

# Introduction to Multimedia

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What is Multimedia?

# What is Multimedia?



Multimedia is the field that deals with sound, still images, animations, moving images, ... or any other media.



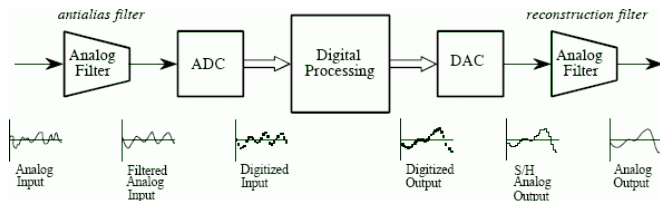
# Usage

- ▶ entertainment  
(video games, digital cinema, music, photography, television)
- ▶ communications (telephony, web sites, social media)
- ▶ content publishing  
(journalism, online repositories, digital preservation)
- ▶ science (hyperspectral imagery, plenoptic representation)
- ▶ cultural heritage digitization
- ▶ medicine (medical image sharing, ultrasound video)
- ▶ education (online courses)
- ▶ video surveillance

## Related fields

- ▶ signal processing (A/D conversion, sampling theorem)
- ▶ audio/speech signal processing (speech compression)
- ▶ image processing (low-pass filtering, deblocking)
- ▶ data compression (every single multimedia format)
- ▶ computer graphics (color models, rendering)
- ▶ computer vision (optical flow, intelligent image search)
- ▶ cryptography (digital rights management)
- ▶ ... and mathematics (vector spaces, Fourier transform)

# Digital Signal Processing (DSP)



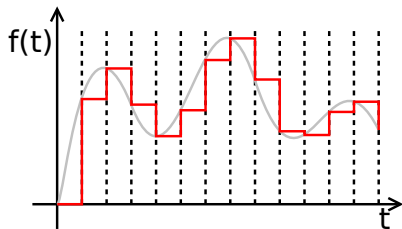
# Sound

What is a sound?

# Sound

## What is a sound?

mechanical vibrations that travel → the air, perceived by human



- ▶ usually represented as digital audio signal
- ▶ humans can hear 20 to 20 000 Hz
- ▶ A/D and D/A converters, Nyquist frequency
- ▶ low-level view: sound cards, sound interfaces, audio samples
- ▶ high-level view: playing MP3, AC3, AAC formats



# Still images

What is an image?

# Still images

## What is an image?

visual perception, perceived by human

- ▶ cameras, displays, video projectors
- ▶ raster image = rectangular grid of pixels
- ▶ pixels, color model, RGB, YUV/YCbCr
- ▶ low-level view: pixel format, chroma subsampling
- ▶ high-level view: displaying PNG, JPEG formats



# Moving images

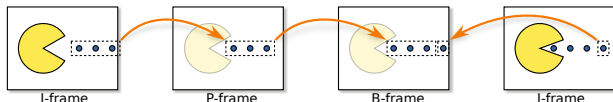
What is a moving image?

# Moving images

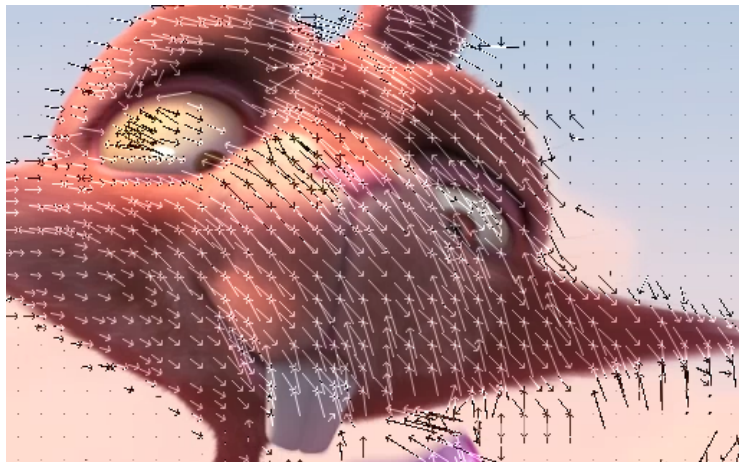
## What is a moving image?

a sequence of images, illusion of continuous movement

- ▶ animation, video
- ▶ video and audio usually stored in multimedia containers
- ▶ multimedia frameworks
- ▶ low-level view: frames, interlacing, framerate, . . . , still images
- ▶ high-level view: playing the MP4 container



## Moving images: Motion vectors



# Compression

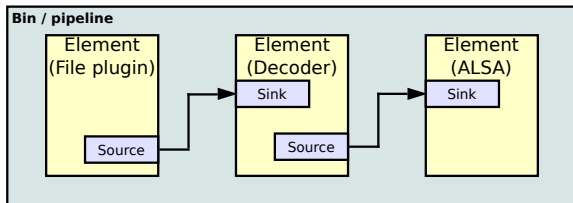
- ▶ one 20Mpx digital photo = ca. 57 MiB
- ▶ one second of 4K video = ca. 1.5 GiB
- ▶ two hours of 4K video = ca. 10.5 TiB
- ▶ lossy vs. lossless compression
- ▶ lossless compression is rarely used (PNG, FLAC)
- ▶ lossy compression is everywhere  
(JPEG, MPEG family, MP3, H.265, DVB-T2, digital cinema)
- ▶ encoding can be slow, usually want to decode in real time
- ▶ often hardware support  
(sound cards, graphics cards, multimedia SIMD instructions)

## Compression: Artifacts



# Interfaces, libraries, frameworks

- ▶ low-level APIs: DirectSound, ALSA, OpenGL, DirectX
- ▶ low-level formats: sampling rate, pixel depth, color model
- ▶ high-level APIs: DirectShow, FFmpeg, game engines
- ▶ high-level formats: containers, audio/video codecs
- ▶ high-level tools use some high-level abstraction





# Lectures

1. Introduction, Compression techniques (February 7)
2. Signal processing (February 14)
3. Filtering (February 21)
4. Image and video compression (February 28)
5. Audio interfaces (March 7)
6. Audio formats (March 14)
7. Image formats (March 21)
8. Video formats (March 28)
9. Multimedia frameworks (April 4)
10. Vulkan interface (April 11)
11. OpenGL interface (April 18)
12. Project defences (April 25)
13. Conclusions (May 2)

# Points

10 pts. midterm test

39 pts. individual project

51 pts. final exam

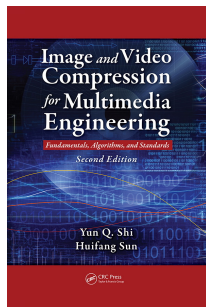
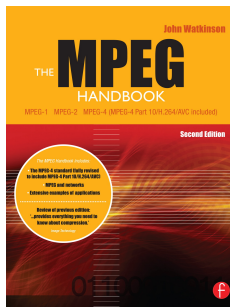
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100 pts. in total

# Projects

- ▶ up to 39 points  $\implies$  really important
- ▶ a computer program, not an essay
- ▶ related to multimedia (audio, images, video)
- ▶ a single student or group of two students
- ▶ own assignments are welcome, mail to [ibarina@fit.vutbr.cz](mailto:ibarina@fit.vutbr.cz)
- ▶ a public defence with five-minute talk
- ▶ the defense will take place at the end of semester
- ▶ examples: photo editor, multimedia player, video effects

# Literature



- ▶ John Watkinson. The MPEG Handbook. CRC Press, 2012. ISBN 978-1-136-02898-6
- ▶ Yun Q. Shi, Huifang Sun. Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards. CRC Press, 1999. ISBN 978-1-4200-4979-8