Task 2.1: play (encoded) audio files

DESCRIBE THE PHYSICAL APPEARANCE OF SOUND AND HOW IT IS CONVERTED TO DIGITAL SAMPLED AUDIO. EXPLAIN HOW SAMPLING WORKS AND THE MEANING OF THE TERMS AMPLITUDE, SAMPLING FREQUENCY, AND QUANTIZATION.

Sound from the physical aspect can be seen as a mechanical deformation travelling like a wave in some media (like gas, air, liquids ...). To convert analog sound to digital audio, sampling of the analog signal has to be done.

A sample is a recording of the signal's frequency and its amplitude (pressure) at a certain time. Nyquist-Shannon's sampling theorem says the sampling rate must be at least twice the highest frequency coming from the input signal.

Quantization (resolution in amplitude) means how many bits are used to store such a sample (e.g. cd audio 44100 kHz/16 bit). Rule of thumb: +1 bit -> +6db better SNR

Task 2.2: generate "thumbnails" from audio files

WHY DO WAV FILES REQUIRE MORE STORAGE SPACE THAN MP3 FILES?
wav is a not compressed audio format, while mp3 is.

IN THE JAVA SOUND API: WHAT IS A SAMPLE, WHAT IS A FRAME?
Sample rate = number of samples / second
Frame Size = Sample Rate * number of channels for PCM
Frame Rate = frames / second.

Task 2.3: extract/get audio metadata

HOW IS VOLUME (I.E., HOW LOUD A SOUND IS) REFLECTED IN ANALOG AND DIGITAL AUDIO SIGNALS? WHY DOES IT MAKE SENSE TO PERFORM NON-UNIFORM QUANTIZATION?
It would be nice if the quantizer had SNR independent from the signal level (% error is constant). We can do this with non-uniform quantization.

WHAT IS PULSE CODE MODULATION (PCM)?
Using PCM an analog signal will be converted to a digital signal (abtastung -> quantisierung -> codierung).

Task 2.5: extract frames from video files

WHAT IS (DE-)MULTIPLEXING? WHAT IS A CODEC?
Videos usually consist of several streams (audio, video, subtitles, …). A multiplexer mixes them together into one coherent data stream, whereas a demultiplexer separates them again. The quality of the data itself is not changed.

Codecs are algorithms that de- or encode ((de)compress) media data. Most media files on the web are already compressed/encoded, and clients can encode (and thus play) them given they have the same codec that has been used for encoding installed. Codecs can be lossy or lossless. [1]

IN WHAT COLOR SPACE ARE IMAGES USUALLY REPRESENTED IN VIDEO FILES? WHAT COLOR SPACE IS USUALLY USED FOR COMPUTER IMAGES?
Videos usually use color formats that separate luminance and chrominance, such as YCbCr. Since the human eye reacts more to luminance, this allows more efficient compression. [2] A popular color space for computer images (according to my experience) is RGB.

Task 2.6: video thumbnail

WHAT IS VIDEO TRANSCODING?
Video transcoding is the process of converting a video to a different format and/or bitrate. [3]

BRIEFLY DESCRIBE AND COMPARE THE VIDEO CODECS WE USED IN THIS ASSIGNMENT.
When converting thumbnails to the AVI format, I used the MPEG4 codec for the video stream. MPEG achieves high compression by storing only the difference between frames. [4]
When checking the provided example videos in the media/videos-Folder, I noticed the codecs used for the video streams were MPEG4, cinepak, indeo video V3 and theora video. Cinepak is a rather old and lossy [5] codec which uses vector quantization [6]. Indeo Video, too, is rather old [8] and uses the Y'CbCr colorspace [7]. Theora Video is an open-source, lossy codec designed to compete with MPEG4, and uses DCT. [9]

HOW DOES CHANGING THE CONFIGURATION OF THE IMAGECOMPARE OBJECT AFFECT THE THUMBNAIL?
There can be no general answer, since all videos react differently to the changing of parameters. Generally, the following trend has been identified by looking at the source code of ImageCompare:
- The higher compareX and compareY, the more blocks are being looked at. It directly influences how often the program loops over the image to extract sub-images. The higher these value are, the longer the program takes to execute.
- The higher factorA, the higher the threshold to accept a difference. A low threshold means small changes in luminance lead to a change (match=false).

This is an excerpt of the Excel file which I used to track the changes:

File Defaults		Effect		ImageCompare Parameters			
File	No. Frames	No. Frames after IC	% of original frames	compareX	compareY	factorA	factorB
dutch.asf	568	54	9.51%	1	1	0	1
dutch.asf	568	21	3.70%	1	1	1	1
dutch.asf	568	26	4.58%	2	2	2	2
dutch.asf	568	46	8.10%	5	5	5	5
dutch.asf	568	43	7.57%	10	10	10	10
dutch.asf	568	4	0.70%	20	20	20	20
dutch.asf	568	2	0.35%	50	50	50	50
dutch.asf	568	176	30.99%	10	5	5	10
dutch.asf	568	128	22.54%	5	5	10	10
dutch.asf	568	163	28.70%	8	6	5	10
dutch.asf	568	42	7.39%	6	6	20	10
DREIZEHN.AVI	644	38	5.90%	1	1	1	1
DREIZEHN.AVI	644	76	11.80%	5	5	5	5
DREIZEHN.AVI	644	83	12.89%	10	10	10	10
DREIZEHN.AVI	644	2	0.31%	50	50	50	50
DREIZEHN.AVI	644	68	10.56%	6	6	20	10

Sources
[1] https://www.microsoft.com/windows/windowsmedia/howto/articles/codecs.aspx
[2] http://www.equasys.de/colorformat.html
[3] https://wiki.videolan.org/Transcode
[4] http://www.webopedia.com/TERM/M/MPEG.html
[5] https://en.wikipedia.org/wiki/Cinepak
[6] http://multimedia.cx/mirror/cinepak.txt
[7] https://en.wikipedia.org/wiki/Indeo
[8] http://www.free-codecs.com/download/indeo_codec.htm
[9] http://theora.org/faq and http://theora.org/doc/Theora.pdf