논문 2005-42CI-5-9

동적 재구성이 가능한 Qis Visualization Spreadsheet

(Dynamic Reconfiguration of Qis Visualization Spreadsheet)

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요 약

Qis 이미지 스프레드쉬트(Qis Image Spreadsheet) 환경은 다차원 멀티미디어 데이터집합(multi-dimensional multimedia datasets)의 조직적인 비쥬얼라이제이션(visualization)을 수행하는데 매우 효과적이다. Qis는 실시간에 재구성 가능한 셀(cell)단위 스트래드쉬트이며 각 셀은 프레임스택 (framestack)으로 구성된다. 이러한 동적 재구성으로 인하여, Qis는 많은 양의 멀티미디어 데이터들을 집약적으로 압축하고 3차원 자료구조로 빠르게 구성할 수 있을 뿐 아니라 효과적으로 관리할 수 있다. 다차원 멀티미디어데이타 응용실험을 통해서도, Qis가 각 프레임 (frame)의 빠른 랜더링(rendering), 2D 및 3D그래픽 디스플레이, 다차원 데이터집합의 분석 등을 수행할 수 있는 상호작용이 우수한 비쥬얼 툴(interactive visual browsing tool)임을 입증하였다.

Abstract

The Qis visualizational spreadsheet environment is shown to be extremely effective in supporting the organized visualization of multi-dimensional data sets. The Qis consists of the reconfigurative 2D arrangement of spreadsheet elements at run time and each spreadsheet element has a novel framestack. As the feature, it supports 3D data structure of each element on the Qis. 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 2D and 3D graphics, and rendering in each frame of the spreadsheet.

Keywords : Information Visualization, HCI, Qis, Cell, Framestack, Event handling

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

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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.

- $V = \bigcup_{o < m \le M} B_m = \{B_1, B_2, \cdots, B_{N_M}\}$ N_M=Number of book
- $B_m = \bigcup_{o < l \le L} S_l = \{S_1, S_2, \cdots, S_{N_L}\}$ N_L=Number of sheet in book B_m
- $S_l = \bigcup_{i,j > 0} C_{ij} = \{C_{A1}, C_{A2}, .., C_{ij}, ..C_{IJ}\}$ IJ=Number of cell in sheet S_l&book B_m
- $C_{ij} = \bigcup_{k > 0} F_k = \{F_1, F_2, \cdots, F_K\}$ K=Number of frame in C_{ij}&S_l&B_m

We consider the visualization space V to be composed of a collection, a book Bm within V, a sheet Sl within the book B m, a cell Cij within the

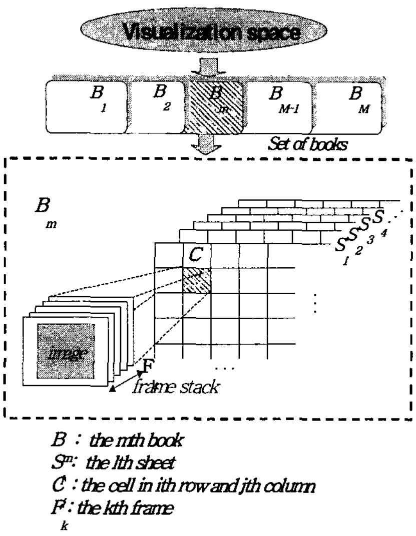


그림 1. Qis 이미지 스프레드시트 구성도
Fig. 1. Qis Image Spreadsheet Paradigm.

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.

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 5. 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 multi dimensional data sets within and across compactly speed up the animation or temporal phenomenon

The Qis easily supports animation by using the frame stack per each cell. The Qis can provide various kind of looping unction 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

- $S \rightarrow Sp/p$

Where p means $F_i^{\Delta k} \rightarrow F_{i+1}^{\Delta k}$ and $F_{i+1}^{\Delta k} \rightarrow F_i^{\Delta k}$ It means that the $i+1^{th}$ frame image $F_{i+1}^{\Delta k}$ is shown after the i^{th} frame image $F_i^{\Delta k}$ is shown and also the ith frame image $F_i^{\Delta k}$ is shown after the $i+1^{th}$ frame image $F_{i+1}^{\Delta k}$ is shown. Δk means delay time during image visualization

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 data sets. 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 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

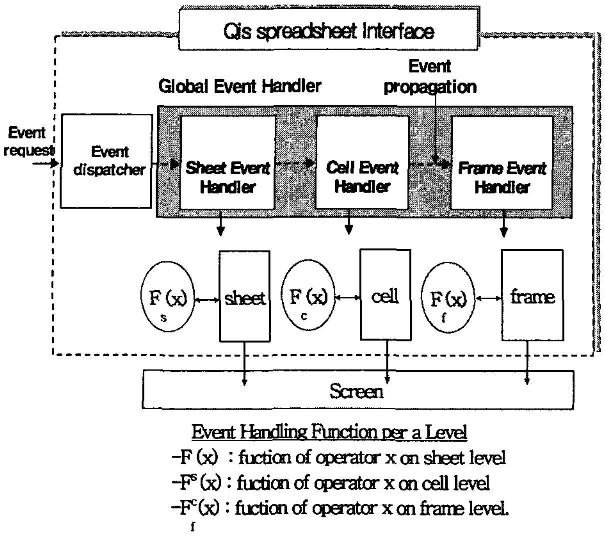
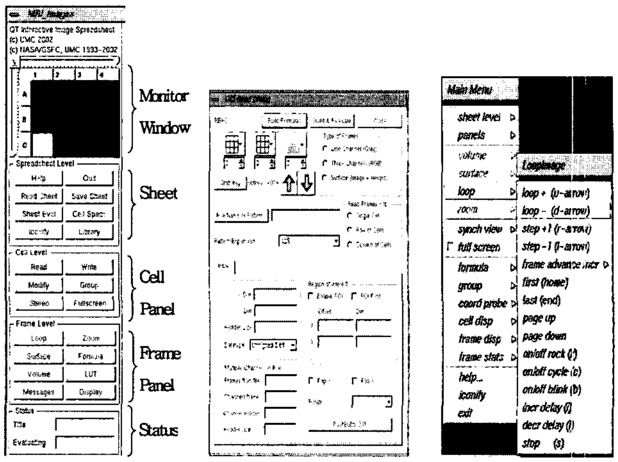


그림 2. Qis 이벤트처리 인터페이스
Fig. 2. Qis Event Handling Interface.

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



(a)The main panel(a) The main panel is accessed directly (b)read dialog box on the Cell level in (a) (c)Popup menus

그림 3. Qis 이벤트처리 인터페이스
Fig. 3. Qis Spreadsheet visualization interface.

highlighted. A mouse click on a monitor window cell causes the matching cell to be positioned upper-leftmost in the spreadsheet window. The scroll bars 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.

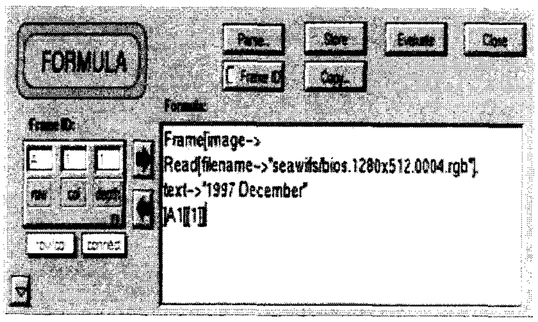
From our experience of the two systems, we believe a combination of the two approaches is appropriate for the visualization spreadsheet. The advantage of a menu-based interface are that it is relatively intuitive to use for first-time users, and training time to users is short, because there are many 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. Frame Analysis Model

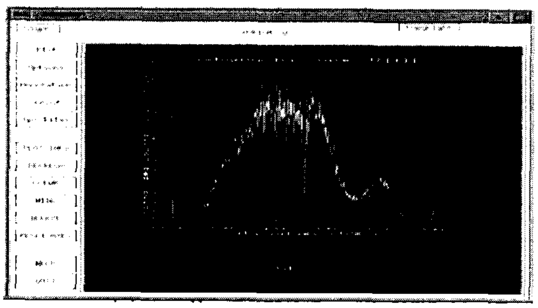
By using the Qis, standard mathematical functions, such as addition, subtraction, multiplication, division, mean, standard deviation etc., should be performed easily on individual image cells or on groups of two or more images. The standard mathematical functions mean the textual expressions that specify computations that yield data sets e.g. images. Each frame currently contains a single formula that fully describes its image data. Formula syntax provides for functions fcn_name, arithmetic (infix) operators , frame references, numeric values, text strings and expression grouping. Formulas can be uniquely represented by:

- *fcn_name* [$A_1 \rightarrow V_1$, $A_2 \rightarrow V_2$,$\cdots$, $A_n \rightarrow V_n$] RC[[*level*]] or
- *fcn_name* [V_1, V_2,$\cdots$, V_n] RC[[*level*]]

A frame reference is required to have the form: *RC[[Level]],* where R is an alphabetic row descriptor, C is a numeric column descriptor, and Level is a numeric index into a framestack. The brackets [[]] define the data extraction operator. Figure 4(a) shows an example of the formula panel which has the information;*Frame[image→Read[file-name→"seawifs/bios.280.512.0004.rgb"],text→"1997 December"]A1[[1]].* It implies that the Qis read the file, which is named by *"seawifs/bios.280.512.0004.rgb"* and has the text information *"1997 December"* on first frame in the C_{A1}. Formula operators operate on complex data types using operator overloading. The formula can simply be re-evaluated in which case the *modif.* The Qis also provides a histogram as an image analysis information per an image data (frame). We used Khoros data flow environment for the image processing and the image analysis.



(a) Formula Panel



(b) Histogram

그림 4. Formula 판넬과 히스토그램
Fig. 4. Formula Panel and Histogram.

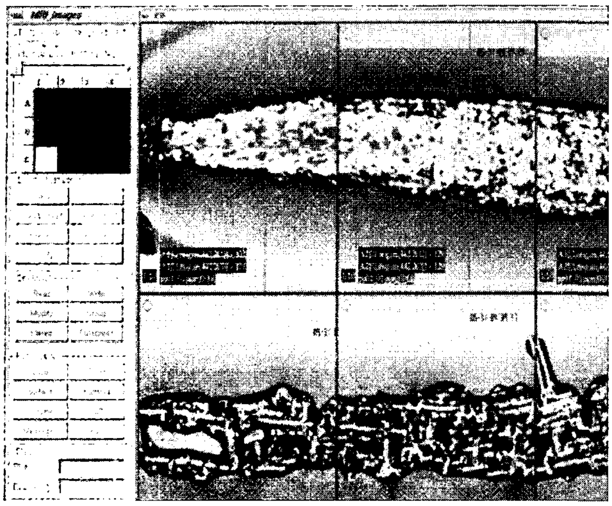
V. Expert Users & Applications

The Qis is extremely effective in supporting the organized visualization of multidimensional data sets when it is compared to conventional visualization spreadsheets. The Qis enables to reconfigure a 2D arrangement of spreadsheet elements at run time and to have a novel framestack per a cell element. As the feature, it supports 3D data structure of each element on the Qis. This allows the Qis to effectively manage, organize, and compactly encapsulate multi-imensional data sets for visualization.

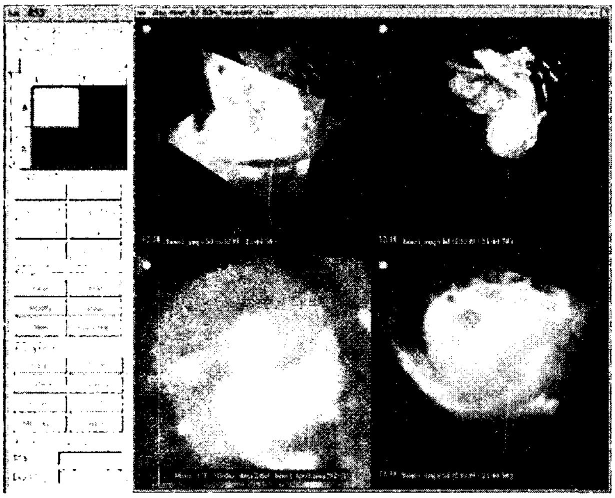
The Qis has been demonstrated as highly interactive visual browsing tools combined 2D or 3D graphics rendering in each frame by various scientific applications.

Figure 5(a) shows an example of the biological imagery. We can estimate root motion using tensor combined with robust matching method. The mask on the second row is from the tensor method, which is the thresholded velocity confidence field in the tensor method. We use the application to make information by overlapping the mask on the original image to check if the velocity is located in the right areas and performance of the algorithm. The Qis has 24 cell array structure and each cell has a frame stack which consists of ten frames. Each frame on a cell has its own text information and indexing. For example, the first frame on C_{A1} has indexing (1/10) that means the first frame among total images in the frame stack on C_{A1}.

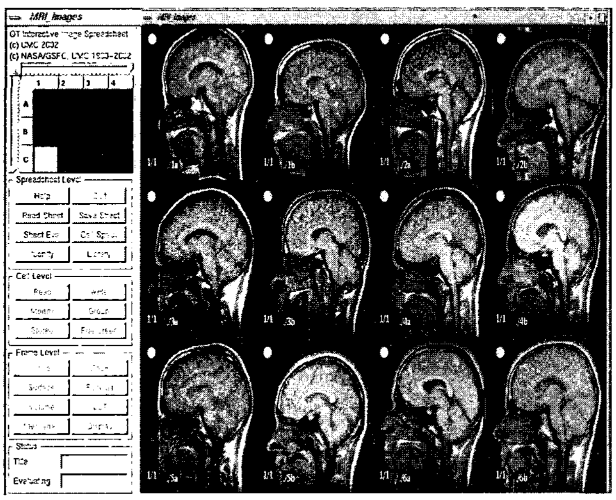
3-D heart volume imagery can be seen in Figure



(a)



(b)



(c)

그림 5. 다차원 멀티미디어분야 응용 예제
Fig. 5. Application Examples.

5(b). There are 18 volumetric data sets 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 resolution is isotropic 0.925 x 0.925 x 0.925 mm3with each voxel stored as an unsigned 8-bit data type. Cell C_{A1} shows horizontal and vertical colored slices of the volumetric data combined with the transparent isosurface shown in C_{A2} that outlines some of the heart wall structures and blood vessels. Cell C_{B1} shows a gray scale image of a horizontal slice through the first volume in the eighteen-volume time sequence. Figure 5(c) 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 person's head. For example, the first frame on C_{A1} has indexing (1/1) which means the first frame among total image 1 in the frame stack on $C_{A1}$and text information ".\1a". By formula, we also know that each frame's x-dimension and y-dimension is each 256.

VI. Conclusion

Visualization research spans a remarkable range of scientific disciplines and corresponding visualization techniques. Furthermore, the need to explore multiple visual representation arises in information visualization. A visualization spread -sheet is an excellent way to address issues that involve multiple visualization.

In this paper, we showed that a visualizational spreadsheet supports an imagery exploitation, which utilizes multi-dimensional data sets. By using the 3D data structure of elements, the spreadsheet effectively manages, organizes, and compactly encapsulates 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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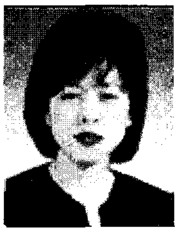

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