MULTIPLE SYSTEM INTERACTIVE MAP COMPILATION WITH DISTRIBUTIVE COMPUTER NETWORK

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1. Introduction

The use of digital photogrammetric map compilation systems with interactive display and editing capabilities is providing an unprecedented opportunity for achieving new levels of efficiency, cost effectiveness and improved responsiveness in the production of topographic maps, charts and related data.

During the last decade, there has been a noticeable acceptance of the advantages of map data in digital form. This change is due to several reasons, which include:

- the ability to create a digital cartographic data base;
- the increased demand for digital map data from users for computation, geographic modelling and geographic information systems;
- the rapidly improving technological methods for digitization display, edit and drafting;
- the increased demand for special types of maps and charts;
- the possibility of preparing maps at successively smaller scales, with a selection and generalization of what shall be represented at each scale;
- the elimination of the re-digitization of substantial amounts of the plot inherent in the generation of maps at larger scales;
- the elimination of manual drafting and scribing work;
- the speeding up of the map-making process;
- the possible acceleration of map revision;

- the present availability of software for display, edit and data base manipulation.

In the Topographical Survey Division, the development of a digital compilation system was started in 1972 to digitize photogrammetric measurements from stereo-plotters and record data. This system was developed in 1975 and had no display or editing capabilities, and the operator had limited control over the recorded information.

In 1976 the first experimental interactive digital map compilation system with display and editing capabilities was developed in the Topographical Survey Division by integrating our data collection system with the Interactive Graphic Design System (IGDS) developed by M&S Computing (Huntsville, Alabama, U.S.A.).

Based on the experience gained from the experimental system, two interactive mapping systems were installed in the Topographical Survey in 1978.

2. System Configuration

With regard to the way and extent of involvement of digital computers and peripheral units in automated photogrammetric systems, several feasible configurations can be drawn up. In principal they can be classified according to one or more of the following options:
a. single or multiple station;
b. capabilities for interactive display and editing;
c. uni-directional or bi-directional communication.

In addition to the hardware configuration of the system, the capabilities of the software used adds another factor to the complexity of the desired system. In addition to the basic requirement for cartographic digitization and recording of data, the options for extensive display and editing functions, data processing, system intelligence and degree of operator control or interaction, and the capabilities for data base management must be considered.

The experience of the Topographical Survey Division with digital map compilation using analog photogrammetric instruments is best illustrated with the various configurations of the systems developed since early 1972.

2.1 Multiple Station Digital Compilation (1972-1975)

This system was developed for the digitization of photogrammetric

measurements during map compilation and the recording and storing of data as represented in figure 1.

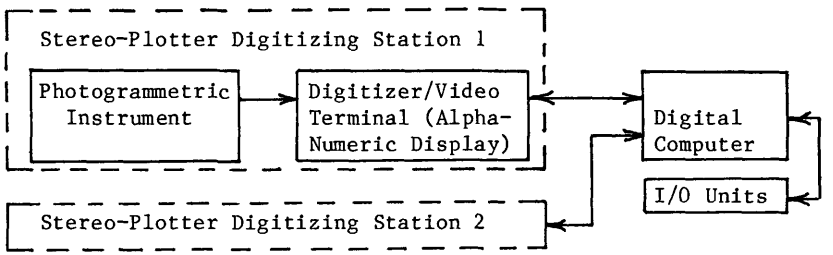

Figure 1. Digitizing/Recording System

The measuring device of the photogrammetric instrument was modified by adding a tri-axis locator with optical incremental encoders for the measurement of the X,Y and Z coordinates in model space. A digitizer video terminal with alpha-numeric display and keyboard was developed in-house to serve as a link between the stereoplotter and the computer. A bi-directional communication existed between the digitizer/video terminal and the computer; thus providing a limited closed-loop system. The stored information consisted of cartographic codes and X,Y coordinates in ground units for the digitized features.

With this system, the operator has no control over the digitized information except for very simple operations provided by the digitizer/video terminal and the software. For example, it is possible to "backspace" any feature and write over old information in a time-shared environment.

2.2 Multiple Station Interactive Map Compilation (1976)

From the experience gained from the previous system and due to the nature of photogrammetric compilation, where a map consists of several models, it was absolutely necessary to provide the operator with complete control over the digitized data. Display and editing capabilities were needed for error detection and editing during the compilation of features in a model and to join models. The configuration of this system is represented in figure 2.

In this configuration each stereo-plotter station is interfaced to the front-end computer (PDP-11/T10) using a digitizer/video terminal as in figure 1. The front-end computer is interfaced to a main computer (PDP-11/45) using a standard Digital Equipment interface. Each stereo-plotter station is equipped with a dual

graphic CRT display terminal.

The control over the digitization is provided by the closed-loop between the digitizer/video terminal and the front-end computer (selection and assignment of cartographic codes, digitizing X and Y coordinates and end-of-feature). The control over the display and editing functions is provided by the CRT graphic terminal and the main computer.

The CRT graphic terminal has a data tablet with a menu of commands. A free cursor is used to select the desired design, display or edit function.

In this configuration, a large surface digitizer table with CRT terminal is used for cartographic editing and a CalComp pen plotter for the production of hard copy proof plots.

2.3 Modified Multiple Station Interactive Map Compilation (1978)

This configuration is represented in figure 3. The main differences between this system and the 1976 system represented in figure 2 are:
- the front end computer and the digitizer/video terminals were eliminated;
- each stereoplotter is interfaced to the computer using a microprocessor.

This system consists of six stereoplotter stations, a large surface digitizing/editing station, and a Calcomp 960 pen plotter.

In this system the computer directly affects the operation of the individual microprocessors and the CRT graphic terminals. The microprocessors have no storage capabilities for the digitized data and are used for the transformation of digitized data from model to ground coordinate system. Bi-directional communication exists between the microprocessors and the computer and between the computer and CRT graphic terminal.

In all these systems a uni-directional communication exists between the stereoplotter and the interface to the digitization system.

3. Software

The main components of the software system for interactive photogrammetric map compilation are:
- Software for data collection from the photogrammetric instrument

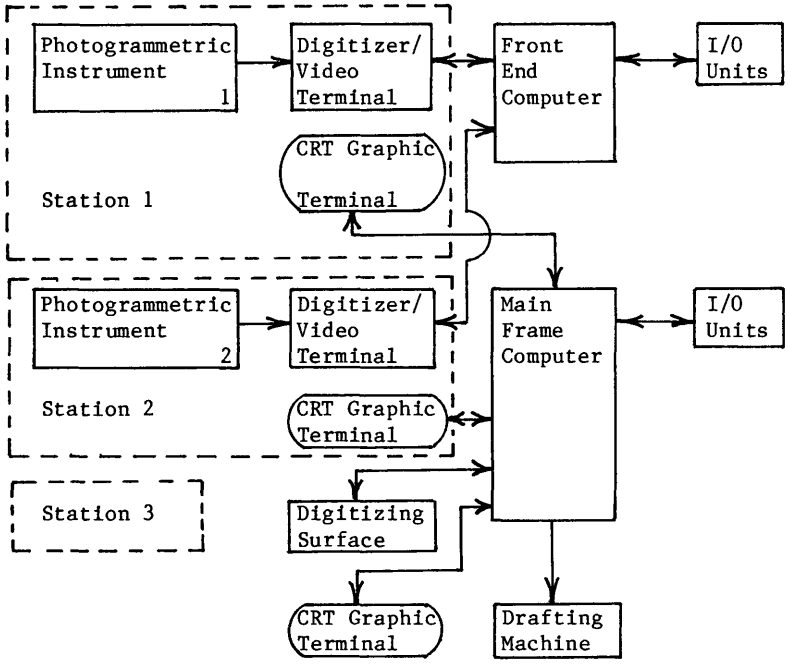

Figure 2. Multiple Station Interactive Map Compilation (1976)

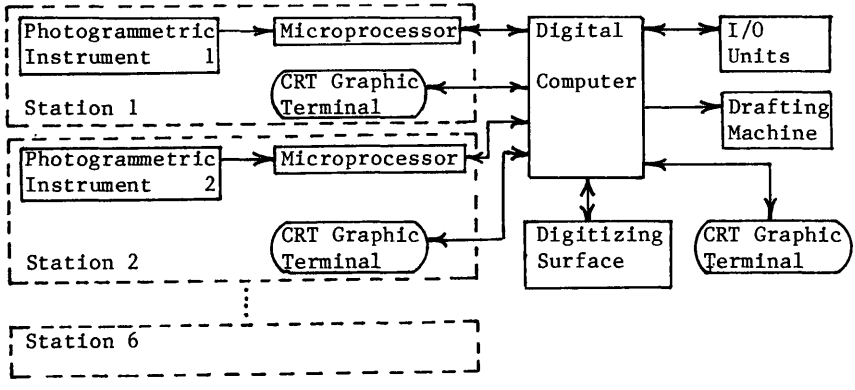

Figure 3. Modified Multiple Station Interactive Map Compilation (1978)

with appropriate cartographic code assignment; and the transformation of digitized X,Y, and Z coordinates from model to ground coordinate system.
- Software for interactive graphic file design, display, and editing purposes.

It is essential that the software be designed as several modular tasks communicating with the user on a real-time, event-driven (user request), priority structured basis.
The interactive graphic programs should be made accessible through the menu and keyboard, or they might be addressed directly by application programs. The main features of the interactive graphics software include:
a) Placement, deletion, modification, and movement of design elements, such as lines, polygons, arcs, circles, ellipses, text and curves.
b) On-line user definition of any combination of design elements as a cell to be added to a cell library; placement, manipulation and scaling of any cell.
c) Storage and retrieval of intermediate and final designs.

4. Operational Procedures: Interactive Display and Editing

Editing can be done during data collection, after the completion of some compilation or after the data have been plotted and reviewed. Editing and graphical display are closely related. The following are some of the combinations that can be graphically shown on the interactive storage display system.
- display one or more overlays in combination with the class of data as identified by association code such as roads, railroads, rivers, etc.
- display with or without: a pattern (e.g. railroad). a symbol (e.g. marsh, building, etc.), a line type (e.g. solid line, dash, dotted, etc.) and line weight.

Also related to editing is the measurement of data. It is possible to measure the distance between graphical elements, the angle between lines or the area bounded by a polygon. Equally important is the precision and exact location and placement of data, e.g. placing a geodetic monument exactly on the map.

The editing, like the display function, is controlled by a menu command. This includes the classical editing capabilities such as add, delete, modify, and smooth data. It is possible to add line data, text data symbols and so on. Part or all of a data element can be deleted. Two segments of data can be joined into one continuous smooth curve. It is possible to modify data such as in the case of road intersections or contour and stream

intersections.

These are a few examples of the numerous combinations that can be performed while editing. It is possible to use automatic dimension to place a name between two specified points. Another useful editing function is the processing of fence content. We can define an area which encompasses some data as a fence and move, rotate, delete, copy, etc. the contents to another location in the design file. The editing functions are interactive and highly responsive. While editing there exists a constant dialogue between the operator and the computer ensuring maximum interaction.

5. Conclusions

The recent progress in computer technology, peripheral units and graphic display terminals promotes increasingly new developments in the field of digital photogrammetric map compilation. Although microprocessors are important as an interface between the photogrammetric instrument and the minicomputer, microcomputers will be used to increase the capabilities of the digitizing station and to reduce the load on the main frame computer. Microcomputers with I/O peripheral units will be used for the recording and storage of data and perhaps for the control of the CRT graphic terminal. In multiple station systems, microcomputers will play the full role of a distributive computer network. In this case, a bi-directional communication between the microcomputers will exist in addition to the bi-directional communication between the main frame and each microcomputer.

For the last few years, the majority of the CRT graphic terminals used with interactive systems are of storage tube type. Vector refresh terminals with excellent brightness, small spot size and large display area are currently available and will be used to increase the system performance by having the capability to erase any displayed feature and to display the modifications without rewriting the entire screen.

6. References

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