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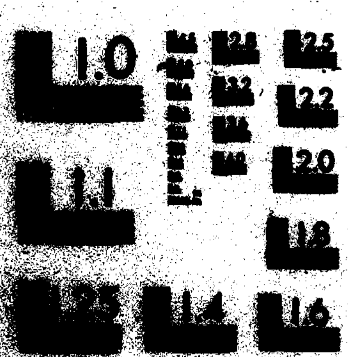

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MAPPING APPLICATIONS OF VIDEO DISC TECHNOLOGY*

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ABSTRACT

Video discs can store large quantities of analog map products in a compact, nonvolatile format. Interfacing them to microcomputers provides a portable, rugged means of accessing cartographic information. This new technology has many potential applications in map data storage, navigation, training, and decision making. The U. S. Army Engineer Topographic Laboratories (USAETL) is studying hardware, software, and map design aspects of video discs with a prototype Map Video Processing (MVP) system.

INTRODUCTION

Optical-reflective video discs permanently store large amounts of data using a method known as optical-recording (Sigel, E., et. al., 1980). First, the information is converted into a video signal and recorded onto video tape. [illegible] a high power laser beam burning pits onto a master disc surface. Finally, the master disc serves as a pattern for stamping out multiple copies of itself onto plastic discs. To read the data, the plastic disc is inserted in a special video disc player. The disc is rapidly [illegible] while a low power laser beam shines on its reflective surface. The beam is reflected back to a photodiode [illegible] intensity differences due to patterns of pits on the disc face. This is converted back into a video signal [illegible] on a television monitor. A microcomputer can be [illegible] with the video disc player to produce an interactive [illegible] (Figure 1).

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*[illegible] at National Computer Graphics Association [illegible] 1983 Annual Conference, in Chicago, Illinois.

These plastic discs are quite durable, and handle like ordinary phonograph records. Unlike magnetic tape or video tape, any information on the disc is accessible in a few seconds or less. Also, unlike magnetic tapes or magnetic disks, they are not affected by magnetic interference, or reader head crashes due to dust buildup. For this reason video discs should last longer in storage than magnetic media. They take up little space, and may be stored in the same manner as phonograph records. Even the video disc/microcomputer combination can fit on a table top. Thus, video disc systems can operate in cramped, dirty environments. Their major disadvantage is that they are unerasable. Once the pattern of pits is put on the disc surface, it cannot be altered and used again. However, this will change when new erasable video discs become commercially available in 1984.

Anything that can be put on video tape can be put onto video disc (McClain, 1983). This includes digital data, as well as analog products like still photographs, movies, video tape, drawings, and maps. Light, 1983 offers an estimate of digital map data storage using this new technology. This paper concerns itself with analog map storage on video disc. It first describes the major hardware and software considerations for utilizing video discs in mapping. It then lists potential mapping applications of video discs. Finally, it describes work USAETL is doing in this field.

STORING MAPS ON VIDEO DISCS

Paper map products are transferred to video disc using precision photography or video taping. The map is first placed down on a flat surface. A video or movie camera is then guided over the map through a computer controlled sequence. It records sections of the map as individual photo or video frames in much the same way aerial photographs are taken over a land area. A master video tape is made of these frames, and this tape is used to make the video disc master. The final video disc holds up to 54,000 frames per side, or 108,000 frames for a two-sided disc. Each individual frame is identified by a frame number, much like the page number of an atlas. In fact, the video disc may be thought of as an atlas with 54,000 individual maps.

The total number of frames needed to cover a map depends on three major parameters (Levine, 1983):

<u>Frame Size</u>- This represents the area of the map covered by each frame. Unfortunately, the video signal from the video disc displays a high resolution scene (the map) on a low resolution television screen, typically of 525 raster lines (Caldwell,1981). As the camera covers a wider area of the map, a certain point is reached where map detail becomes almost impossible to read on the television screen (Wong and Yacoumelos, 1970). Thus, as frame size is increased, less frames are needed to completely cover the map. However, at the same time, map detail becomes unreadable. Likewise, as frame size is decreased, map detail becomes quite clear on the raster screen. Yet, many more frames are required to cover the map. The key is to find a frame size covering a

Figure 1

Table 1

VIDEO DISC STORAGE CAPACITIES

(After Levine, 1983)

% Overlap	Frame Size (km)			Total No. Frames per Map	No. Maps per Video Disc	No. Video Discs Covering Central Europe
	5	10	20			
0	100	25	9	134	402	9
25	200	50	16	266	203	18
50	400	100	25	525	102	35
75	1600	400	100	2100	25	140

[illegible] amount of area, while still showing an acceptable [illegible] of map detail. Determining this can be very difficult.

[illegible] Overlap-This represents the amount of overlap between individual frames. This is used in the panning or [illegible] feature described below. The camera typically [illegible] frames in a north-south, east-west direction. The result is overlap in these directions only. However, the camera could also overlap frames in diagonal directions of northeast-southwest, or southeast-northwest. As overlap increases, so does the number of frames needed to cover a map.

Number of Levels- This relates to different scales of frames used to completely cover the map. A single map can be covered by more than one frame size. This would result in different levels of scale being used in the zoom feature described below. As the number of levels increases, so does the number of frames required to completely cover a map.

Because of the above complicated process, there is much confusion about just how many maps may be stored on a video disc. This depends on how the three parameters were used to [illegible]. For example, central Europe, measuring [illegible] 1,000,000 square kilometers (km) in size, is [illegible] covered by about 3,500 maps at 1:50,000 scale. If [illegible] each map, then only 3,500 frames [illegible] would be needed to cover [illegible] images displayed on [illegible] completely unreadable. [illegible] estimate. The second column [illegible] capacities of video discs [illegible] overlaps ranging from 0 to 75%, [illegible] to 20 centimeters (cm), and three scale [illegible] give the number of [illegible] scale map at each frame [illegible]. For comparison, a [illegible] about 50 x 50 cm.

[illegible] the number of single-sided video discs [illegible] could vary from nine for 0% [illegible] for 75% overlap. This may seem [illegible] even 140 video discs occupy far less [illegible]. For double-sided video discs, [illegible] would be needed, but at present, sin[illegible] are more common.

[illegible] MAPS FROM VIDEO DISCS

[illegible] with maps on video disc is determined by [illegible]. The first factor, which is often over[illegible] maps were put on the video disc. If [illegible] quality is bad, or the frame size too [illegible] too small, then no amount of hardware [illegible]. Many mapping discs on the market [illegible] because too little consideration was [illegible] parameters stated above.

The second factor is the hardware interfaced with the video disc player. A truly interactive video disc system could consist of:

* One or more video disc players.
* 8-bit or 16-bit microcomputer.
* Two floppy disk drives.
* One hard Winchester type disk drive.
* Several frame storage buffers.
* Touch panel controlled television monitor.
* Light pen.
* Joystick.
* Digitizing pad.
* Facsimile printer.
* Line printer.

The third consideration is software written for this system. This software locates individual frames by finding their frame number on the video disc, and displaying each frame on the screen. This is basically where the role of the video disc ends, and the role of the hardware/software begins. With properly written software this system could do the following:

Zoom- Using the touch panel control, the operator could simply touch a spot on a general map of an area. The computer would then pull different levels of frames off the video disc to zoom in on that area. The zoom effect will be "jumpy" or "smooth" depending on the number of levels built into the video disc. Frame size and amount of overlap among [illegible] how close the frames come to zooming on the spot [illegible] at.

Pan or Scroll- At each level, the operator could pan north, south, east, or west using the joystick. To do this, the computer rapidly displays consecutive frames from the [illegible] the illusion of motion across the screen. The [illegible] will be "jumpy" or "smooth" depending on the [illegible] overlap between individual frames.

[illegible]- Different frames could be pulled [illegible] and stored in the frame buffers. Or, the [illegible] pull one frame each off of different video disc players. The frames could then be overlaid on top of each other on the television screen. Map separates, for example, could be put on the video disc, and combined on the screen to produce a composite map.

[illegible] or Mosaicking- The television screen could [illegible] into four separate sections. Four frames could [illegible] from the video disc, and these fused or mosaicked [illegible], producing a composite map. This could be [illegible] with four video disc players connected to the [illegible] the same technique, large scale and small [illegible] of an area could be displayed on the same [illegible]

[illegible] Processing- Since the map is a video signal, [illegible] techniques could be applied to it. The [illegible] bring out important features and suppress [illegible] features from the displayed map. A good example is [illegible] of contour lines above cluttered cultural [illegible].

[illegible] Graphic Symbol Placement- Computer graphics pro[illegible] the microcomputer would allow placement of a wide [illegible] of symbols on the screen. Figure 2 shows a touch [illegible] menu at the bottom of a map frame from the [illegible]. The operator need only touch the menu, point to [illegible] symbol should go, and it will automatically appear [illegible] (Figure 3). Screen positions of these symbols [illegible] on floppy disks. Thus, whenever a particular [illegible] symbols covering it would be automati[illegible] on the screen.

[illegible] Referencing- Precision filming of the maps [illegible] to be written modeling their geographic [illegible]. Thus, the operator could call up a frame [illegible] screen, and point to a spot on [illegible] would then calculate the point's geographic [illegible] to two points would result in a dis[illegible] being displayed. The operator could also [illegible] on the screen by inputting their geographic [illegible].

[illegible] APPLICATIONS FOR VIDEO DISCS

[illegible] could find uses in many [illegible], training, and deci[illegible] possibilities:

[illegible] the greatest advantage of video [illegible] storage of mapping information. A [illegible] the above considerations of [illegible] into account, can hold as [illegible]. When coupled with a [illegible] video disc offers greater flexi[illegible] map library. Graphics [illegible], such as military unit sym[illegible] of the background map stored on [illegible], a minicomputer [illegible] player, and advanced [illegible] elevation data, can be [illegible] frames.

[illegible] Catalog- Map product listings [illegible], confusing paper catalogs. By [illegible] interactive video disc system, [illegible] in locating map products could be [illegible] could be placed on the counter at a [illegible], the user could point to a point on a [illegible] a touch panel controlled video [illegible] system could then display examples [illegible] for that area. A current map listing [illegible] by the microcomputer. Updated video [illegible] just like updated map catalogs.

[illegible] Video disc systems could duplicate [illegible] plastic overlays and light tables.

Figure 2

Figure 3

[Different] terrain analysis maps, land use maps, and color [illegible] could be put on the disc through precision [filming]. The operator could then overlay them on the television screen using frame buffers. All materials would register so long as they used identical map projections and filming techniques. Thus, one could create individually tailored map graphics by pulling the proper frames off the video disc.

__Map Teaching Aid__- Video disc systems also could serve as a useful educational tool for teaching map reading. Specific examples of maps could be brought up onto the screen, and the student asked by the microcomputer to perform different tasks using these map graphics. For example, the student could be asked to find different symbols, measure the distance between two different points, or describe different landforms based on their contour lines. This method would save time, since the computer could pace the student through a lesson, give tests, and monitor the student's progess. In the long run, it would also save in materials costs, since [illegible] video discs store all maps needed for the course.

__Perspective Terrain Views Storage__- High quality perspective terrain views can presently only be generated by mini [illegible] computers. Video discs could serve as a storage medium for these scenes. For example, these views could be generated for important points in a geographic area and stored as individual frames on video disc. The operator [illegible] of these points, and use the joystick to [illegible] the horizon. The microcomputer would display [illegible] to create a panning effect. If 72 terrain [views] [illegible] on every 5 degrees of azimuth) were [illegible] for each ground point, then 1500 panoramas could fit on a [illegible] video disc. The microcomputer could also have [access] to a digital elevation data base stored on hard magnetic [illegible] optical disk. Using this data base, it [illegible] perspective terrain views for any specified [illegible] than those stored on video disc.

[illegible]- In [illegible] aircraft, instead of using a [illegible] map, the pilot could view the same map on a [illegible] video disc. This system could also be used [illegible] vehicles, such as cars, tanks, and [illegible] maps, pregenerated perspective terrain [illegible] tapes, and films of avenues of approach could [illegible] video disc as well. Thus, the operator could [illegible] through an area via the video disc, before actually [illegible].

[illegible] Map- An interactive video disc system could [illegible] dynamic phenomena as military movement or [illegible]. The background video map would appear on [illegible] different symbol graphics generated over it [illegible]. Blinking dots, for example, could show [illegible] of different vehicles, aircraft, or units. The [illegible] could input new information using light pen or [illegible]. Since the map is video based, it could be [illegible] to other terminals on vehicles, ships, or air-

Since maps on a television screen are a new medium of map display, some research is needed into the graphic design of map products to best take advantage of this technology. Therefore, USAETL has undertaken a graphic design study to develop standards and recommendations for putting symbology on a map to appear with maximum clarity on the television monitor. This research will help create better map graphics for use with video technology. USAETL is also looking at integrating perspective terrain views with maps and imagery on video discs.

CONCLUSION

Utilizing video disc technology for mapping applications requires a knowledge of the many hardware and software limitations of video discs, video display equipment, and the microcomputers that control them. Unfortunately, research in this field is scattered among many academic, commerical and government organizations. Guiding literature on the subject is almost nonexistent. Video discs, however, have great potential for mapping. Their great capacity to hold maps, graphics, and imagery solves the major problem of where to store large quantities of paper materials. They can be integrated into a rugged, compact, stand alone system for almost any application the map user might want.

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