

Indeo™ Video Technology Driver

Introduction To The Indeo Video Driver tc "Introduction To The Indeo Video Driver" \1 1§

This paper discusses how to install the Indeo video driver for use with Microsoft's Video for Windows, how to use the VidCap, VidEdit, and Media Player applications, and describes the Indeo video algorithm compression options.

Microsoft's Video for Windows includes three software applications: VidCap, VidEdit, and Media Player. Within those applications the Indeo video driver supports the following features:

VidCap

- Configuration of real-time compression parameters
- Real-time capture and compression

VidEdit

- Configuration of software compression options
- Hardware-accelerated or software-only playback

Media Player

- Hardware-accelerated or software-only playback

Installing the Indeo Video Driver tc "Installing the Indeo Video Driver" \1 1§

The INDEO.DRV driver is automatically installed with Video for Windows. This driver allows for software-only playback of Indeo Video files and, with the presence of Intel i750™ processor-based hardware, capture and hardware-accelerated playback of Indeo Video files.

Softwaretc "Software" \1 2§-Only Playback

Once Video for Windows is installed the INDEO.DRV driver is enabled for software-only playback of Indeo Video files.

Capture and Hardware-Accelerated Playbacktc "Hardware" \1 2§

Capture and hardware-accelerated playback require the presence of either an ActionMedia^a II board or RT Video^a board, which should first be installed using the documentation and installation disks provided with that hardware. Included on the board installation disks are AVK drivers which enable the INDEO.DRV driver to utilize i750-based hardware to capture Indeo Video files, and play back Indeo files with hardware acceleration.

Updating the AVK Drivers for Use with Indeo Video

The following steps are necessary to install the INDEO.DRV driver:

1. Insert the Video for Windows Drivers diskette.
2. Open the Windows Control Panel.
3. Select **Drivers** from the Control Panel. This dialog box displays the list of drivers currently installed on the system.
4. From this dialog box click the **Add** button. This displays a list of additional drivers that can be added to the system.
5. Select **Unlisted or Updated Driver**, then click **OK**.
6. When prompted, type in the letter of the diskette drive which contains the Video for Windows Drivers disk.

At this point the INDEO.DRV installation program will search the DOS path for the AVK drivers. If an i750-based board and AVK software are present, but Video for Windows does not detect them, one of the following problems may have occurred:

The directory in which the AVK drivers are located was not included in the DOS SET

PATH statement in the AUTOEXEC.BAT file;

The AVK drivers directory was added to the DOS SET PATH statement, but the system has not yet been rebooted and so the AUTOEXEC changes have not yet taken effect.

Once the INDEO.DRV installation program finds the AVK driver software additional files will be added to the AVK directory enabling Video for Windows compatibility. Changes will be made to the SYSTEM.INI and AVK.INI files at this time.

Configuring the Indeo Video Driver for Use with i750-Based Hardwaretc "Additional Hardware Installation Requirements" \ 2§

The following steps are necessary to allow the INDEO.DRV driver to take advantage of the installed i750-based playback hardware:

1. Open the Windows Control Panel.
2. Select **Drivers** from the Control Panel.
3. Select the **Intel Indeo(TM) Driver** option.
4. Click the Setup button. The **Intel Indeo(TM) Video Setup** dialog box will appear.
5. If an i750-based board is properly installed in the system the **Hardware First, Software Next** option should be available and selected. Click **OK**.
6. If the **Hardware First, Software Next** option is unavailable (grayed out), this means that Video for Windows is not detecting the presence of a i750-based board. The previous paragraphs on installing and configuring the Indeo Video driver discuss possible installation problems.

Using the Indeo Video Driver in Video for Windowstc "Using the Indeo Video Driver" \ 1§

VidCaptc "VidCap" \ 2§

The VidCap application, along with an i750-based video capture board, digitizes and compresses video data in real time. The application also digitizes audio data from a .WAV-compatible audio device, and stores interleaved audio/video streams to hard disk in the .AVI file format. The resulting .AVI files can be played back by Media Player and other Windows-compatible multimedia applications.

Follow these steps to capture an Indeo Video file:

1. From Program Manager, open the Video for Windows program group.
2. Run **VidCap**.
3. Select **File** from the VidCap menu.
4. Select **Set Capture File** from the File menu. The Set Capture File dialog box appears.
5. Enter a file name.
6. Click on **OK**.
7. Select **Capture** from the VidCap menu.
8. Select **Video** from the Capture menu.
9. Within the **Capture Video Sequence** dialog box:
 - a. Set **Frame Rate** to **30** to attain full hardware scalability.
 - b. Set **Capture Method** to **Directly to Disk**.
 - c. Select **Capture Time Limit** and enter an amount in seconds. One second of video at a resolution of 160 x 120 averages approximately 60 - 150 KBytes.
 - d. If an audio device is present the **Capture Audio** option will be enabled.
 - e. Click on the **Audio** button.
10. Within the Audio Format dialog box:
 - a. Set **Sample Size** to **8-bit**.
 - b. Set **Channel** to **mono**.
 - c. Set **Sample Rate** to **11 KHz**.
11. Select the **Video** button.
12. Within the Video Format dialog box:
 - a. From the **Image Dimensions** menu select **160 x 120** (the default).

- b. From the **Image Format** menu select **Intel Indeo(TM) Video** (the default).
 - c. Select a **Video Quality** level; the default is 2. Higher quality levels will increase the compressed file size.
 - d. Set the **Key Frame** parameter to **4**, instead of the default of 15.
13. Click **OK** to close the Video Format dialog box
 14. Click **OK** to close the Capture Video Sequence dialog box.
 15. Select **OK To Start Capture** to begin capturing.
 16. The capture process will halt after the Capture Time Limit has expired; the process can also be halted by pressing **Escape**. The size of the captured file will be displayed.
 17. To edit the captured video, select **Edit Captured Video**. This saves the file, then brings up VidEdit so you can edit the file. See instructions for VidEdit in the following section.

Compression Options

Frame Rate

Indeo Video can be captured at any frame rate up to 30 fps, and will be played back at whatever frame rate can be supported by the hardware and software in the playback environment. PC's with hardware using the i750 chipset can support up to 30 fps playback. Currently software-only environments may not support full frame rates during playback.

The three factors which affect software-only playback performance are disk access time, processor speed, and graphics subsystem performance. Disk access time (hard disk or CD-ROM) determines how quickly compressed frames can be loaded into system memory. Processor speed determines how quickly video frames can be decompressed. Graphics subsystem performance determines how quickly the decompressed video frames can be displayed.

All of these factors are critical in determining software-only playback performance - an i486™-equipped system with a low-end VGA card may exhibit performance characteristics similar to an Intel386™-equipped system with a high-end graphics controller.

Although playback performance will vary from system to system, some global approximations can be used as guidelines:

Software-only playback on an Intel386 DX-equipped system will allow a playback rate of around 8 to 15 fps, at a resolution of 160 x 120;

Software-only playback on an average i486-equipped system will allow a playback rate of around 20 to 24 fps, at a resolution of 160 x 120;

Hardware-accelerated playback will allow a playback rate of 30 fps on any Intel386- or i486-equipped system, at any resolution from 160 x 120 to 640 x 480.

A file captured at a frame rate less than 30 fps cannot be played back at a frame rate higher than the capture rate, even with hardware acceleration.

Capture Method

Capturing to disk is recommended since most PCs do not have enough memory to store even a short video clip.

Audio Formats

The settings recommended above - 8-bit resolution, single (mono) channel, and 11 KHz sampling rate - are optional but recommended. This level of audio capture will produce acceptable listening quality with the lowest possible storage requirements. Incrementing the quality of any one of these parameters will double the audio storage requirements.

Image Dimensions

Currently 160 x 120 is the only capture resolution supported. Indeo Video files can be scaled up to 320 x 240 or 640 x 480 on playback, but only i750-based hardware can

maintain 30 fps at these resolutions.

Key Frames and Delta Frames tc "Key Frames and Delta Frames" \l 3§

The Indeo video compressor produces two kinds of frames: key frames and delta frames. A key frame is one frame of an .AVI file which contains a compressed still image representing one video frame. When decompressed a key frame is a Windows Device Independent Bitmap (DIB) that can be displayed as a still image independent of any other video frames.

A delta frame is one frame of an .AVI file which contains compressed data representing only the pixels that have changed from the previous video frame. During playback the Indeo Video decompressor combines this data with the previous displayable video frame to create a DIB containing the next displayable video frame.

Generally, since not much information changes from one video frame to the next, delta frames store information about relatively few pixels compared to key frames, and are therefore on average about 60% smaller. However since delta frames are an approximate representation of information changing over time, visual artifacts caused by cumulative errors will occur if too many delta frames are saved in a row. Therefore, key frames must be inserted periodically to maintain acceptable video quality.

Setting the Key Frames parameter in the Video Format dialog box to 4 or 5 (i.e., one key frame every 4 or 5 frames) will produce acceptable quality in most video sequences, while also maintaining moderate file sizes. When capturing more complicated video sequences, such as those involving high-speed motion or large color and contrast variations, a Key Frames setting of 1 (i.e., every frame is a key frame) is recommended. This will reduce the visual artifacts that are often created in such sequences by inter-frame encoding, but will create larger-than-average file sizes. This is typically the best trade-off for difficult sequences.

Video Quality tc "Video Quality" \l 3§

The Video Format dialog box within VidCap offers four quality settings: Low, Medium, High, or Very High. The quality setting allows for trade-offs between video quality and file size, by varying two compression parameters: Filtering and Vector Quantization.

At this time, using the current algorithm at a resolution of 160 x 120, the final video quality and byte size of a compressed video file will depend mostly on the image content of the video itself, and also the Key Frames setting. Varying the quality settings (Filtering and Vector Quantization) will have comparatively little impact. However as the Indeo Video standard evolves to include higher video resolutions and new algorithms, these settings will play a more important role in determining video quality and file size.

VidEdit tc "VidEdit" \l 2§

The VidEdit application can view existing AVI files, save a copy of some or all of the file, and save files with new properties, including new compression parameters. VidEdit also displays the properties of an AVI file.

Opening an .AVI File in VidEdit

Follow these steps to open a file under VidEdit:

1. From Program Manager, open the Video for Windows program group.
2. Run VidEdit.
3. Select **File** from the VidEdit menu.
4. Select **Open** from the File menu. The Open Video File dialog box will appear.
5. Enter a file name

6. Click on **OK**. The file will now load, and Frame 1 will be displayed.

VidEdit dithers the first displayed frame to the color depth supported by the system's graphics controller. When VidEdit plays the file the Indeo Video driver takes over and either: performs its own software-only dithering for display on the system's graphics controller, or; uses an installed i750-based board for hardware-accelerated 24-bit playback. Therefore the first video frame may be displayed at a slightly lower quality, but when the file begins to play the video display quality will improve.

Configuring VidEdit to Compress Indeo Video Filestc "Configuring the Indeo Video Compressor Within VidEdit" \l 3§

Video capture equipment not equipped with Intel's i750 processor will create .AVI files that contain either uncompressed video or video compressed using an algorithm other than Indeo Video. VidEdit can compress or re-compress such files in the Indeo Video format, allowing video from any capture source to take advantage of Indeo Video's scalability and hardware acceleration features.

Follow these steps to compress a file into the Indeo Video format:

1. From the **Video** menu select **Compression Options**. The Compression Options dialog box will appear.
2. Click on the down arrow under **Video Compression Method**. A list box will be displayed.
3. Select **Intel Indeo(TM) Video**.
4. Click on the Details button to display and adjust file compression settings.
 - a. **Data Rate**: Should be deselected. The Indeo Video compressor does not support readjustment of data rate on compression.
 - b. **Interleave Audio** Interval: Should be set to 1.
 - c. **Key Frame** interval: Should be set to 4 or 5 for most sequences, or set to 1 for difficult sequences.
 - d. **Pad Frame for CD-ROM playback**: Should be selected only if the file will be pressed onto a CD-ROM for playback.
 - e. **Quality** Slider: Is analogous to the Video Quality settings in VidCap discussed above. Here the default is 100, which is equivalent to 0 or High in the Video Format dialog box.
5. Click on the **Preview** button. This will expand the dialog box to include a video window and some useful frame statistics.

As when it first opens the file, VidEdit dithers the first displayed frame to the color depth supported by the system's graphics controller. However, at this point the dithering takes into account the value of the Compression Settings slider.

Below the video window, VidEdit displays the number of the frame currently in the window, the size of the frame once it is decompressed, the size of the frame as compressed video data, and the ratio of these two sizes. The compression factor can be calculated by subtracting the Ratio value from 100 per cent.

Displaying Input File Statisticstc "Learning Input File Parameters" \l 4§

To display useful statistics of the file:

1. From the Video menu, select Statistics... The Statistics dialog box will appear.
2. After viewing these statistics, click the **OK** button to exit.

Information displayed in this dialog box includes estimated file size, file length in frames, file length in time, and frame rate. The file data rate calculation, however, is inaccurate. The true data rate, measured in KBytes per second, can be calculated by multiplying the Video Track Size by the Frame Rate, and then dividing this product by the File Length.

Media Playertc "Media Player" \l 2§

The Media Player application is an audio/video player program that can be used to control any media device for which drivers are written. In the context of Video for Windows, Media Player can play any .AVI format file, including those compressed with Indeo Video.

Follow these steps to select and play an Indeo Video file with Media Player:

1. From Program Manager, select the Video for Windows program group.
2. Run Media Player.
3. From the **File** menu, select **Open**. The Open dialog box will appear.
4. Enter a filename with the .AVI extension.
5. Click the **OK** button.

When the file has been opened, a video window will appear on the desktop. If the system has i750-based hardware installed, the first instance of Media Player will display the Indeo Video hardware-accelerated. Any subsequent instances of Media Player will display Indeo Video files software-only.

Hardware Capture and Compression

Analog video signals are broadcast in either *NTSC* format (American and Japanese standard of 30 fps), or *PAL* format (European standard of 25 fps). Indeo Video technology, combined with i750-based video capture hardware, can digitize and compress an incoming video signal in real time, at up to full broadcast frame rates (i.e., 25 or 30 fps).

To understand the Indeo capture and compression process it helps to first understand the color space used in broadcast video signals. Both broadcast standards represent video using two signal components, *luminance* and *chrominance*. Luminance represents the black-and-white portion of an image, and chrominance represents the color portion of the image.

The two signal components are abbreviated as *Y* (luminance) and *C* (chrominance). The *C* component is also sometimes referred to by the abbreviations for the two color components that make up chrominance, *U* and *V*. So the terms *luminance/chrominance*, *Y/C*, and *YUV*, are all commonly used and mean essentially the same thing.

The reason the luminance/chrominance system is used for broadcast is that the *C* signal can be sent at a lower resolution than the *Y*. This reduction in data storage is possible because the human eye is less sensitive to changes in color data than in brightness data, and the color data can therefore be represented at a lower data resolution without affecting the apparent quality of the video signal.

Some video capture and compression standards utilize the RGB color space, which requires that the red, green, and blue signal components each be stored at full data resolution. Indeo Video compression, however, utilizes the YUV color space to take advantage of chrominance reduction to reduce data storage requirements.

When a video frame is captured by an i750-based video board it is held in memory with the *Y*, *U*, and *V* components separated. Each of the three *image planes* is captured at a resolution of 160 x 120 pixels, with each pixel value stored using eight bits for its *Y*, *U*, and *V* component - i.e., the image is currently in 24-bit YUV format, or YUV24.

The first compression technique used by Indeo Video is *color subsampling*. The Indeo Video compressor subsamples the *U* and *V* image planes down in resolution by a factor of four, from 160 x 120 to 40 x 30. This is done by dividing each plane into regions 4 pixels square, averaging the 16 values in each region, and storing the one averaged value into the new compressed image plane. The resulting image bitmap, consisting of the *Y* plane at 160 x 120 and the *U* and *V* planes each at 40 x 30, is now in the format known as YUV9.

Once the video frame is in YUV9 format it is compressed and stored as either a key frame or a delta frame. A key frame will be stored every *n*th frame, where *n* is the Key Frame period set in the Details section of the VidEdit Compression Options menu. Once a key frame has been stored delta frames will then be stored until the next Key Frame period, with one possible exception: if the compressor attempts to store a delta frame and detects an abnormally large amount of change between the previous frame and the current frame (e.g., a cut to a new scene) then the compressor will automatically store a key frame instead.

Software-Only Compression

The software-only compressor performs exactly the same functions as the hardware-accelerated compressor, but these functions are performed on the host CPU, in non-realtime, on files which have already been digitized and stored to disk in uncompressed format.

The software-only compressor differs in process from the hardware-accelerated compressor in one way. Since most non-i750-based capture hardware digitizes video in RGB format, the software-only compressor must first convert the RGB frames into YUV.

Software-Only Playback

During software-only playback each compressed video frame is first decompressed back into a YUV9 bitmap. Then, since all video display systems are RGB, the Indeo compressor interpolates the YUV9 data and converts to RGB24 data. The video is then displayed at the bit depth supported by the host PC's graphics subsystem. For example, a 256-color graphics card will display the video at 8-bit pixel depth, using the most significant 3 bits of red, 3 bits of green, and 2 bits of blue. A 16-bit card can display the same Indeo file using the most significant 5 bits of red, 6 bits of green, and 5 bits of blue. And a 24-bit card can display the file with no loss of color depth. Indeo Video's ability to adapt to different display environments is one important aspect of scalability.

Hardware-Accelerated Playback

Using i750-based hardware to play back Indeo files offloads all decoding and display tasks from the host CPU. The compressed video frames are read from hard disk into system memory, and then immediately moved into the video memory of the i750 board. There the frames are decompressed, upsampled from YUV9 to YUV24, and displayed by the i750 chipset. As mentioned above all video display systems are RGB, so specialized hardware on the i750 board converts the YUV24 data to RGB24 format for display.