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ABSTRACT

A videodisc system provides a means of storing substantial volumes of pictorial information. Individual pictures and sequences of images may be accessed directly thereby providing many novel approaches to image retrieval and display. When combined with an interactive computer system, a videodisc is able to create a useful tool to aid the dissemination and assimilation of pictorial material. This paper outlines the type of facilities provided by an optical disc and then describes some approaches to programming a computer controlled system. The six-part article includes: (1) a discussion of the inter-relatedness of books and videotapes and ways in which they may be used to supplement each other; (2) a section on the advantages of using videotape for information storage; (3) a section on using optical discs for information storage, including recording and playback techniques and types of optical discs; (4) a section on interactive video systems covering videodisc control, the computer interface, videodisc facilities (including random access, freeze frame, single stepping, slow motion, fast motion, search, indexing options, and teletext); (5) programming techniques including programming languages and authoring systems; and (6) conclusions. Twenty-one references are included. (Author/THC)

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Programming a Video Disc

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A video disc system provides a means of storing substantial volumes of pictorial information Individual pictures and sequences of images may be accessed directly thereby providing many novel approaches to image retrieval and display When combined with an interactive computer system a video disc is able to create a useful tool to aid the dissemination and assimilation of pictorial material This paper outlines the type of facilities provided by an optical disc and then describes some approaches to programming a computer controlled system

Keywords Interactive video, Author languages, Programming, Image retrieval, Teletext

1. Introduction

Information takes a variety of different forms. Three of the most commonplace are probably text, sound and pictures. Most people will be familiar with each of these. However, in order to demonstrate (a) how they are inter-related, and, (b) the ways in which they may be used to supplement each other, two simple illustrations will be given: a book and a video tape.

Essentially, books and other printed documents are based upon the use of textual and pictorial information. Thus, most books contain pages of printed text interspersed with pictures and diagrams. Within all books the pictorial information is static – that is, the pictures do not move; furthermore, in most cases the images are not coloured. Usually, 'black and white' toned pictures are used In distinct contrast to a book, a video tape is concerned with the use of sonic and pictorial information. However, in this case, the pictures are usually coloured and are presented in rapid succession so as to produce a high degree of animation that is able to mimic life-like reality.

Both the book and the video tape are examples of storage media that can be used to record, for posterity, the results of human endeavour. However, they each do this in very different ways. Information recorded in conventional printed form is very difficult to update, difficult to move from one location to another, and hence, not easy to share between many users simultaneously. In contrast, because it is essentially electronic, information in video form can be easily modified and updated. Furthermore, it can be transmitted around a broad band communication network and is thus, in principle, easy to share between several potential users – all of which may wish to access it at the same time.

Two basic storage media are used for storing video information: video tape and video disc. Usually, pictorial information is held on each of these in a strictly sequential fashion. That is, successive images occupy successive physical locations within the information store. Unfortunately, with video tape there is no easy and elegant way of rapidly and directly accessing particular images within the tape. This is not necessarily so in the case of a video disc store. With this medium each image can have a number associated with it. This can be used to uniquely identify and retrieve it – independently of any of its surrounding images. Currently, the major advantage of video tape systems is the fact that they offer the end-user both a read and a write capability for video information. Unfortunately, at present it is only possible to read video discs that have been previously created by a manufacturer. There is no end-user write/read/erase facility.

Both types of video image store can be connected to a computer system for control purposes. The computer provides an interactive facility that enables users to specify: (a) which images are to be retrieved; and (b) the manner in which they are to be displayed. This paper describes approaches to the provision of interactive video systems that have been produced by interfacing microcomputers to various video storage units Particular emphasis is given to a description of the results of some experiments into programming techniques for an interactive video system that has been produced by interfacing a commercial laser-based optical disc unit to a microcomputer

2. Using Video Tape for Information Storage

One of the major advantages of tape over disc is that users themselves are (easily and inexpensively) able to create their own video store – provided that they have suitable video recording and editing facilities. The major disadvantages of tape (compared with disc) are: it is less robust; it has a slower access time; and, it is less versatile in terms of the variety of image presentation strategies that it permits.

Most early interactive video systems that were based on tape technology allowed only linear presentations. That is, users accessed images (or image sequences) purely sequentially in the order in which they appeared on the tape. Because of its inherent limitations this type of equipment did not allow jumping forward (to skip images) or backward (to re-show images); furthermore, frame freezing (that is, the display of a single image for an extended period of time) was also difficult to implement. However, rapid advances in tape handling technology have removed many of these early limitations thereby making this medium a far more acceptable one for use in interactive video applications.

A number of interactive tape based systems have been described in the literature [1, 2, 3, 4]. One of the simplest approaches [1] involves the direct interfacing of a microcomputer to a standard industrial VHS video recorder by means of (i) a special purpose interface board, and, (ii) appropriate control software running within the micro. This software (which is normally stored on the micro's flexible disc) uses previously recorded electronic pulses (suitably placed on one of the two audio tracks of the video tape) in order to rapidly locate the image sequences that the user wishes to see. Improved speeds to access (and, hence, smoothness of presentation) can usually be achieved by using specially designed random access video tape equipment [2] rather than that of the conventional type. If need be, the use of separate storage media for the video images and the computer control software can be avoided by storing the latter on the video tape; it can then be loaded into the computer as and when it is required [3].

Several types of tape based interactive video systems are available commercially. One of the most well documented of these is probably the CAVIS system [5]. CAVIS (which is an acronym for *C*omputer *A*udio *V*isual *I*nstruction *S*ystem) has been widely used for a number of different types of application such as computer based training, sales promotion and straightforward image sequence retrieval.

3. Using Optical Discs for Information Storage

In appearance, the shape and size of an optical disc is very similar to a conventional LP gramaphone record. The diameter of the disc is about 300 mm. Its flat surface may be thought of as containing about 54.000 concentric tracks each one holding video/audio information equivalent to 1 still TV frame. At a playback rate of 24 frames per second there would thus be sufficient storage for a 37 minute movie. An optical disc differs from a gramaphone LP in a number of ways. The most outstanding differences are probably its colour (silvery and highly reflective), its greater robustness, its higher storage capacity and the way information is recorded on it.

3.1. Recording and Playback Techniques

There are two basic approaches to information storage and retrieval from optical discs. One relies upon the ability of an electronic stylus to detect capacitance changes while the other utilises the reflective properties of laser light. In the first of these, two basic signals are recorded (as a series of pits) on the disc; one signal records the video (or audio) information while the other provides an "electronic track" for the stylus to follow during playback. The information signal creates variable pits on the disc surface while the tracking signal creates lines of playback pits. Both signals are picked up as electronic capacitance variations between the conductive disc and an electrode mounted on a playback stylus [5].

Discs intended for use with a laser playback system contain a spiral shaped track of optically tiny pits embedded in a reflective layer. The complete video signal (the luminance, chrominance and the synchronisation of the video signal) along with the sound information associated with one (or two) audio channels are stored in the track by varying the length and the spacing of the pits (see Fig. 1A). During playback the rotating disc is scanned by a laser beam that is focussed on the track containing the required frame (see Figs. 1B and 1C). The reflected light from the disc is modulated with the track information and then, by means of a suitable photodetector, subsequently transformed into an electrical signal This signal is then processed in order to decode the video, audio and control information that was originally stored within the track from which the signal originated

The discussion that follows is concerned only with video disc systems that are based upon a laser playback mechanism More specifically, unless otherwise stated, the descriptive material refers to the Philips Professional VP705 LaserVision system [7, 8]

3.2. Types of Optical Disc

Basically, there are two types of disc available for use with optical disc players. These are known as CAV and CLV discs.

A CAV disc rotates with a Constant Angular Velocity (1500 rpm) such that the time for one revolution of the disc is exactly equal to the time for one video frame. For such a disc the mean length and spacing of the pits increases linearly with increasing track radius. They contain a maximum of 55.500 frames which is equivalent to a playing time of 37 minutes. Such discs offer the capability of providing a number of special effects such as fast forward, slow motion, reverse motion and still frames. Sometimes, CAV discs are referred to as "active play" discs.

A CLV disc rotates with a Constant Linear Velocity. This means that the disc rotation speed decreases linearly with increasing track radius. For

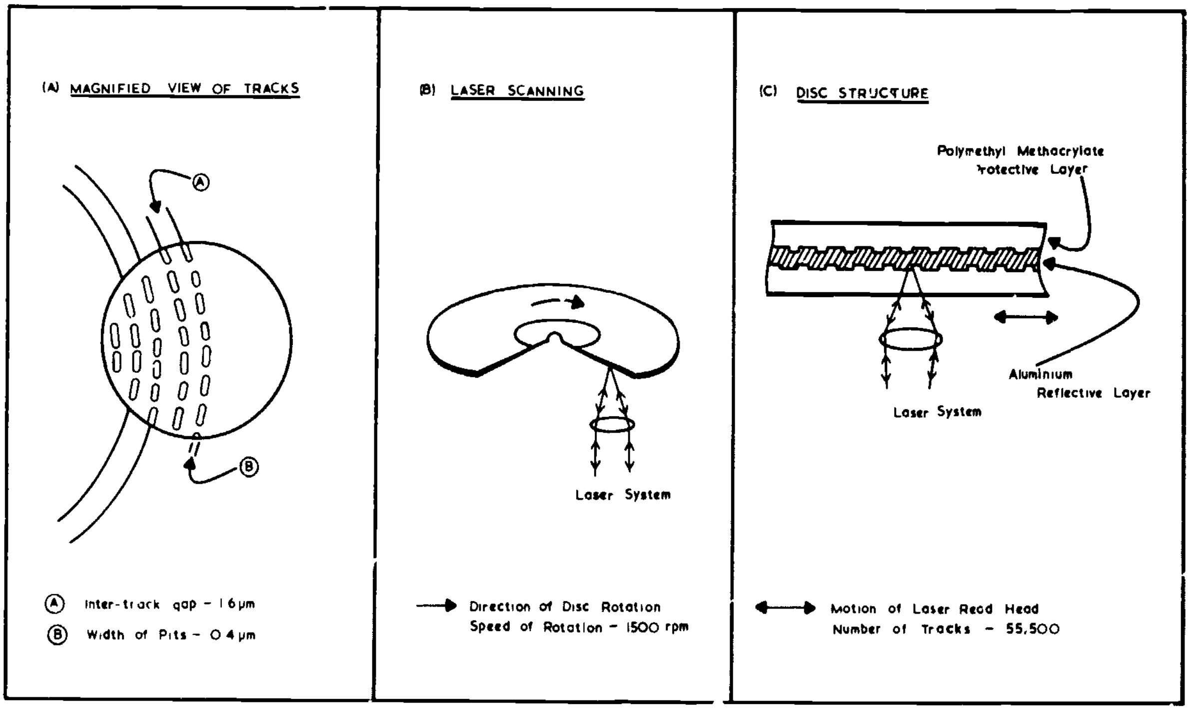

Fig 1 Structure and Mode of Operation of an Optical Disc

this kind of disc the mean length and spacing of the pits is constant all over the disc. This type of disc therefore contains more information and the playing time for one side is about 60 minutes. CLV discs are sometimes referred to as 'long play' discs Discs of this type can only be used for normal speed playing in a forward direction; they cannot be used to achieve any of the special effects that may be created using CAV discs.

CAV and CLV discs differ in an important way in that the former contain 'picture numbers' as part of the information stored on each track. These are not present in CLV discs. They therefore cannot be used for interactive video applications similar to those that are to be described in the following sections of this paper.

4. Interactive Video Disc Systems

The interactive video disc system used in this investigation is illustrated schematically in Fig. 2. It consists of three essential components: a teletext TV receiver with an associated remote control function pad; a BBC Model-B microcomputer system [6]; and, a Philips Professional VP705 LaserVision video disc player [7, 8]

The microcomputer is a MCS-6502 based system fitted with twin integral flexible disc drives and two serial communication ports. One of these (the RS-423 port [9]) was used to facilitate its connection to the optical disc unit. A second (parallel) port was used for the attachment of a conventional printer. Each of the ports operated asynchronously at speeds of 1200 and 300 baud, respectively. All programs were developed under the CP/N operating system [10] using BASIC and MICROTEXT [11]. Further details of software development will be given later.

The VP705 LaserVision system [7, 8] differed from conventional commercially available video disc players in two ways. First, it contained an RS-232-C interface [9] to enable its connection to the computer; second, it contained a special teletext encoder. The latter may be used to encode program generated teletext character strings (and/or graph-

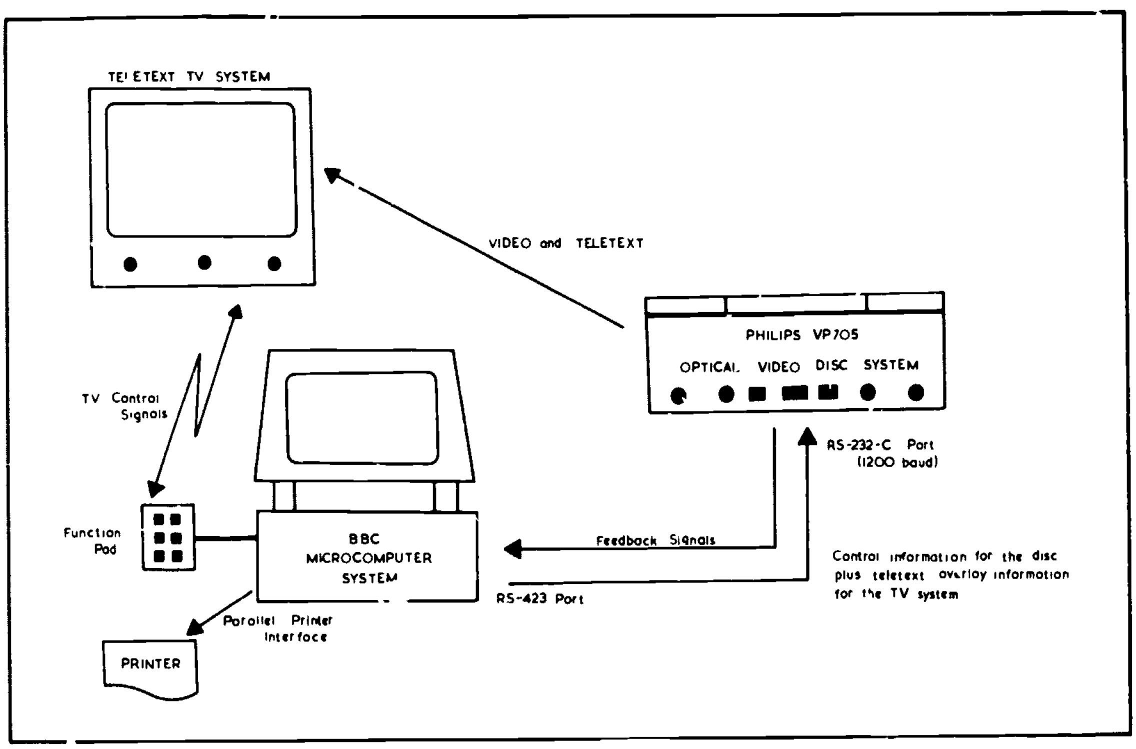

Fig 2. A Computer Controlled Video Disc System

ics) in such a way that they can be transmitted to the teletext TV, decoded and then displayed on top of the video images originating from the optical disc. This overlaying facility will be described in more detail later.

4.1 Video Disc Control

The video disc may be controlled in either of three basic ways: manually, remotely, and/or, by computer. The manual mode of operation is effected using the control buttons and switches that are located on the front panel of the player. Each of the functions that these perform may be invoked remotely via the use of a special hand-held infra-red remote controller keypad. Because this provided facilities for the entry of strings of decimal digits, this pad could be used to effect operations that were not possible using the front panel controls alone. For example, direct retrieval of individual pictures and entry of data into the start and auto-stop memory of the player. The third method of controlling the video player is via a computer. This is the most versatile method since all the functions that the player is able to provide may be invoked by stored operational programs running within an attached computer system. This is achieved by sending a suitable string of control characters to the player's RS–232–C port and, if need by, waiting for an acknowledgement to indicate that the control operation has been performed.

4.2 The Computer Interface

As was mentioned above, bi-directional communication between the video player and the microcomputer is achieved via an asynchronous serial RS–423/RS–232–C interface operating at 1200 baud.

Command strings from the microcomputer to the player are transmitted via the standard RS–423 output line to the player's complementary input pin. Similarly, character string information is returned from the video disc to the control program via the computer's RS–423 serial input line. The control command format is illustrated schematically in Table 1.

This notation specifies that a command string may consist of from 1 to (a maximum) of 64 characters. The command must be terminated by a carriage-return character (C/R). Some examples of single and multiple character command strings are also presented in Table 1. When the "*" character is sent to the player it, causes the player to stop playing and "frame-freeze" on the particular picture it happens to be displaying. Similarly, sending the character "N" to the player causes it to commence normal playing again. In contrast, use of the letter "O" as a command character would cause the player to go into reverse mode and show frames at normal speed while traversing the disc backwards. The multi-character command shown in example 4 is used to make the disc's laser read head move directly to the track (or picture) having the number 15000; it would then display this as a still picture on the TV screen. When the command string shown in example 5 is sent to the player it would activate the internal teletext encoder causing the message "THIS IS AN APPLE" to be overlaid on the TV screen in yellow characters (CY) at row 5 (RO5) starting at the left hand screen margin.

When commands are sent to the video disc player a finite amount of time is required to service them. Thus, the stop command (*) requires 40 millisecs; the normal play forward (N) takes 200 millisecs to action; and, the teletext command (T) takes 60 millisecs. Most commands take a fixed length of time to execute. However, the length of time that the "GOTO picture number" command (P) takes is completely variable since it will depend upon the number of disc tracks that have to be traversed in going from the current track to the destination target track.

It is important to realise that when a command has been down loaded to the player, a second command must not be sent until the first has been com-

Table 1
Video Disc Command Format

<command> = [<character>] (0 64) <c/r>		
EXAMPLES		
(1)	"*"	– stop playing
(2)	"N"	– normal play in forward direction
(3)	"O"	– play in reverse at normal speed
(4)	"P15000R"	– find picture number 15000
(5)	"T/R05/CY@THIS IS AN APPLE@"	– overlay teletext

pleted. Any additional commands sent to the disc while it is "busy" will be lost. In order to avoid problems associated with the disc's busy state a suitable synchronisation procedure is required. This can be achieved in either of two ways. One of these involves putting a delay loop into the control program thereby halting it for the length of time needed to service any particular command. Alternatively, the computer system can "watch" for feedback information sent to it by the video disc. This can originate either from the player's DTR (Data Terminal Ready) line or its RS-232-C serial output pin.

The simplest way in which the microcomputer can acquire feedback information from the disc is via the player's RS-232-C serial output line. Two examples of situations in which this line is used will be described. First, consider the "GOTO picture number" command illustrated in example 4 of Table 1. When this command is sent to the player it causes the laser read head to move to the specified frame. When the head is positioned at the destination track, the player will send the decimal value 6 back to the computer; it will then display the still picture on the TV monitor. If the player reaches the end of the disc and has not found the required picture it will return an acknowledgement value of 21. The second example of a command that uses the serial communication port for feedback is the "read picture number" command (?). When this control character is sent to the player it will cause the number of the picture that is currently being displayed to be sent back to the computer. In order to ensure that the software in the host computer is ready to receive transmitted data, the player always checks the CTS (Clear To Send) line before starting to transmit.

Software control of the interface between the computer and the video disc is fairly straightforward. Programs may be written in BASIC, MICROTEXT or a special purpose authoring language such as PHILVAS [12]. Essentially, programs written in these languages have to send text strings to the optical disc player over the hardware interface link. This is easily achieved in BASIC by means of PRINT statements. The way in which these are used is discussed in more detail in section 5.

4.3. Video Disc Facilities

Since this paper is concerned only with computer control of the video disc player, the discussion in this section relates only to this mode of operation. This is the most comprehensive control mode since many features (particularly, teletext overlay) cannot be achieved without the computer. The main facilities that can be controlled by the computer are summarised in the table presented in Fig. 3. These may be used to effect the following types of operation:

4.3.1. Random Access

Using either the enter (/) and run (R) commands or the picture command (Pxxxxx) the player can be made to display any of the available pictures on the disc. This is achieved by moving the read head directly to the track containing the required picture.

4.3.2. Freeze Frame

At any time during the display of a series of frames the picture sequence can be stopped. This enables a single picture to be viewed for as long a period as is required. Freeze frame can be achieved either by passing a stop command (*) to the player or by using the player's auto-stop facility (see section 4.3.7. below).

4.3.3. Single Stepping

This useful feature enables the system to step forward (control code L) or backward (control code M) a single frame at a time – thereby enabling each picture in a sequence to be viewed individually.

4.3.4. Slow Motion

This is a useful facility since it enables the speed of presentation of both forward and reverse picture sequences to be reduced to any value from normal (25 frames/second) down to a single frame every 4 seconds. The slow speed change is effected by means of the Sxxx command string; here xxx is a number in the range 2 through 255. Multiplication of this value by 20 gives the time lapse between each new picture. For example, the command U followed by the command string S50 would cause slow motion in the forward direction with 1 second intervals between pictures.

(A) COMMAND CODES

REQUIRED DISC FUNCTION	CONTROL CHARACTER(S)	DECIMAL CODE	TIME TO EXECUTE
Audio Beep	!	33	Depends on beep duration
Stop	*	42	40 ms
Correction	.	46	40 ms
Enter	/	47	40 ms
Digit 0	0	48	40 ms
Digit 1	1	49	40 ms
Digit 2	2	50	40 ms
Digit 3	3	51	40 ms
Digit 4	4	52	40 ms
Digit 5	5	53	40 ms
Digit 6	6	54	40 ms
Digit 7	7	55	40 ms
Digit 8	8	56	40 ms
Digit 9	9	57	40 ms
Pause	:	58	40 ms
Memory	;	59	500 ms
Search Reverse	<	60	40 ms
Auto-Stop	=	61	500 ms
Search Forward	>	62	40 ms
Read Picture Number	?	63	200 ms
Audio I	A1=ON A0=OFF	65	200 ms
Audio II	B1=ON B0=OFF	66	200 ms
Picture Number Display	D1=ON D0=OFF	68	200 ms
Video Mute	E1=ON E0=OFF	69	40 ms
Normal Play Forward	N	78	200 ms
Normal Play Reverse	O	79	200 ms
GOTO Picture Number	Pxxxxx	80	-
Run	R	82	40 ms
Slow Speed Change	Sxxx	83	40 ms
Teletext	Txxxxxx	84	60 ms
Slow Motion Forward	U	85	200 ms
Slow Motion Reverse	V	86	200 ms
Fast Forward	W	87	40 ms
Clear	X	88	40 ms
Repeat	Y	89	40 ms
Plus	Z	90	40 ms

Fig 3 Video Disc Control Commands

4.3.5. Fast Motion

In order to facilitate the quick preview of a section of the disc contents, the fast forward command (W) causes the display speed to be increased to a value that is three times the normal rate.

4.3.6. Search

The search forward (>) and search reverse (<) commands can be used to scan the disc at 70 times the normal playing speed in order to visually locate particular sequences of interest. During the search, every hundredth frame is briefly displayed.

(B) EXAMPLES OF TELETEXT COMMANDS

```
(1) T/HBL
    T/R12/15/CR@WHAT IS THIS CALLED?@

(2) T/HBL
    T/R03/05/CY@THIS BALLET IS BY@CR/05/FL@BIZET@

(3) T/HCL
    T/R04/CY/NB/CR/SB@THIS IS A BALLET@EB/

(4) T/HCL
    T/R08/CY/DH/05/SB@WHO WROTE IT?@EB/

(5) T/HCL
    T/R01/CW/NB/CR/DH/05/SB@THIS IS A BALLET@EB/
    T/HCN
    T/R22/CY/NB/CB/DH/05/SB@CAN YOU NAME IT?@EB/

(6) T/HBL
    T/R06/GY/12@#####k@
    T/R07/GY/12@5@05@j@
    T/R08/GY/12@5@05@j@
    T/R09/GY/12@upppppz@
```

4.3.7. Indexing Operations

Each picture on the disc is labelled with a five digit frame number. This number can be displayed on the top left hand corner of the TV screen by issuing a D1 command; similarly, display of the frame number can be inhibited by means of the inverse command D0. The picture number can be used by a computer program to start, stop and initiate a variety of different facilities. For example, at any time, the computer can find out which frame is being displayed by means of the "read picture number" command (?). Similarly, the three variants of the picture (P) command:

(A) PxxxxxR

(B) PxxxxxS

(C) PxxxxxI

also allow several useful facilities In the first of these, (A), the player finds frame xxxxx and then displays the still picture. The second command, (B), instructs the player to go into still mode when it encounters the specified picture number; an indication of this state of affairs is then sent to the computer (acknowledgement code 6). The final example, (C), is similar to (B) but the player does not stop when the specified frame is displayed.

The player has a built in memory that is able to store two five digit frame numbers; these are referred to as the ordinary memory (M) and the auto-stop memory (AS). Values are entered into these by using the enter (/), memory (;) and auto-stop (=) commands. Values may be erased from these memory locations by means of the clear command (X). When values are stored in these two memory locations some interesting effects can be achieved, for example:

(1) auto stopping, (2) repetition, and, (3) frame skipping.

In the first case, the video player will enter into still mode whenever it encounters the picture number value that is contained in the auto-stop memory. In example (2), whenever the repeat command (Y) is issued, the player will replay the sequence of frames commencing at the number defined by the contents of the M memory and proceeding through to the value contained in the AS memory. Frame skipping (example 3) is achieved by using the plus (+) command in conjunction with the enter command. Thus, the command sequence. "/300+" would cause the player to skip to the frame which is 300 ahead of the value contained in the M store. As we shall see later, these facilities can be used under computer control to achieve a variety of interesting animation effects.

4.3.8. Teletext

One of the most attractive features of the optical disc player is its built-in teletext encoder. This enables static images (text and graphics) to be overlayed onto video images being displayed on the TV screen. The facilities provided by the encoder are invoked by means of the teletext command (T). Teletext may be displayed against either a black video background or against a normal picture. In the latter case, the text itself is contained within a background "box" which may be either black or coloured. When using the teletext command it is possible to use both text (that is, alpha-numeric characters) and graphics (shapes based around a 2 × 3 matrix) as with normal broadcast teletext [13]. The desired graphic characters are produced by transmitting the appropriate ASCII codes within the teletext command (T). The format of this is as follows:

T/<control info>[<display info>!
<control info>](1:N)

The teletext command contains two types of parameter: control codes; and, information that will appear on the TV screen. Control and display information may be freely inter-mixed – subject to the limitation that the overall length of the command is not greater than 64 characters. Control codes are separated from each other by oblique strokes (/) while information that is to be presented on the screen is delimited by @ characters. An example of a simple teletext command was presented in Table 1 (example 4). Some further examples are presented in Fig. 3B.

The teletext command contained in example 1 would cause the string of characters "WHAT IS IT CALLED?" to be overlayed on top of the video pictures. The teletext characters would be coloured red and would be positioned on the screen at row 12 starting 15 spaces in from the left hand margin. Example 2 is similar to example 1 except that two colours (yellow and red) are used for the displayed text; also, the word BIZET would flash on and off. The use of box creation facilities is illustrated in example 3. Here the new background (NB), start-box (SB) and end-box (EB) control codes are used to create a yellow background box upon which is displayed red text. In example 4, the double height code (DH) is used to cause yellow text to be displayed at twice its normal size within a black background box. Similarly, the sequence of instructions shown in example 5 would cause two double height teletext overlay lines to appear. The first would occupy lines 1 and 2 and would contain red letters within a white box; the second would appear at lines 22 and 23 and would contain a yellow box with blue letters. The final example shown in Fig. 4B illustrates the use of some of the teletext graphic codes. When these commands are down-loaded to the video player they would cause a yellow square to appear on the teletext screen; its top left hand corner would be located at column 12 within row 6.

4.3.9. Other Special Effects

In addition to the major facilities outlined above a number of other useful features are available. For example, the audio commands (Ax and Bx, where x = 1 or 0) can be used to control the playback of the individual audio tracks on the disc. Similarly, the audio beep command (!xy) can be used to produce simple sound effects via the loudspeaker contined within the teletext TV. The video mute command (Ex, where x = 1 or 0) can be employed to mute both video and sound simultaneously. This effect can also be achieved using the pause command (:). There are several other useful facilities that can be controlled by the computer – such as activation/deactivation of (a) the manual controls on the front-panel of the player, and, (b) the remote control keypad. Using these facilities software can be constructed that will enable quite sophisticated control of the disc user's interaction environment.

5. Programming Techniques

Programming a video disc is fairly straightforward. Two basic approaches may be used for programming depending upon whether a conventional programming language or a special purpose authoring system is employed [14, 15, 16]. For simple applications the former method is undoubtedly the least expensive approach and so this is described in greater detail than is the latter.

5.1. Using Programming Languages

Both BASIC and MICROTEXT have been used to construct control programs for the video disc system shown in Fig. 2. Because of space limitations only the use of BASIC is described in this paper. When this language is employed for control purposes two approaches to command down-loading are possible:

(a) by means of direct commands typed in through the computer keyboard, and,
(b) via strings that are generated by a stored operational program.

In both cases, string transfer to the disc may be achieved using the PRINT statement. When this is used the string that it transmits must be terminated by the code representing a carraige return character For example, the following command, when typed in directly through the microcomputer's keyboard, would cause the optical disc unit to halt operation·

```
PRINT "*" + CHR$(13)
```

This same command could, of course, be embedded within a BASIC program and would achieve the same effect. Such an approach to software control is illustrated in the following lines of code:

```
10 PRINT "P1500R" + CHR$(13)
20 FOR I = 1 TO 1000
30 K = K
40 NEXT I
50 PRINT "N" + CHR$(13)
```

Execution of these statements would cause the video disc player to move its read head to frame 1500 and then start normal image display from that point. Notice that in this example there is a timing loop which prevents the "N" command (contained in line 50) being sent to the player before it has completed actioning the "P" command that was issued in line 10

An example of a situation where it is necessary to wait for feedback information from the disc is illustrated in the following simple program:

```
100 *FX3, 1
110 *FX8, 7
120 PRINT "ENTER YOUR FRAME
    NUMBER"
130 INPUT N$
140 PRINT "P" + N$ + "R" + CHR$(13)
150 *FX2, 1
160 A = GET
170 IF A = 6 THEN 190
180 GOTO 160
190 *FX2, 0
200 PRINT "N" + CHR$(13)
210 GOTO 120
```

Here, the user is asked to type into the computer the frame number at which image display is to commence. A "P" command is then constructed and sent to the video unit (line 140). The computer then waits for an acknowledgement signal from the player (lines 160, 170 and 180). The GET command causes a value to be input from the RS–423 port and assigned to the variable A. The IF statement checks that a value of 6 is received before it allows the program to issue an "N" command to start the display of images (line 200). Notice the use of the operating system calls (the *FX commands) in lines 100, 110, 150 and 190. Those in lines 100 and 110 are used to configure the RS–423 output port while those in lines 150 and 190 are used to specify the source of input characters for the GET command.

A slightly more advanced application of the basic control operations outlined above is depicted in Fig. 4. This depicts how a BASIC program might be constructed in order to show the same animated sequence over and over again. The user enters the four important control parameters for this mode of operation by means of the simple dialogue shown in Fig. 4A. This permits specification of: (a) the starting frame number of the animated sequence that the user wishes to have displayed, (b) the final frame number in that sequence, (c) the number of times the segment is to be repeated, and (d) the time interval that is to be observed between successive repeat showings. Once this information has been entered, computer control of the video disc can commence.

The read head is first positioned at the starting track by means of the PRINT command in line 130. Before a subsequent command is given, the computer must wait for the disc to send an acknowledgement signal indicating that it has arrived at the required track (line 200). As soon as this is received the display of the animated sequence can commence. The "N" command embedded in line 230 initiates this action. In order to arrange for the computer to be informed when the disc reaches the end of the display sequence another "P" command must be given to the player – this time, one having an "S" suffix. However, before this is issued, a timing loop is entered (line 260) to ensure that the video player is not in a busy state as a result of the previously, transmitted command. As soon as the program passes out of its wait state the computer down-loads a PxxxxxS command (line 280); it then goes into a loop to await an indication (from the

(A) THE USER INTERFACE

TYPICAL VDU DIALOGUE

```
ENTER STARTING FRAME NUMBER: 12000

ENTER LAST FRAME NUMBER: 12500

ENTER NUMBER OF REPEATS: 10

ENTER INTERVAL BETWEEN REPEATS (SECS): 55
```

(B) PROGRAM CODE

```
10  REM - REPEAT SHOWINGS WITH TIME DELAY
20  *FX5,2
30  *FX8,7
40  *FX3,1
45  PRINT "T/HBL"+CHR$(13)
50  INPUT "STARTING FRAME NUMBER: ",S$
60  INPUT "FINISHING FRAME NUMBER. ",F$
70  INPUT "NUMBER OF REPEATS",N
80  INPUT "TIME DELAY BETWEEN REPEATS. ",T
90  REM BUILD VIDEO DISC COMMANDS
100 SF$="P"+S$+"R"+CHR$(13)
110 LF$="P"+F$+"S"+CHR$(13)
115 K=0
120 IF K=N THEN 390
125 REM  SEND START COMMAND TO VIDEO DISC
130 PRINT SF$
140 REM - WAIT FOR ACKNOWLEDGEMENT FROM VIDEO DISC
150 REM - SELECT RS423 PORT FOR INPUT
160 *FX2,1
170 PEM - SELECT INPUT BAUD RATE
180 *FX7,7
190 X=GET
200 IF X=6 THEN GOTO 220
210 GOTO 190
220 REM - START VIDEO DISC PLAYING
230 PRINT "N"+CHR$(13)
240 REM - DELAY FOR 45 MILLISECS
250 J=TIME
260 IF TIME<J+45 THEN 260
265 PRINT "E0"+CHR$(13)
270 REM SEND LAST FRAME NUMBER TO VIDEO DISC
280 PRINT LF$
290 REM - WAIT FOR ACKNOWLEDGEMENT FROM VIDEO DISC
300 *FX2,1
310 IF GET=6 THEN 330
320 GOTO 310
330 *FX2,0
335 IF K=N-1 THEN 370
338 PRINT "E1"+CHR$(13)
340 PRINT "T/HBL"+CHR$(13)
345 PRINT "T/R10/CY/NB/CR/SB/DH@INTERVAL@EB/"+CHR$(13)
350 J=TIME
360 IF TIME<J+100*T THEN 360
370 K=K+1
372 PRINT "T/HBL"+CHR$(13)
380 IF K<N THEN GOTO 120
390 PRINT "T/HBL"+CHR$(13)
400 PRINT "T/R10/10/CW/NB/CB/DH/02/SB@END@02/EB"+CHR$(13)
```

Fig 4 Software Control of the Video Disc

video unit) of the fact that the last frame in the sequence has been shown (lines 310 and 320). When this loop terminates a counter is incremented (line 370) and then tested (in line 380) to see if the overall control sequence is complete. If the animated sequence has not been shown the required number of times then a timing loop is used (line 360) to halt execution of the computer program for the delay period specified in the initial user dialogue (see figure 4A). Notice how the teletext commands in lines 345 and 400 are used to create overlays that are superimposed on top of the video images.

5.2. Using Authoring Systems

Discs intended for use in a turn-key computer-based interactive video environment require substantial planning and testing. Indeed, disc authoring involves a number of quite complex tasks: (1) preparation of the pictorial information, (2) preparation of the supporting sound tracks, (3) production of computer software for programme control, (4) creation of special effects - for example, sound and teletext overlays, and, (5) coordinating and testing the results of integrating each of the communication media. In order to achieve these objectives in a facile way, conventional computer programming languages (such as BASIC) are quite inadequate - particularly, for users who are not technically orientated. This point can easily be seen by analysing and nature of the teletext commands presented in Fig. 3B. Quite complex instructions are needed in order to produce what are, in principle, very simple screen effects. Because of the need to provide a friendlier easier to use programming interface for this type of system a number of special purpose languages are being developed. They are called authoring languages [12, 14, 15, 16]. Their design embraces two important objectives. First, removal of the technical complexity associated with using the kind of sophisticated interaction environments provided by interactive video disc systems (see Fig. 2). Second, the provision of linguistic primitives that provide the dialogue designer with an easy way of (1) soliciting user input, (2) analysing this input, and subsequently, (3) making the video system react in an appropriate way. Authoring languages for simple CAI and CAL applications have been available for some time. However, the new facilities provided by video disc technology have shown up many of their inadequacies and limitations. Much current research and development in this area is therefore orientated towards the addition of facilities that will enable them to incorporate techniques for handling interactive video disc.

A number of video disc authoring systems are now starting to become available commercially. One example is the PHILVAS system [12]. PHILVAS is an acronym for *PH*ilips *I*nteractive *L*aser *V*ision *A*uthoring *S*ystem. This interactive software package has been specially designed to simplify the tasks associated with preparing programs to control the operation of interactive video disc equipment of the type illustrated previously in Fig. 2. Embedded within PHILVAS is an author language called ALLVA (an acronym for *A*uthor *L*anguage for *L*aser *V*ision *A*pplications). This provides an easy to use method of preparing control programs for the video disc. A typical example of a simple program written in ALLVA is shown below:

```
12000  PLAY
       SWITCH ON VIDEO, REMOTE
       ERASE TEXT
13000  TEXT FRAME1
14000  SOUND BEEP
15000  ENDPLAY
```

These statements would cause the video player to retrieve picture number 12000 and start showing animation (in a forward direction at normal speed) commencing at that frame. The video and remote control keypad are then switched on and any text on the TV screen is erased. When picture number 13000 is encountered the overlay text fragment called FRAME1 is retrieved and then superimposed over whatever is on the TV screen. It is assumed that FRAME1 has been previously created and formatted using the teletext editing subsystem that PHILVAS provides. Animation continues and when picture number 14000 is reached a tone is sounded. Finally, animation ceases as soon as frame 15000 has been shown.

Although their use is as yet not widespread, it is easy to see the potential utility of authoring systems similar to that described above. Undoubtedly, they greatly simplify the process of software development. Furthermore, systems of this type provide many other useful facilities that would not normally be available when conventional programming languages are used for software development.

6. Conclusions

The use of video disc systems is growing substantially in a large number of application areas [17, 18, 19, 20, 21]. The increasing demand for this storage medium is undoubtedly due to the wide variety of retrieval and display strategies that it permits when a computer is used as (a) the control element for disc operations, and, (b) the interface between the disc and its users Programming interactive video disc systems is fairly straightforward; many simple control strategies can be implemented using a high level language such as BASIC. However, for more advanced applications (and in situations where users do not have a programming background) the use of a special purpose author language is extremely advantageous

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