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Technical Brief ■

Converting Laserdisc Video to Digital Video: A Demonstration Project Using Brain Animations

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Abstract Interactive laserdiscs are of limited value in large group learning situations due to the expense of establishing multiple workstations. The authors implemented an alternative to laserdisc video by using indexed digital video combined with an expert system. High-quality video was captured from a laserdisc player and combined with waveform audio into an audio-video-interleave (AVI) file format in the Microsoft Video-for-Windows environment (Microsoft Corp., Seattle, WA). With the use of an expert system, a knowledge-based computer program provided random access to these indexed AVI files. The program can be played on any multimedia computer without the need for laserdiscs. This system offers a high level of interactive video without the overhead and cost of a laserdisc player.

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Multimedia-based hardware and software now allow the manipulation of medical images and animations on high-end multimedia personal computers. Laserdiscs are frequently used to distribute multimedia-based teaching programs. Laserdiscs offer considerable advantages over conventional videotapes.^{1,2} Laserdisc is an interactive medium that is widely used in teaching situations to offer insight into complex relationships in neuroscience.¹ There are two general obstacles to wide implementation of laserdisc-based teaching programs: 1) the weak use of interface of

laserdisc players and 2) the added expense involved in providing individual students with laserdiscs and laserdisc players.

We implemented a four-phase plan to change an educational program from laserdisc video to digital video (Table 1).

Table 1 ■

Features of a Four-phase Plan to Change an Educational Program from Laserdisc Video to Digital Video

Operational Requirements					
Phase	Video Monitor	Laserdisc Player	Data-indexing Capability	Video Capture Card	Audio Capability
I	Yes	Yes	No	No	No
II	Yes	Yes	Yes	No	No
III	No	Yes	Yes	Yes	No
IV	No	No	Yes	No	Yes

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Phase I. Objective: To Implement a General-purpose Laserdisc Playback

We purchased a brain-animation laserdisc designed by Sundsten and Kastella.⁴ This laserdisc presents computer-generated 3-D animations of the brain and its major components. These images were generated on a computer graphic workstation. We played the laserdisc back on a Pioneer LD-V4400 laserdisc player (Pioneer Electronic Corp., Yamanashi-Ken, Japan). During video play, the user needed to press the buttons on the front panel of the player to find desired sequences on the laserdisc. This laserdisc playback lacks narration and indexing capability to allow quick access to a specific frame.

Phase II. Objective: To Improve Playback by Adding Indexing Capability

To provide indexing capability, we utilized KnowledgePro for Windows (KPWIN; Knowledge Garden Inc., New York, NY),⁵ a Windows-based expert system shell with hypermedia capabilities. It allows the designer to control the media by calling external dynamic link library (DLL) functions in the Microsoft Windows (Microsoft Corp., Seattle, WA) environment. KPWIN sends media control interface (MCI) command strings⁶ to control all multimedia resource files with tagged file format (RIFF) or external multimedia devices supported by Windows-based device drivers. We designed a control program in KPWIN to play the human brain animation program by connecting the host computer to a videodisc player. We were able to easily display target frames by applying a data-indexing method to the image frame sequence.⁷

Phase III. Objective: To Display Laserdisc Video on the Host Monitor

Displaying brain components on the video monitor by driving a laserdisc player is not a cost-effective solution for large numbers of medical students due to the expense of purchasing and maintaining a large number of laserdisc players. To display animated images on the host monitor simultaneously, we installed an Intel Smart Video Recorder card (Intel Corp., Hillsboro, OR) in a personal computer. This industry standard architecture (ISA)-bus expansion board allowed us to view video images in real time. Indeo video technology offered by Intel improved playback quality. It can be used to capture and compress high-quality quarter-screen full-motion video. A drop-down-style list of menu items on the control panel

conserves the space for screen layout and provides an intuitive user interface.

Phase IV. Objective: To Add Audio Capability to Captured Video and to Remove the Laserdisc Player

To eliminate the need for a laserdisc player to display brain animations, we captured animations from the laserdisc by using Intel Indeo video technology and an Intel Smart Video Recorder (same implementation as Phase III). Captured images were compressed and saved as Microsoft audiovisual (AVI) files in an Indeo video format.* Since an Intel Indeo video device driver is needed to play these AVI files, we recompressed them using SuperMatch Cinepak CODEC video compression technology (Radius, Inc., Sunnyvale, CA). This technology provides a more favorable data compression ratio by downsizing AVI files by up to 60% (depending on the complexity of the original AVI files), as well as provides device-independent playback. We recorded paragraphs of narration and interleaved them with captured video files. At this time, we could remove the video capture card from the host computer. The animation program was played on a Pentium-based personal computer (Gateway 2000, N. Sioux City, SD) equipped with a 24-bit color video adapter, a sound card, and a pair of speakers. A list of the specific objects and associated AVI file names were stored and indexed in the program's knowledge base.

There are five key points we learned from this project:

1. Although every video-compression technology permits the user to recompress already-compressed AVI files, more compression lowers video data rates instead of keeping better video quality.
2. The interleaved audio in the AVI file was not affected by the compression.
3. Multiple video compressions reduce the color quality in the AVI files, especially that of the red-green-blue (RGB) tuning.
4. The recompressed AVI files become less vivid than the original files.
5. We elected to apply compression twice on original AVI files to offer better data rates while retaining good visual characteristics.

*An entire videodisc converted to ISO AVI files.

With the support of KPWIN, our program provided easy access to the powerful University of Washington brain animations without requiring a laserdisc player to avoid possible copyright infringement, the converted files are used only for educational purposes within the Department of Neurology at the University of Illinois. A hypermedia interface provided random access to the brain animations. We were able to convert the animations to AVI format with narration by digitizing the laserdisc video. Conversion to digital video format allowed us to use expert-system methods in the design of the user interface. It also allowed users to display the brain animations on high-end multimedia personal computers without the need for laserdisc players. It took about 300 hours to develop this educational training tool. Most of this time was spent on file capture, conversion, and recompression. A video capture card was the only new hardware used. The total program size, including audiovisual clip files, is about 130 megabytes after color-mapped video compression and necessitates using CD-ROM or other high-capacity storage media to prepare copies for wide distribution.

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