

INTERACTIVE MAPPING SOFTWARE OF THE DOMESTIC INFORMATION DISPLAY SYSTEM

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I. Introduction

The Domestic Information Display System (DIDS) is an interactive, menu driven software system which produces single and bivariate choropleth maps on color television monitors of socio-economic data by county and Congressional District at the national and state level, and by census tract for Standard Metropolitan Statistical Areas (SMSA's). The system was developed by NASA, Goddard Space Flight Center and the Bureau of the Census at the request of the Executive Office of the President to demonstrate the potential of image analysis systems developed in the space program for the interactive geographic display of federal statistics.

DIDS is minicomputer-based and utilizes the image manipulation capabilities of a sophisticated image analysis terminal designed at NASA/Goddard as part of the Atmospheric and Oceanographic Information Processing System (AOIPS) [1]. The system is highly interactive, and can produce a color map display within seconds of the selection of a data item from a menu. The geographic display format used in DIDS was developed by the Bureau of the Census based on color statistical map products produced by that agency [2].

An example of a DIDS choropleth map display is the U.S. map of unemployment by county in April 1970, shown in Figure 1. In this map, the range of unemployment, 0 to 26.3 percent, is divided into quintiles. Class intervals and color assignments may be interactively

modified by the user.



FIGURE 1. Unemployment rate for U.S. by county, April 1, 1970.

User selected areas, identified using a cursor, may be interactively enlarged to show greater detail. U.S. maps may be expanded by factors of 2, 4, and 8; while SMSA maps may be expanded by factors of 2 and 4. Figure 2 shows a factor of 8 zoom of the east coast region of Figure 1.

Development of DIDS software has taken place in three phases. The first, Demonstration, version was developed in Spring 1978 and demonstrated to the Executive Office of the President, Members of Congress, their respective staffs, and potential users throughout the Federal government. In October 1978, 19 Federal agencies joined together in a one-year cooperative effort to evaluate DIDS in real applications and to support development of additional system capabilities. This second phase resulted in the current version of the system. The third phase, now in progress, is the development of a prototype remote terminal system. The interactive mapping approach used in each of these three phases is discussed in the following sections.



FIGURE 2. Factor of 8 enlargement of east coast region showing unemployment by county in 1970.

II. Development of the Demonstration System

In order to provide highly interactive response, the Demonstration version was designed to make maximum use of the raster-oriented AOIPS image analysis terminal hardware. Geographic maps are represented as raster images, with each geopolitical unit identified by a unique gray level. Using lookup tables in the image analysis terminal, each image element (pixel) is translated into a gray level proportional to the data value in the corresponding map area, and subsequently into class color values. As shown in Figure 3, this process is performed under control of the AOIPS PDP 11/70 minicomputer.

The area enlargement process is accomplished by storing higher resolution maps for each of the expansion factors in TV image-sized segments on disk for rapid access. Using shifting and re-recording features of the terminal the four map segments required to form a user-specified area are merged to form a complete map at the higher resolution. This process is illustrated in Figure 4.

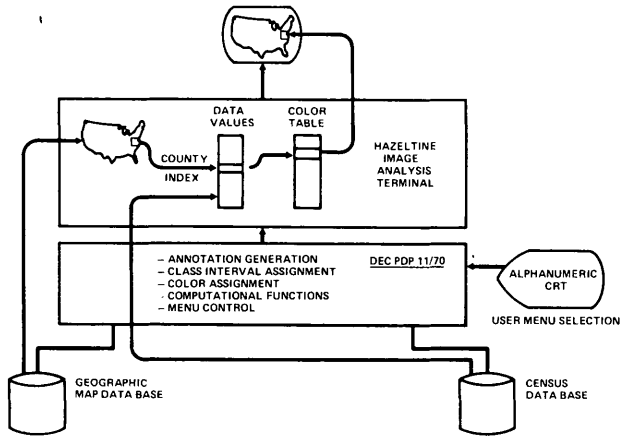


FIGURE 3. DIDS Operation

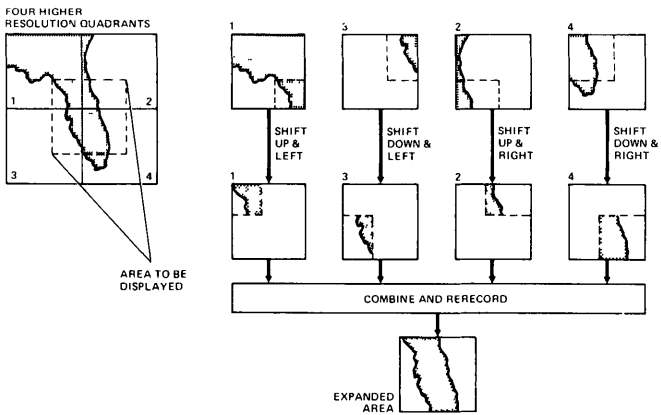


FIGURE 4. Area Enlargement Process

The operation of the Demonstration version of DIDS is discussed in greater detail in [3].

III. Development During the Evaluation Phase

A major emphasis during the interagency Evaluation Phase was the addition of new geographic maps and statistical data bases to the system. Congressional District boundaries and corresponding Census statistics were added, as well as the boundaries and statistical data for additional SMSA's. The map storage and display methods described in the Section II became less desirable, both because of the large storage requirement (42.5 megabytes (MB) per map) and because of the dependence on expensive AOIPS terminal hardware. A data compression method was sought, combining storage efficiency with rapid access for raster displays; and a bidirectional run length coding scheme was subsequently developed.

As shown in Figure 5, each map image raster line is divided into segments, with each pixel in a segment having the same area identification and the same distance in lines upward to the nearest state and county boundaries. Each segment is represented by a node defining the beginning pixel (x), the area identifier (c), the number of lines upward to state and county boundaries (l_s and l_c), and the presence of a vertical state boundary at the beginning of the segment (s). These nodes are grouped by line and sorted by pixel coordinate.

The advantage of this approach arises from the fact that only 512 lines of encoded map information need to be processed for any scale factor. In processing each node, the boundary distance indicators, l_s and l_c , can be compared to the scale factor to determine whether or not to insert a boundary in the display image.

This approach, which is described in greater detail in [4], has resulted in a factor of 10 reduction in storage requirements, with little effect on display response.

IV. Development of a Prototype DIDS Remote Terminal

Because the AOIPS system was heavily committed to severe storms research and earth resources applications, demand for DIDS during the Evaluation phase greatly exceeded the time available. Also, the cost of video communica-

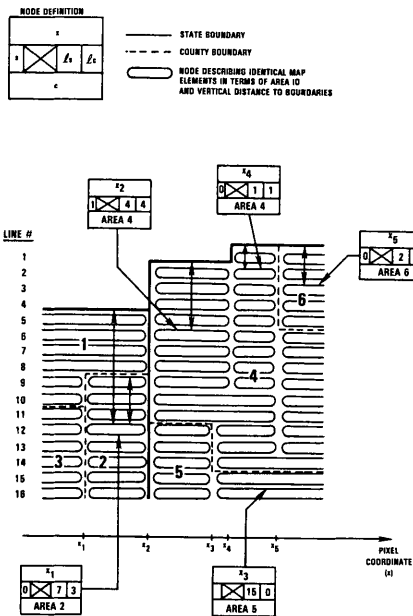


FIGURE 5. Bidirectional Run-Length Coding Example

tions severely limited the potential for remote use and demonstrations. Consequently, an effort was initiated to develop a dedicated system with remote terminal capability designed especially for DIDS. The system concept is shown in Figure 6.

The map compression scheme described in the previous section removed the dependency on high capacity storage devices. Because the geographic data base is relatively static, and because rapid access of this data base is required for interactive display, the geographic base maps will be stored at the remote terminal. An LSI minicomputer will control the access of this data base and all other interactive functions.

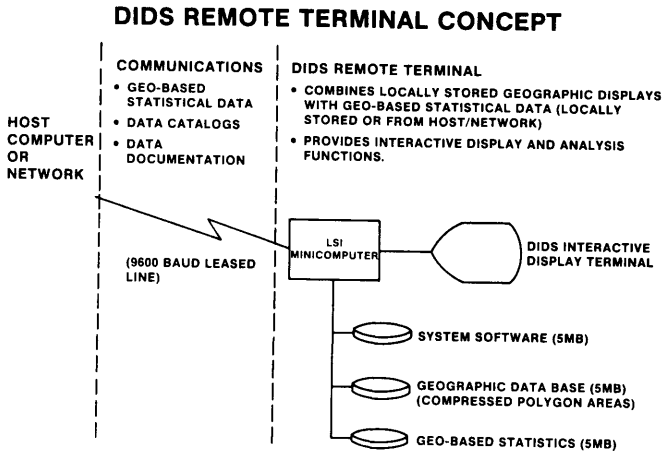


FIGURE 6. DIDS Remote Terminal Concept

Geo-based statistics represent a relatively low volume of information. County statistics for the U.S., for example, consist of 3141 numbers per variable. In order to provide timely access to recent statistics and possibly access to statistics from different sources, these data will be transferable as required by the remote terminal over conventional data communication lines. A limited amount of on-line storage will be available in the remote terminal for storage of frequently accessed statistics, and will permit stand-alone operation of the terminal, independent of a host computer or network.

The interactive display terminal shown in Figure 5 has been designed especially for the DIDS displays, and is currently being developed by deAnza Systems, Inc.

A DEC VAX 11/780 computer, is currently being installed at Goddard to serve as a host processor for the prototype remote terminal. This host will support development of the geographic data base and serve as a source

of geo-based statistics for the remote terminal. The host processor will also support a local DIDS display terminal and thus serve as an additional analysis resource.

The host/local terminal system is planned for completion in February 1980. The prototype terminal is planned for April 1980.

Acknowledgements

The authors would like to acknowledge the outstanding efforts of the DIDS development team: Mr. John Quann, Mr. Joseph Johns, Ms. Martha Szczur, Mr. Mel Banks, and Mr. George Winkert (NASA/Goddard), Mr. Roy Borgstede (Bureau of the Census), Drs. Jeffrey and Lily Chen (General Software Corporation), and Mr. Gene Cyprych (Computer Sciences Corporation).

References

1. Bracken, P.A., Dalton, J. T., Quann, J. J., and Billingsley, J. B., AOIPS - An Interactive Image Processing System, National Computer Conference, (1978), pp. 159-171.
2. Meyer, M. A., Broome, F. R., and Schweitzer, R. H., Color Statistical Mapping by the U.S. Bureau of the Census, The American Cartographer, Vol. 2, No. 2, (1975), pp. 100-117.
3. Dalton, J., Billingsley, J., Quann, J., and Bracken, P., Interactive Color Map Displays of Domestic Information, ACM/SIGGRAPH '79, Vol. 13, No. 2, (1979), pp. 226-233.
4. Dalton, John T., Winkert, George E., Quann, John J., A Raster Encoded Polygon Data Structure for Interactive Mapping, Second Annual International User's Conference on Computer Mapping Hardware, Software, and Data Bases, Harvard University, Laboratory for Computer Graphics and Spatial Analysis, (July 1979).