sets for the multimedia visualization. The Qis enhances interactive features of the DISS tool by adding new interface capabilities such as dynamic resizing of rows and columns adaptively based on the underlying and collaborative features. Note that in this paper we use the term image to refer to the 2D projection of multidimensional data sets.

II. Qis Image Spreadsheet Paradigm

In order to structurally manipulate multi-dimensional data sets within a limited display space and a large visualization parameter space, we designed Qis, for imagery exploitation, by providing more interactive organization and of the framestack to easily manipulate, and

structurally organize rich data sets.

To realize the dynamic tabular layout for various end-user requirements, the image visualization tool that satisfies the following criteria is required: (1) effective support of multi-dimensional data sets as well as vectors, tensors, and strings, (2) effective organization of data sets for management, (3) effective application of operators. The general approach taken to produce a structural organization description is as follows.

We consider the visualization space V to be composed of a collection, a book Bm within V, a sheet Sl within the book Bm, a cell Cij within the sheet Sl, and a frame Fk within the cell Cij. In the Cij, the subscript i means the ith row and j means the jth column within a sheet and Cij is also referred to as a framestack. We consider a spreadsheet as being composed of an arbitrary number of sheets, cells, and frames. We also consider that a sheet has the unlimited number of the cells.

$$nV = \bigcup_{o < m \leq M} B_m = \{ B_1, B_2, \cdots, B_{NM} \}$$

NM = Number of book

$$nB_m = \bigcup_{0 < l \leq L} S_l = \{ S_1, S_2, \cdots, S_{NL} \}$$

NL = Number of sheet in *Bm*

$$nS_l = \bigcup_{i, j > 0} C_{ij} = \{ C_{A1}, C_{A2}, \cdots, C_{ij}, \cdots C_{IJ} \}$$

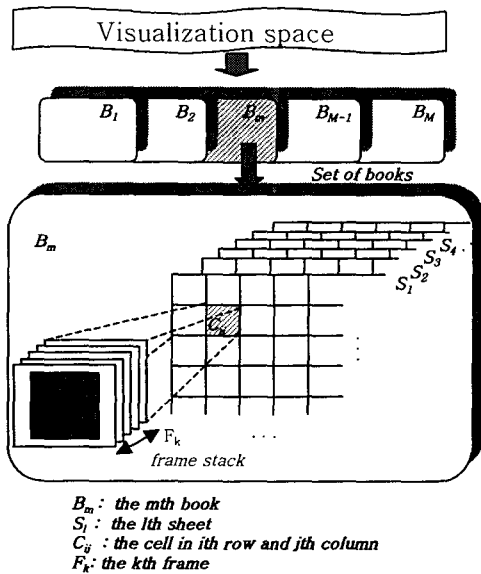IJ = Number of cell in sheet *Sl* and *Bm*

$$nC_{ij} = \bigcup_{k > 0} F_k = \{ F_1, F_2, \cdots, F_K \}$$

K=Number of frame in *Cij* & *Sl* & *Bm*

The Qis is designed to use a 3-D arrangement of elements at the sheet level and a 3D tensor

indexing scheme of the visualization space to accommodate organizing large data sets across flexible dimensions   such as time, location, frequency, phase or parameters for scientific data. The new image spreadsheet paradigm can be seen in Figure 1. Each cell Cij is built by a framestack that store a lot of frames (data sets) for visualization information. Each frame of the framestack contains one or more multidimensional data sets to be visualized as shown in Figure 4. Visualization data sets include raw and processed satellite imagery, graphical (vector) data, surface and terrain models, and three-dimensional volumes. The Qis also supports distributed network access to data sets and computation capabilities[9].

The image spreadsheet paradigm has a variety of advantages for imagery exploitation. One of the key advantages is a simple structured organization of highly interrelated and correlated data sets as an intuitive indexed dictionary. Using the indexed image dictionary, we can structurally organize multidimensional data sets within and across compactly speed up the animation or temporal phenomenon.

B_m : *the mth book*
S_l : *the lth sheet*
C_{ij} : *the cell in ith row and jth column*
F_k: *the kth frame*

▶▶ **Figure I. Qis Image Spread Sheet**

The Qis easily supports animation by using the frame stack per each cell. The Qis can provide various kind of looping function by using all frames or the selected frames in the frame stack on the same cell or different cells. During the animation, we can set the delay time or can set several sub-loops on the same cell. The looping can be uniquely represented by the Context Free Grammar (CFG). Let S be the start symbol of this grammar

■　$S \rightarrow S\acute{o} \mid \acute{o}$

where $\acute{o}$ means $F_i^{\Delta k} \rightarrow F_{i+1}^{\Delta k}$ and $F_{i+1}^{\Delta k} \rightarrow F_i^{\Delta k}$, which means that the i+1th frame image $F_{i+1}^{\Delta k}$ is shown after the ith frame image $F_i^{\Delta k}$ is shown and also the ith frame image $F_i^{\Delta k}$ is shown after the i+1th frame image

III. Direct User Interface Model

The Qis is a system that allows the user to browse large image data sets quickly, to efficiently manipulate the dataset, and to analyze among image datasets. Interactive image browsing of the Qis is accomplished using a QT Graphic User Interface (QT GUI). This interface allows the user to use the Qis on any hardware system. How to access and apply operations is an important aspect of the image visualization tool. We used two different methods for performing spreadsheet operations for providing a highly interactive function.

The first method is a global event handling based on the user interface. The user can
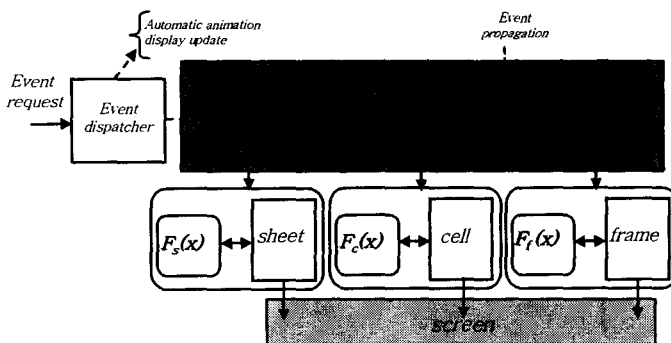
Event Handling Function per a Level

- $F_s(x)$: *fuction* of operator x on sheet level
- $F_c(x)$: *fuction* of operator x on cell level
- $F_f(x)$: *fuction* of operator x on frame level.

▶▶ **Figure 2. Structural Global Event Handling**

interactively manipulate and apply operations to image data sets by using global event handling. The user requests an event by handling a keyboard or a mouse event. Whenever an event occurs, the event dispatcher saves the event in its own queue and then determines if the event is done directly or not. If the event requires an event handling service, the global event handler wakes up and then propagates the event from top level (sheet) to the lowest level (frame) on the Qis structure. While the event is passing the event handler per each level, the event handler checks whether it can perform the event or not. If the event handler can perform the event, it applies the event to those selected sheet, cells, or frames.

Figure 2 shows the diagram of the event propagation on the Qis. The global event handler can manipulate the event without waiting time. The second method is a direct manipulation interface corresponding to a model where the user first selects a group of cells or a cell, and then applies an operation to those operators. The operation is specified using a combination of menus and panels. The method is similar to a traditional numerical spreadsheet. Qis can directly access the image data sets per each level, by having independently a sheet panel, a cell panel, and a frame panel

Due to the interactive panels, the Qis can highly interact and give scientists an integrated view of data, computation, and display. We can also supervise and dynamically reorganize cell structure of the Qis via the monitor window. The monitor window is shown in Figure 3(a). It works as follows: when the mouse occupies a cell, the corresponding cell in the monitor window is highlighted. A mouse click on a
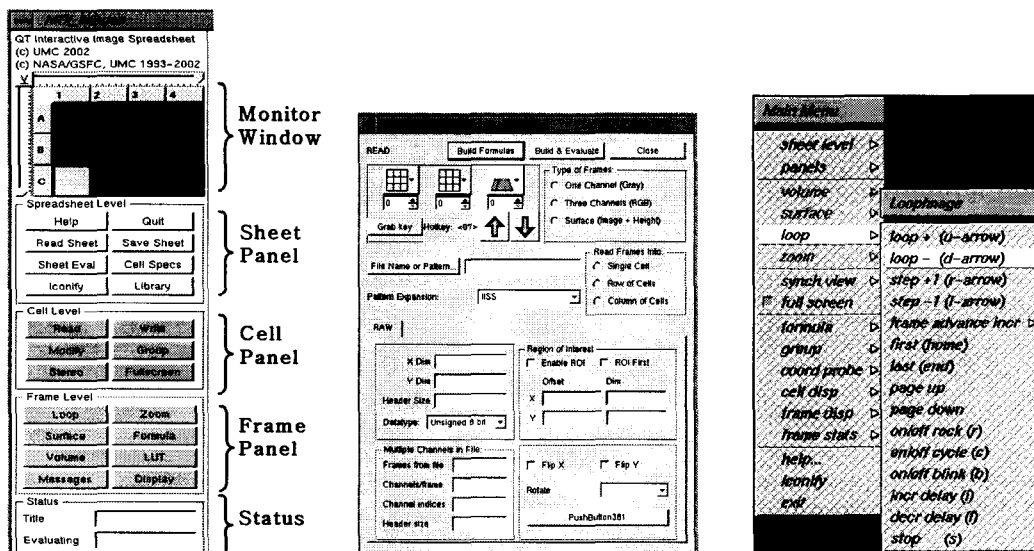
(a) The main panel is accessed directly　　　(b) read dialog box on the Cell level in (a)　　　(c) Popup menus

▶▶ Fig 3. Our spreadsheet visualization system uses a direct manipulation interface with menus, Popup menus, monitor window and dialog boxes, which makes the system easy to use.

monitor window cell causes the matching cell to be positioned upper-leftmost in the spreadsheet window. The scrollbars allow finer control over positioning. The "V"(View) pull-down menu in the monitor window allows the user to add rows and columns to the cell matrix at any time. We can also check ratio of a visual image to whole image size. Example menus and panels used in the Qis system are shown in Figure 3. From our experience of the two systems, we believe a combination of the two approaches is appropriate for the visualization spreadsheet. The advantage of a menu-based interface are that it is relatively intuitive to use for first-time users, and training time to users is short, because there are many functionalities in a visualization spreadsheet system, there is the danger of creating a large number of menus with no structure to them. The advantage of global event handling interface is that we cannot need to choose a panel for the event.

IV. Expert Users & Applications

The Qis supports the scientists and end-users to study, analyze, and compare large multidimensional data sets in a near real-time mode. The Qis has been demonstrated as highly interactive visual browsing tools combined 2-D or 3-D graphics rendering in each frame by various scientific applications.

Figure 4 shows a gray scale image of a horizontal slice through the first volume in the eighteen-volume time sequence. that outlines some of the heart wall structures and blood vessels. Cell shows horizontal and vertical colored slices of the volumetric data combined with the transparent isosurface shown in -D heart volume imagery can be seen in Figure 4(a). There are 18 volumetric datasets of a dog heart through the cardiac cycle, sampled at 33.33 m sec/volume and acquired using the Dynamic Spatial Reconstructor (DSR). The left ventricle is perfused with an iodinated contrast agent for clear visibility, and each volume is oriented along the long axis of the left ventricle and in full registration with the other volumes. Each volume consists of 110 slices (slice 92 for the first volume is shown in cell B1), with each slice being 98 x 100 spatial sampling. The spatial

(a)   (b)
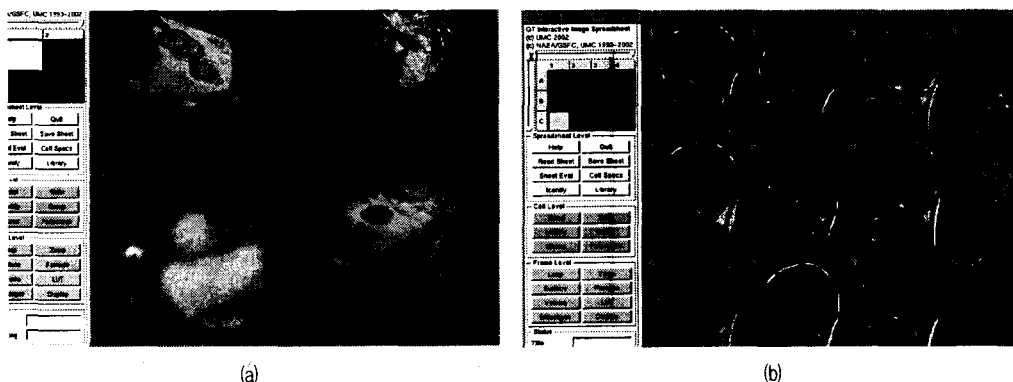
▶▶ Fig 4. Application Examples

resolution is isotropic 0.925 x 0.925 x 0.925 mm3 with each voxel stored as an unsigned 8-bit data type. Figure 4(b) also shows an example of the medical imagery. The Spreadsheet has 34 cells which has 1 frame in each frame stack. Each head frame on a cell can get by MRI technique, which takes a picture of 12 different persons head. For example, the first and text information .\1a . By formula information, we also know that each frames x dimension and y dimension is each 256.

V. Conclusion

Visualization research spans a remarkable range of scientific disciplines and corresponding visualization techniques. Furthermore, the need to explore multiple visual representations rises in information visualization. A visualization spreadsheet is an excellent way to address these issues that involve multiple visualization.

In this paper, we showed that a visualizational spreadsheet supports an imagery exploitation, which utilizes multi-gigabyte multidimensional data sets. By using the 3-D arrangement of elements, the visualization spreadsheet effectively manage, easily organize, and compactly encapsulate multi-dimensional data sets. For the next future, we will design database, searching a frame which is directly stored in same cells, and rendering indexed dictionary index page like a book. We will also add the pyramid file format for large data sets.

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