96-56

PROCEEDINGS OF THE

TWELFTH ANNUAL LOUISIANA REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS WORKSHOP

APRIL 16-18, 1996

Edited by:
L. N. May, Jr.

Sponsored by:
The National Biological Service; the Louisiana Department of Environmental Quality; the Louisiana Department of Natural Resources; the Department of Geography and Anthropology at Louisiana State University; the University of Southwestern Louisiana; the Louisiana Geographic Information Systems Council; the Louisiana Chapter of the Urban and Regional Information Systems Association; the National Oceanic and Atmospheric Administration, National Marine Fisheries Service; and the Mid-South Region and Gulf Coast Chapter of the American Society for Photogrammetry and Remote Sensing

published Apr. 1998

ABSTRACTS OF PAPER PRESENTATIONS SESSION VIII: GEOSPATIAL ANALYSIS TOOLS AND TECHNIQUES

SPECIALIZED GIS VIA A HIGH-PERFORMANCE SEMANTIC DATABASE[1]

by

MARIO R. SANCHEZ[2], NAPHTALI D. RISHE, and DAVID BARTON
High-Performance Database Research Center
School of Computer Science
Florida International University
University Park
Miami, Florida 33199-0001

ABSTRACT

We have successfully implemented an innovative Geographic Information System where vast amount spatial-temporal multi-dimensional, i.e., *intricate*, data are efficiently applied and effectively rendered. The visualization facet of our GIS is robust since we assign colors to the range of measures then map the colorized values on orthographic, orthogonal, sinusoidal, stereographic, homolographic and Mercator projections. The GIS geodetically depicts the measures in the various projection forms by accomplishing the transformation *on the fly*; namely, just prior to being displayed. Hence, we need only to define, represent and store the variant forms of intricate data in the database just once.

GIS

The GIS is designed to facilitate the interpretation by earth scientists of intricate data by affording controlling options. Some examples of such features are:

---

[1] This research was supported in part by the National Aeronautics and Space Administration (under grant NAGW-4080), ARO (under BMDO grant DAAH04-0024), the North Atlantic Treaty Organization (under grant HTECH.LG-931449), the National Science Foundation (under grant CDA-9313624 for CATE Lab), and the State of Florida.

[2] For additional information, please visit the High-Performance Database Research Center's internet web site located at http://hpdrc.cs.fiu.edu or contact M.R.S. by telephone (305-348-2025) or internet E-mail (msanch03@fiu.edu).

- the projections can be made to rotate forward or backward in time either incrementaly (e.g., stopping every hour) or continually; where continually can be for a time range or for the duration of the representing data,

- the projections can be halted at a given date and time,

- zoom a user defined area where the magnification maintains a perspective of the data resolution,

- zoom a user defined area and that area continues to display the measures in time and in any of the projection types.

Additionally, we classify our GIS as intelligent. The system can *remember* distinctive geographic apparitions, such as continent and clouds, then display them in *other projections* as points of reference (as in the outline of the continents) or omit them for clarity (as in a persistent cloud cover).

SEMANTIC DATABASE MANAGEMENT SYSTEM

An integral facet of our GIS is the proficient use of a high-performance semantic database. The semantic database is based on the semantic binary model of databases. The use of the semantic model ensured better logical properties: friendlier and more intelligent generic user interfaces based on the stored meaning of the data, comprehensive enforcement of integrity constraints, greater flexibility, and substantially shorter application programs. The semantic database represents information as a collection of objects and relationships between these objects. The Semantic Binary Model of databases is a semantic model with object-oriented features. Data items related to the object can be of arbitrary size, multi-valued, or missing entirely. Flexibility is enhanced since objects are not required to be identified by keys.

We have demonstrated that the GIS running on a semantic database, is more efficient than on other database machines. The higher-efficiency goal was attained by exploiting the system's understanding of the data's semantics and due to the higher abstraction level. The GIS is highly efficient with both small and massive numbers of processors equipped with separate memories and storage devices. In particular, the use of the semantic model allowed a better exploitation of parallelism by providing a means of distributing data among processors in a way which was invisible to both database programmers and database users.

APPLICATION RESULTS

We proved our methods by creating a semantic database with ocean temperature data for an 18 month period and with ozone readings from two different satellites for an overlapping five year period. Visually interpreting the ocean temperature revealed a generalized band of higher temperatures in certain equatorial regions and in environmentally sensitive areas. Visually interpreting daily ozone readings revealed a smaller than anticipated *ozone hole* over the Antarctic during September thru November, with the greatest extension of the hole being in October. For both intricate data sets to be depicted in sync with time and geodetically correct with the rotation of the selected projection, the semantic database provided a high response rate for servicing complex queries.

FUTURE WORK: 3-d VISUALIZATION

An extension to our GIS will be a 3-d visualization system whereby variant intricate data sets can be concurrently viewed and manipulated. We have found that earth scientists need the means by which to visually interpret data that provides a measure localized by three coordinates or more. Further, these researchers need to *concurrently* visualize (and hence interpret) several of these intricate data sets. Such a feature of a 3-d program that visualizes intricate data, we have found, would be extremely valuable, as it would enable the interpretation of several measures (as in the ocean temperature at sea level, the ocean temperature at a certain depth and atmospheric temperature) at the same space-time (as in a particular region of ocean at a particular date and time).

An integral element to our 3-d visualization system is the spatial function superimposition. An example of such a superimposition would be the result of a query whose output consists of two spatial functions of the same two-dimensional subspace. The proposed 3-d visualization extension to our GIS will service generalized spatial functions that are stored in the semantic database as well as information contained in the output of a query. This feature presents several complicated technical questions in the domain of computational theory as well as dynamic memory allocation. Specifically, the superimposition is constructed by taking two intricate data sets and; interpolate each as an $R^3 \to R$ function (where R is a continuum of real numbers); superimpose them as an $R^3 \to R^2$ function and then display them as an animated series of $R \to R$ objects.

SUMMARY

We have provided a novel and continually evolving GIS using a semantic database for effectively and efficiently depicting environmental observations. The GIS has aided in the rapid interpretation of highly complex measures of massive amount of intricate data. An extension to our GIS will provide the superimposition of myriad spatial functions thereby affording a highly intuitive 3-d visualization feature.