Information Technology
Inside and Outside
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IV. Data Compression

9. Digital Video

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9. Digital Video

- Objectives:
  - the fact that the appearance of motion is formed from a rapid succession of still images;
  - the manner in which compression may be achieved by finding the (generally small) differences between successive still images;
  - the insensitivity of the eye to fine detail in areas of rapid motion;
  - MPEG video coding, which takes advantage of these effects; and
  - the new and evolving world of Digital Television (DTV) which includes High Definition Television (HDTV) as a component.

9.1 Video Compression

- ***Image difference coding*** : transmitting only the changes from one image to the next

9.1.1 Image Difference Coding Virtual Lab

Figure 9.1: Screen image of the image sequence compression applet in action.

9.2 MPEG Video Compression

- **Motion Picture Expert Group (MPEG) → Motion Picture**
- **Application Areas :**
  1. **Digital Movie Editing:** Most movies are put into digital format for editing because of the versatility of computer-based editing systems. Because of the very high image quality of motion pictures, little distortion is tolerated in this application. However, the digital tape recorders that are used provide immense bit rates for image transfer to and from the computer as well as enormous data storage capacity; hence, little compression is needed.
  2. **Digitized Television:** The bit rates that are possible over television transmission systems are fairly high, and users are fairly insensitive to quality owing to the relatively low quality of existing non digital television systems.
  3. **High Definition Television(HDTV):** New Digital Television (DTV) formats have recently become available on the market that will greatly enhance the quality of the picture seen on new TV sets at home. To obtain higher definition images requires significantly higher bit rates and use of less lossy compression technology.

9.2 MPEG Video Compression(2)

- **Application Areas :**
  4. **Video Discs:** A variety of video disc technologies have been created to provide consumers with the ability to purchase video in a form that is easily handled and cheap to manufacture. Here the video quality simply matches that of Digitized Television. However, the compression requirements vary widely according to the storage density of the media being used to hold the data, which include high capacity systems such as the DVD and low capacity systems such as the ordinary CD.
  5. **Internet Video Clips:** Many Web sites today feature small,10 to 60 second, video clips. Because these will usually be viewed in a small portion of a video monitor the quality of the displayed video need not be high. The video usually is displayed only after the full video file has been downloaded; hence, the only impact that compression ultimately has is in the amount of time that a typical user wishes to wait for the download. In general, the compression rates need to be fairly high but the low quality requirement allows this need to be met.

9.2 MPEG Video Compression(3)

- **Application Areas :**
  6. **Video Teleconferencing:** With commerce becoming more global each day, many businesses are resorting to the use of video teleconferencing over telephone and Internet connections as a substitute for travel.Here the quality requirements are about the same as in the case of Internet Video Clips, but the transmission must be made in *real time*. Thus, compression levels must be high enough to move entire frames of the video across the connection before the next frame is ready. To accomplish this feat involves the use of very low bit rate digital video, which implies extremely high levels of lossy video compression.

9.2 MPEG Video Compression(4)

- MPEG Standards:
  1. **MPEG-1:** which was intended for the compression of video for storage on CD media to meet digitized television quality standards. Typically the full frame rate video stream is compressed into a digital data stream employing approximately 40,000 bits per frame, for a total of **1.2 Mbps** on compression of a continuous stream.MPEG-1 is the most common video format in use today on Web pages as the means to encode and transmit video clips. The is also a common selection for the storage of longer video sequences (up to entire movies)on **CD discs.**
  2. **MPEG-2 : is directed at higher quality**, high bit rate applications.With a target bit rate between **4 and 10 Mbps**, MPEG-2 addresses the needs of high definition television and studio editing systems. MPEG-2 is the format used today to encode feature length movies for the **DVD-Video** disc market.
  3. **MPEG-4** : addresses the needs of video Teleconferencing systems that must sacrifice video quality for the need to obtain very low bit rates. The bit rates addressed by this compression scheme **range from 4.8 Kbps to 64 Kbps**, rates that are supported by **telephone connections and many Internet connections**.

9.2 MPEG Video Compression(5)

9.2.1 Some Examples of MPEG Encoded Video

Figure 9.2: Single frame from a **high quality, high bit rate** MPEG-1 encoded video.
Ratio = 2.437MB/5.648MB=0.431

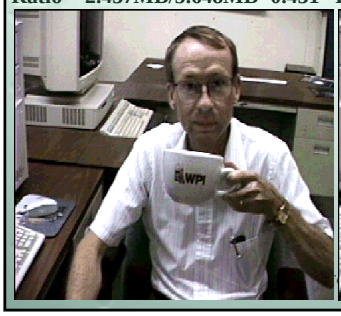
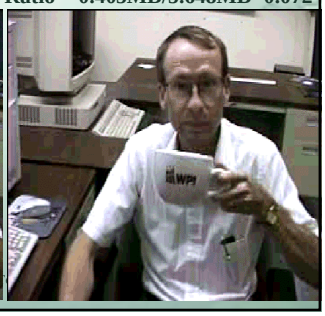


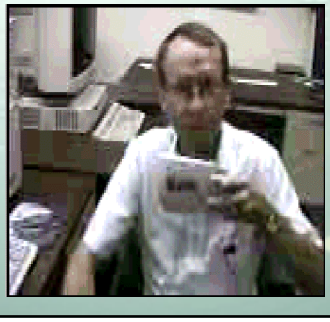
Figure 9.3: Single frame from a **medium quality, medium bit rate** MPEG-1 encoded video.
Ratio = 0.405MB/5.648MB=0.072



9.2 MPEG Video Compression(6)

9.2.1 Some Examples of MPEG Encoded Video

Figure 9.4: Single frame from a **low quality, low bandwidth** MPEG-1 encoded video.
Ratio = 0.145MB/5.648MB=0.026



9.3 Digital Television

- Fully analog (**National Television System committee**, or **NTSC**) transmission system
- **Federal communications Commission (FCC)** to allow the transmission of color pictures.
- On February 17, 1998, the FCC adopted a new **Digital Television (DTV)**
  1. **Higher quality image** on the home television
     ➔ "**High Density TV(HDTV)**"
  2. **Aspect ratio** : The NTSC television video aspect ratio is **4:3(1.33:1)**
     ➔ **1.85:1 ~2.35:1**
  3. **Digital technology** : transmit the higher quality video in the same bandwidth as the original signal
     ➔ the **insensitivity** of digital transmission to many effects that produce ``**snow**'' or ``**ghosts**'' in an NTSC video

9.3 Digital Television(2)

- DTV standard:
  - United States standard **NTSC** video provided the television viewer with an image consisting of **525 lines** (of which 486 are visible on most screens) transmitted in two interlaced parts so that a complete new picture is rendered **30 times a second**: *the frame rate*. (an image with the quality of a **720 x 480 pixel** image)
  - The **new DTV standard** addresses the desire for HDTV by both increasing the frame rate to **60 frames per second** and increasing the full color pixel resolution. It provides an image with **a resolution of 1920 x 1080 pixels** in an **aspect ratio of 16:9 (2.11:1).** Thus DTV provides more than **four times as many pixels** in an image than current technology
  - The new **Advanced Television Systems Committee (ATSC)** standard requires DTV to use the **MPEG-2 compression** scheme and transmission format.