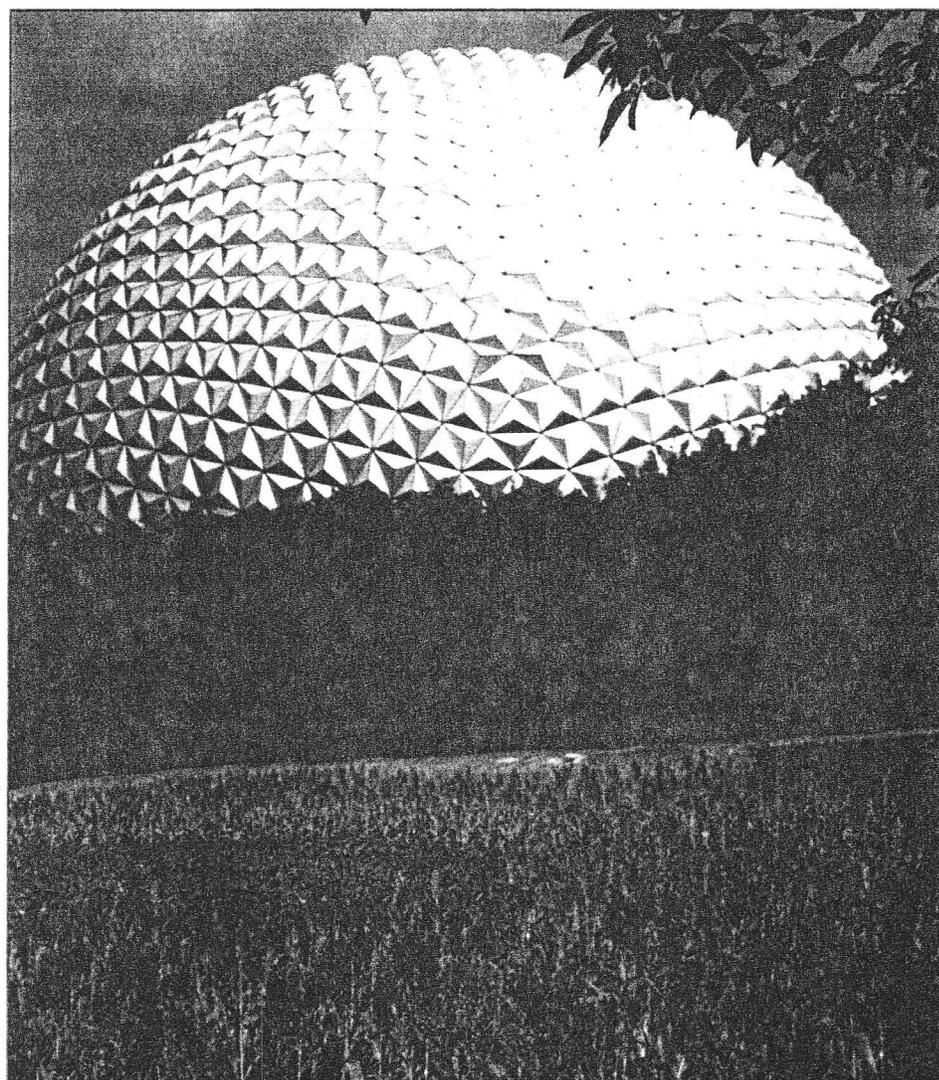


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Decision Support, Technology, and Applications



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SEMANTIC DATABASE SCHEMA EDITOR AND VIEWER TOOL FOR GEOSPATIAL
APPLICATION * **

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ABSTRACT

The High Performance Database Research Center (HPDRC), a division of the School of Computer Science at Florida International University (FIU), has been involved in research concerning information processing technologies that can efficiently store and retrieve remote sensed data. This paper describes two graphical tools: the Semantic Schema Editor and the Semantic Schema Viewer. These tools allow the design and creation of semantic database schemas as well as an easy and intelligent access to all textual and spatial data stored in the databases by providing a friendly interface to the World Wide Web users. The Semantic Schema Editor provides an easy to use Graphical User Interface (GUI) that can be used to create and view a semantic schema diagram. Using a similar GUI, the Semantic Schema Viewer provides the capability of graphically querying the semantic database. With the help of these tools, and the Semantic Database Management System (DBMS) interface, several databases have been created for remote sensed data like SeaWiFS, Ozone (TOMS), and Ocean Temperature as a way of testing the tools and helping the center to cope with the storage and retrieval of the data.

1.0 INTRODUCTION

Over the past few years, the use and availability of remote sensed data has increased exponentially, particularly in the area of forestry and agricultural land management. Thus, this has increased the need for information processing technologies that can efficiently store and retrieve these data types. The High Performance Database Research Center (HPDRC) (Rishe, 1995), has developed a semantic binary database system, which is efficient in storing and retrieving these types of spatial data sets. In addition, intelligent user interfaces have been developed and used to easily access this data.

At the HPDRC, we have a wide variety of spatial data sets from several sources including Ocean Temperature data (supplied by the University of Miami Rosenstiel School of Marine and Atmospheric Science), Simulated SeaWiFS (Sea-viewing Wide Field-of view Sensor) (deployed by NASA from the SeaStar satellite) and Ozone data (TOMS, Total Ozone Mapping Spectrometer) (deployed by NASA's Goddard Space Flight Center). Due to the large amount of data inherent in these types of data products, we also found the need for efficient applications that can store and manipulate all these remote sensed data. This paper describes the client/server Semantic Schema Editor and Viewer tools that have facilitated efficient storage and retrieval of remote sensed data. Both tools provide a friendly graphical user interface between the users and the semantic databases, allowing the user to modify existing semantic database schemas or create new ones. This is possible by creating new categories and relations, modifying the attributes and all the related information, and by being able to delete existing relations and categories.

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The described tools are portable and flexible applications that can be run locally or remotely through the Internet. In addition, by storing the data using a semantic DBMS system, efficient storage, manipulation, and retrieval of spatial data is provided. The semantic database will provide protection and security for the data and at the same time, enforce consistency of the stored data. It will also provide efficient simultaneous retrieval of massive amount of data to multiple users, and ensure better logical properties such as a comprehensive enforcement of integrity constraints, greater flexibility, and substantially shorter application programs (Rishe, 1992).

2.0 BACKGROUND

2.1 SEMANTIC DATABASE MANAGEMENT SYSTEM

The High Performance Database Research Center (HPDRC) is presently developing, under NASA sponsorship, a high performance semantic/object-oriented database system. HPDRC's Semantic Database Management System (DBMS) is based on the semantic binary model. In the semantic binary model, information is represented by logical associations (relations) between pairs of objects and by the classification of objects into categories. The semantic binary model is the most natural and convenient way of specifying the logical structure of information and for defining the concepts of an application's world. It is represented in the form of a semantic binary schema (Rishe 1992).

The Semantic Database models are potentially more efficient than the conventional models for two main reasons. The first is that all the physical aspects of the representation of information by data are invisible to the user and the second is that the system knows more about the meaning of the user's data and about the meaningful connections between such data. The first reason creates a potential for optimization by allowing more changes without affecting the user programs. The second allows this knowledge to be utilized to organize the data so that meaningful operations can be performed faster at the expense of less meaningful operations (Rishe 1992). Decomposing queries into atomic retrieval operations maximizes the efficiency of retrieval requests and each atomic retrieval request normally requires only one disk access.

The mathematical abstraction of the relational model has allowed the introduction of powerful and easy -to-use languages for retrieval and updates of databases. The semantic model however, offers a higher degree of abstraction, which results in more concise user programs, speedier processing (due to optimization), and a wealth of other features. Relational databases are good for general conventional database applications. However, in situations where the structure of information is complex, or where greater flexibility is required (objects with unknown identifiers, or objects moving from one category to another, etc.), or where non-conventional data is involved (spatial data, long text, images, etc.), semantic databases are successful.

Our database system provides exceptional usability and flexibility. This strength is inherent to the object-oriented approach of our binary semantic model. A database developer will find designing in the semantic model intuitive since it mostly reflects the real world. The model captures the data along with its meanings (through relations). The model allows the production of the same database design for clients and developers. A client will have a greater understanding of a schema and will be in the position to offer more valuable input. This understanding comes at the price of more iteration in development. Once clients have a better understanding of their design, they usually find it easier to make more demands. A client reviewing the design can easily spot flaws in the understanding of the problem requirements.

A database for Earth Science data must address the issue of storage size reduction since the amount of data tends to be large. The relational model carries a lot of overhead in the space allocations for its tables and indices (keys). The semantic database reduces space allocation by eliminating this overhead. Although we also store inverse facts, the absence of additional tables and index files allows us to offer a better space management than relational model does. Usually database systems use various data representation structures where the semantic database system only uses a B-tree as its data structure that facilitates data packing. Since our data are in lexical order, prefix packing is

used in a block of data regarding an object; we only record the object id for the first entry. Access to the data is faster in semantic database since all facts about an object will be stored in contiguous disk blocks.

3.0 SEMANTIC SCHEMA EDITOR

The Semantic Schema Editor is a client/server application where the server is a C++ program running on the provider computer and the client part is a Java based application that can run locally or remotely on any client computer via the Internet (WWW). This tool allows users to create a brand new database schema or modify an existing database schema, and then save it on the client side. New databases can be easily created by clicking on the 'new icon' from the GUI and writing the name of the new database in the dialog box provided. Then the user can use the other GUI menus to create Category, Relation, and Attributes for their new database. If the user prefers, this graphical tool can open any existing semantic databases. Once the tool starts running, the user is allowed to browse through the directory of the most frequently used databases or enter the name of another database. Figure 1 shows the screen that it is used to enter or select the database name.

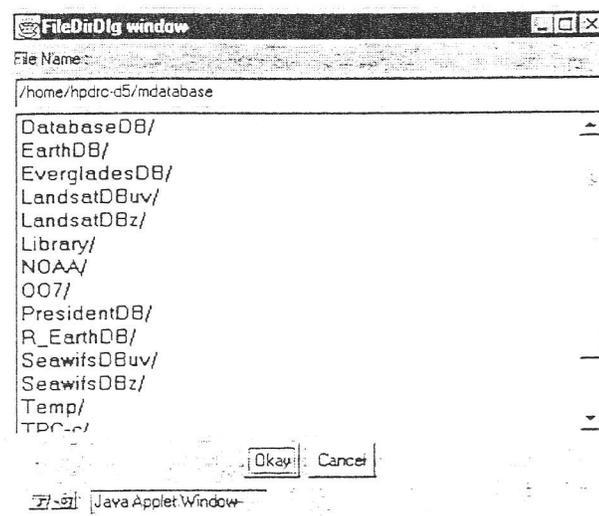


Figure 1: Database selection window

Once the database has been selected, a request can be made to open the database and the server will send the semantic database schema description to the client side. Then the client side will display the semantic database schema representation of the opened database. Once the graphical semantic schema is displayed, the user can add new Categories, Relations, or Attributes or delete any existing ones. In addition, the schema can be redrawn or some properties modified, like change relation types from m:m to 1:m (possible types are: 1:1, 1:m, m:1, m:m) (Rishe, 1992). Figure 2 displays two snapshots: one of the screen after a test database has been opened and the second one after deleting the Category 'Instrument' and its relation with the 'Observation' Category.

This tool allows users to design, create and modify their semantic schemas without the need of writing programs or using any data definition language. This is done transparent to the user's view by the server program running behind the graphical interface. We have tested this application creating different semantic databases including the Earth database (containing: Ozone, Ocean Temperature and simulated SeaWiFS data), SeaWiFS database, Landsat database and other spatial databases. In all the cases the tools have been reliable, and easy to use.

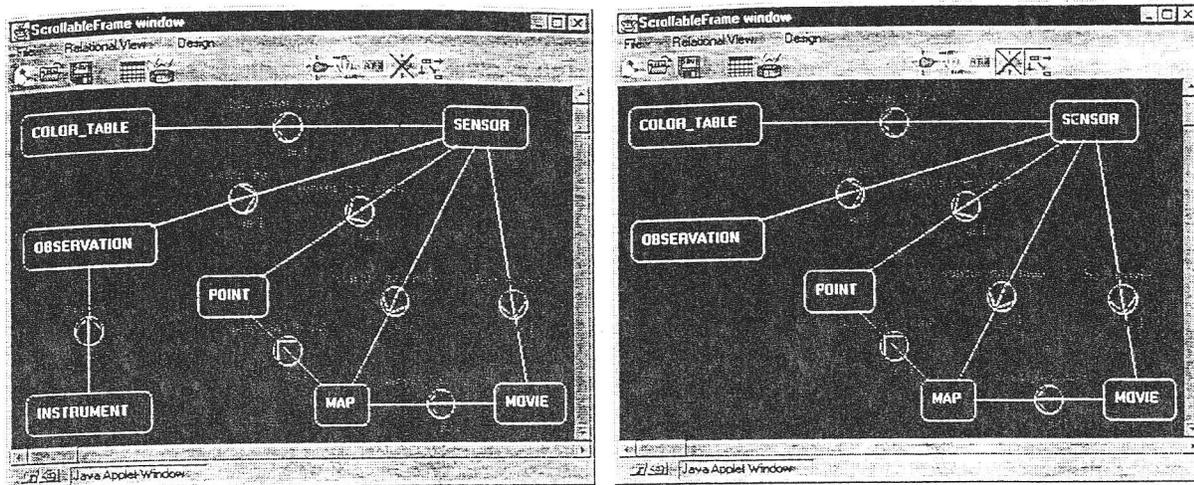


Figure 2: Semantic Schema Editor GUI

4.0 SEMANTIC SCHEMA VIEWER

The Semantic Schema Viewer is another client/server application having a C++ server program to access the database and a Java Applet client that provides a friendly graphical user interface. This tool has been used to retrieve both textual and spatial data for several of our current existing databases including Earth database, and the SeaWiFS database.

4.1 EARTH DATABASE

The Earth database contains two different data sets: Ocean Temperature data (supplied by the University of Miami Rosenstiel School of Marine and Atmospheric Science), and Ozone data (TOMS, Total Ozone Mapping Spectrometer) (deployed by NASA's Goddard Space Flight Center). This database stores the spatial and semantic data together in the same database. It also stores several types of information for many different data sets. For example, for each data set the following information needs to be stored: the name and description of the satellite, the instrument used, a color table (containing color, value, and a short description), the observation program used, the collection of all binary data files containing the data maps and the date for each map in the database. Based on these requirements, the following (Figure 3) semantic database schema was designed and implemented with the help of the Semantic Schema Editor.

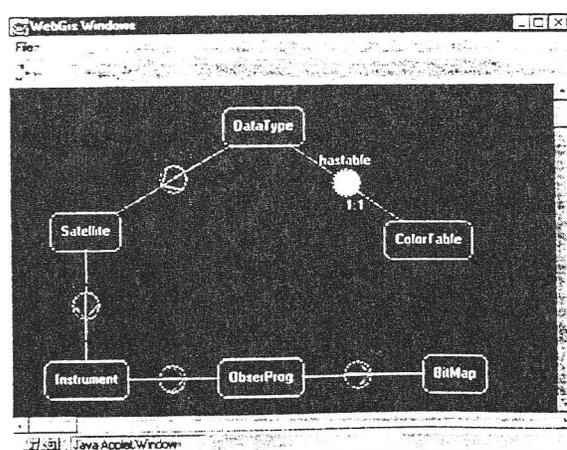


Figure 3: Earth database schema

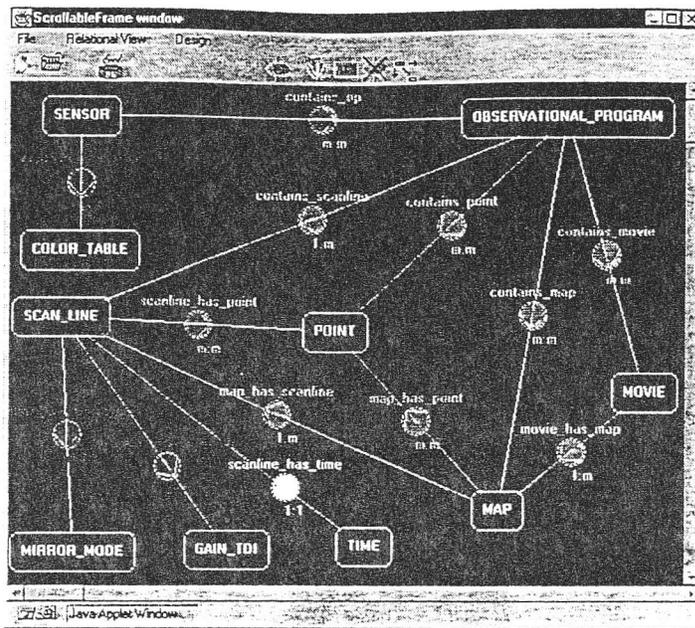


Figure 4: SeaWiFS database schema

The Semantic Schema Viewer is used to retrieve and display the data contained in this data set through different platforms. Through this page, a user can retrieve textual and technical information about the SeaWiFS data including date/time, scan line, gain-tdi mirror mode, sensors, points-colors and many others. A user can select at random an area of the whole (1984x3560-pixel) image, that they want to view and retrieve it from the database. Another feature about this system is that the user can request from the database a particular value of a point of the whole image, then the value (digital number) and the actual color are displayed on the window. Figure 5 shows a screen capture of the application running.

Users can click on the Category names, and they will get a window with the list of Attributes of that category. For example, for the Category 'Point', the user gets a window with three attributes: X Coordinate, Y Coordinate and Color. Then, they can either enter a parameter in any of the fields and click on the Query button, or they can press Query and the program will return all the information found in the database related to that Category. After the data is displayed, users can click on the Previous or Next button to browse all retrieved data. This tool is constantly retrieving data from the database. The users do not need to have knowledge about semantic databases or about the structure of the database to be able to retrieve all needed data/information. As seen in Figure 5, both textual and spatial data can be retrieved simultaneously and efficiently through the same interface.

5.0 CONCLUSION

At the High Performance Database Research Center we have developed a variety of tools including the Semantic Schema Editor and the Semantic Schema Viewer, with the purpose of finding solutions to the storage and access problems of remote sensed data. This problem has limited the scientific community to take full advantage of the large amount of remote sensed data available today. The Semantic Schema Editor has facilitated the creation and modification of semantic database schemas to store the data. The Semantic Schema Viewer has provided swift and efficient retrieval of huge amounts of data from our semantic databases. These tools also have the advantage of being portable. They run in different platforms including Windows95, Windows NT, Solaris, and via the Internet using a Java enable browser like Netscape or Internet Explorer.

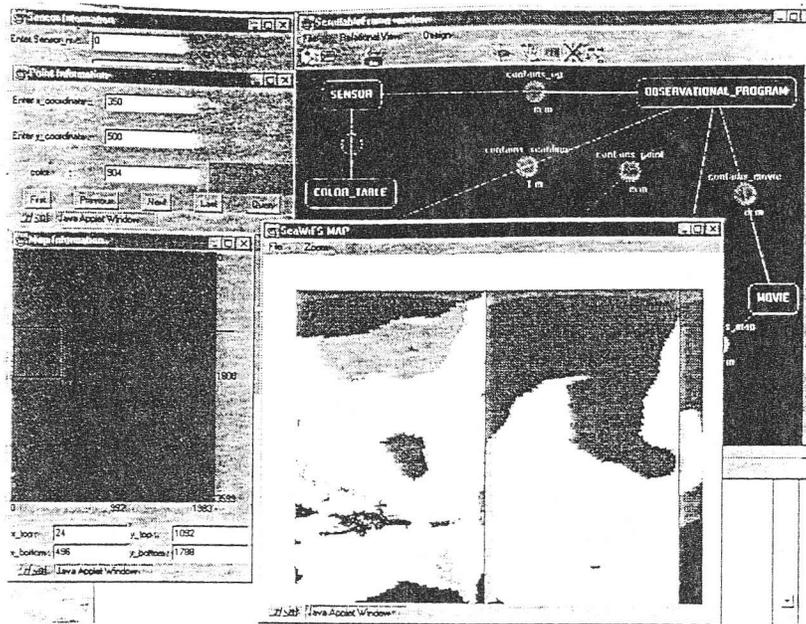


Figure 5: SeaWiFS database application running.

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