SPECIAL PURPOSE APPLICATIONS OF THE OPTICAL VIDEODISC SYSTEM

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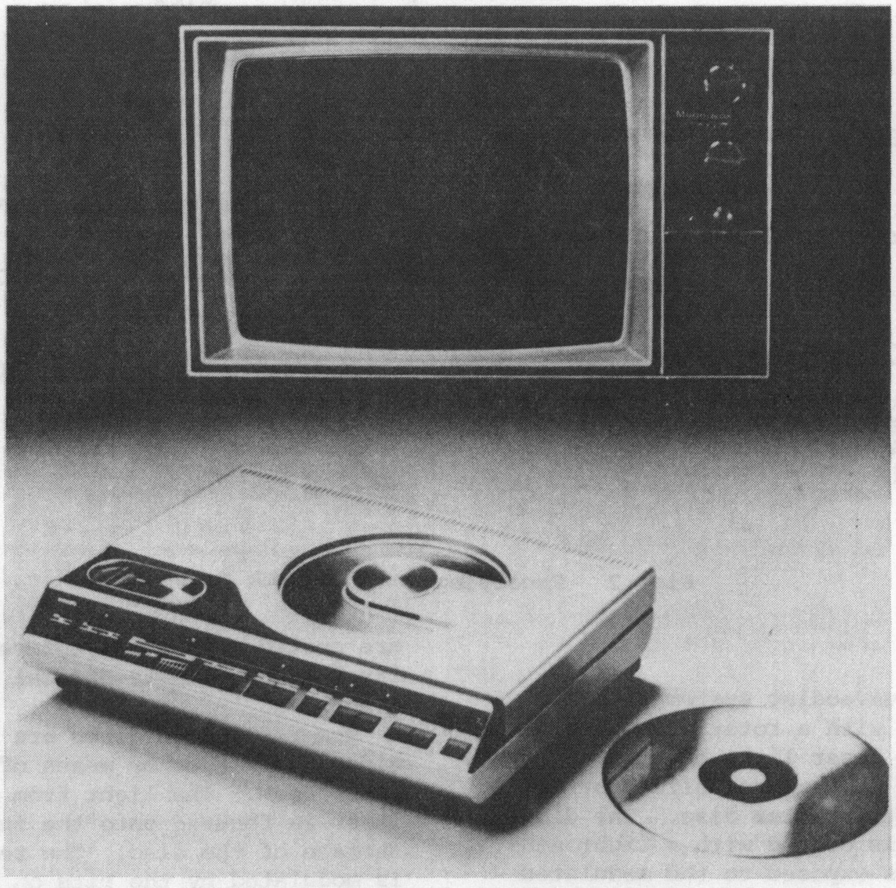

Fig. 1 Consumer Optical Videodisc System.

SUMMARY

The entertainment function of the Philips and MCA Optical Videodisc System (Fig.1) has been established by numerous public demonstrations,[1,2,3,4,5] and various authors,[6,7,8]. The freeze frame and random access capabilities of this optical system enables extremely effective storage of special purpose information. Examples of such special purpose applications employing the Philips consumer player include digital Read-Only-Memories, X-Ray and document storage, and a talking encyclopedia.

Before describing these special purpose applications, a brief description of the optical videodisc system is necessary.

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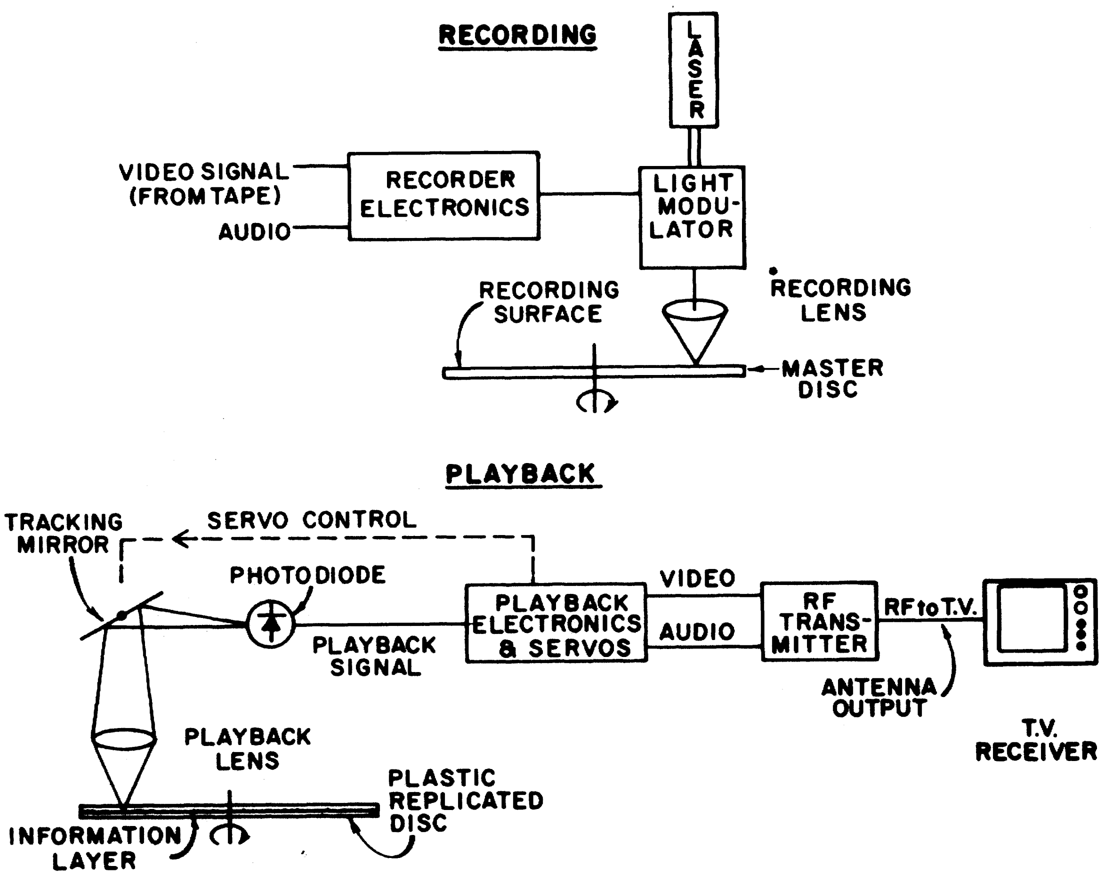

Fig. 2 Recording and Playback process.

INTRODUCTION

The optical videodisc system shown in figure 2 begins with a rotating master disc and a modulated laser light beam. The light beam is focused to a micron size spot on the surface of the master disc. The disc's surface, which is coated with a light sensitive layer, is exposed to the modulated and focused laser beam. The result is a recording of pits in the sensitive layer which maps the light modulation. The light is modulated by an electrical signal composed of video and audio information.

Following a procedure similar to that used to produce audio long play records, a nickel stamper copy is prepared from the master disc. Plastic discs are then replicated from the stamper. The plastic discs are coated with a reflective aluminum layer to facilitate optical readback.

The replicated discs are read on the videodisc player by means of a low-power laser beam. The light from a small HeNe laser is focused onto the information surface of the disc. The reflected light is modulated by the pits on the disc's surface and focused onto a photodiode. The electrical output of the photodiode is a faithful mapping of the pits which are in turn a mapping of the modulated light and the original recorded signal. After appropriate processing, the playback signal is ready for display on a normal television set. One or both of two audio channels can be played through the TV's normal audio system.

Since the disc rotates at 1800 rpm, each rotation represents one full TV frame. The pits form a spiral with 54,000 revolutions called 'tracks'. Through the use of a servo tracking mirror, the focused laser beam can be controlled to follow the spiral tracks to produce moving pictures or to follow one particular track over and over again to produce a still picture. Each frame has a unique digitally encoded address number which can be used for search-and-locate random access operations. The entire surface of 54,000 frames can be scanned and in a few seconds display any pre-selected frame. Since the optical system is contactless, there is no wear of the record or player during playback, thus allowing continuous display of a still frame indefinitely. These unique features of rapid random access and freeze frame display allow other modes than simple linear playback and open up a great potential in many non-entertainment areas.

If the cost, performance, and convenience benefits of the videodisc system are to be transferred to special purpose applications, then one simple rule must be rigidly followed: adherence to the format employed by the consumer record/playback chain (Fig. 3).

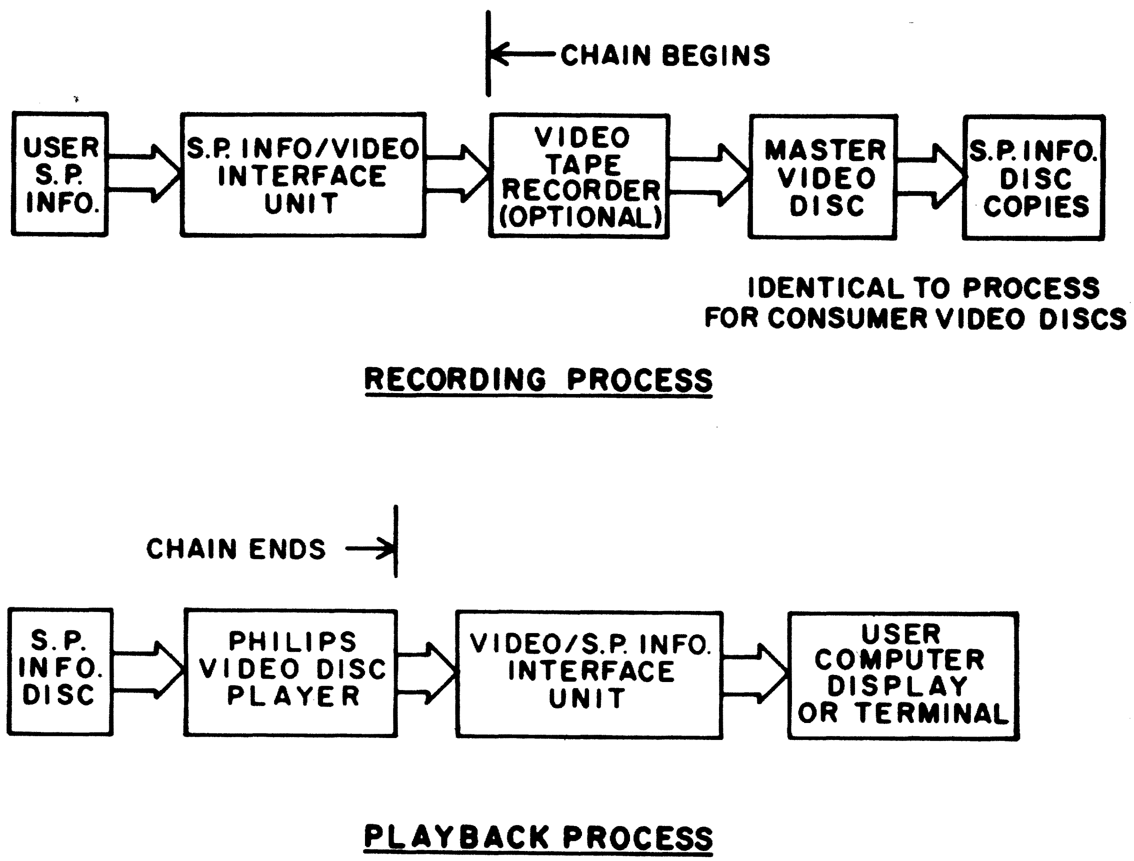

Fig. 3 Technique for storing special purpose (S.P.) information on the videodisc.

This format is intimately tied to the NTSC television standard and may not directly accommodate much of the special purpose information which the user may wish to store. Formatting the information to insure compatibility with the NTSC standard and rearrangement of the information on playback is the most significant technical problem facing the special purpose user. However, once the user's special purpose information has been formatted by an appropriate "info/video interface unit" it is compatible with the NTSC standard. The beginning of the record-playback chain is the video tape recorder which would normally be at the user's site. The recorded tape is then sent to a videodisc manufacturing center such as MCA, Torrance, California, or N.V.Philips in Europe. From the tape, a master disc is recorded, stampers made, and plastic replicas produced. The replica discs and the original tape are returned to the user. The replica discs are playable on the consumer videodisc player, because they do indeed conform to the specified format. The economic benefits of adhering to the format are that MCA[9] will record a master disc and produce a stamper of the special purpose information for under $1000, the same price as for a large-volume entertainment disc. Replicated copies would be supplied by MCA for under $1.00 each. Therefore, the cost of a low-volume run of say 200 discs would cost the user less than $6.00 each. Secondly, the user will be able to read the special purpose disc on a readily available player. Abandoning the TV format with the result that mastering cannot be done on a normal mastering facility and the discs are unplayable on the consumer player, means that the user must be prepared to do his own mastering, replication, and playback.

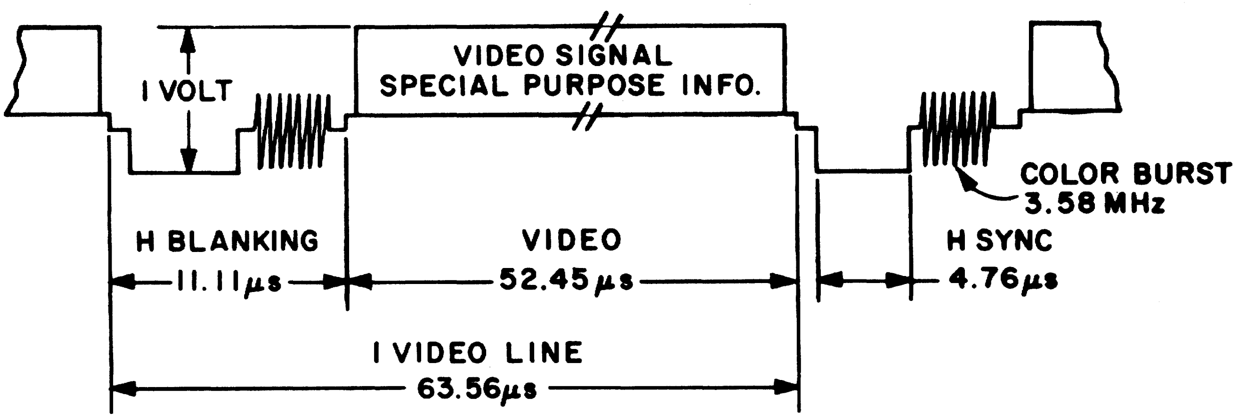

Fig. 4 NTSC color video signal.

Assuming that the reader now is sufficiently impressed with the importance of adherence to the specified format; it is now best to examine the real business at hand - arranging the user's information to be compatible with the NTSC television signal. The waveform in Fig. 4 is that of a standard NTSC color video signal. The picture information is interrupted by synchronization signals every picture line or 63.5 µs. The useful video information is present for only 52.45 µs per line. It is in that time slot that the user can insert his information. The choice of signal format is only limited by the bandwidth (4.2 MHz) of the channel. The recorder interface unit must insert the user's information in a discontinuous manner between the normal television synchronization pulses. If the user's information is continuous, then buffering of 11.11 µs or greater will be required by the interface. The same buffering requirement is needed at playback interfacing and additional features such as error detection and correction, signal conditioning, timing control, and signal routing may be necessary. The extent and complexity of the interface boxes will depend on the user's special needs.

The remainder of the paper discusses three examples of special purpose applications and the specific interfacing techniques required for each case. These examples have not yet been implemented and are only intended to illustrate the general principles of special purpose applications.

COMPUTER INTERFACED DIGITAL READ ONLY MEMORY

The videodisc contains 54,000 tracks of information with each track representing one frame of video. One frame of video contains 495 horizontal lines usable for data. An NRZ data rate of 7.16 Mbits/sec will yield a total of 375 stored bits per line (Fig. 4). The total bits per track may now be calculated as the product of 375 bits per line times 495 lines or 185,625 bits/track. Utilizing all 54,000 tracks yields a total storage capacity of 10^{10} bits per disc.

The choice of a 7.16 M/bits data rate is optimum in view of two fortuitous characteristics of the NTSC television standard and the optical videodisc system. First, the timebase stability and the amplitude and phase response of the system at the video color frequency of 3.58 MHz are excellent, and second, the color burst synchronization signal is suitable for deriving a highly accurate data clock.

The timing errors from line to line are corrected by the videodisc player to less than 10 ns. This effectively eliminates timing variations as a source of errors during playback.

Figure 5 is a diagram example of a video-to-data playback interface unit. The data and synchronization signals are first extracted from the video signal. The raw data is then examined for errors and corrected. The clock is regenerated by phase locking to the NTSC color burst synchronization signal. The data can then be converted from serial to parallel if required and subsequently fed to an output buffer to await loading into a data bus. A logic controller is also included to check the disc's status such as speed, track location, etc.

Access to given data locations is accomplished by providing data address to the interface unit. From this data address, the video disc player is directed to the appropriate track and verifies the track address on the incoming video signal. This random track accessing technique is accomplished by using the digitally recorded track address, a feature on all optical videodiscs.

The read operation of the data from the videodisc can be similar to that of a magnetic disc. Every track of data can be addressed with an appropriate code, and a servo mechanism will move the optical readback head to the appropriate position. A tracking mirror insures that the beam remains centered on the track. With the focusing arm stationary, the tracking mirror allows for the addressing of 100 tracks. Thus, a very fast access time (60 µs per track) results when the addressed track is within the beam deflection range of the

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