21M.380 Music and Technology
Sound Design

Lecture №10
Digital audio theory

Monday, March 7, 2016

1 Announcement: QZ1 (next Mon)

1.1 Quiz contents

- Physics of sound (Farnell 2010, chs. 3–5)
- Perception of sound (ibid., ch. 6)
- Digital audio (ibid., ch. 7)
- Pd basics (ibid., chs.9–14)

1.2 Example questions

- Will be provided to aid your preparation

2 Announcement: Recording/editing workshop

- Please bring laptops and headphones on Thursday
- Please install Audacity before class (see syllabus for details)

3 Digital audio

3.1 Overview

- Why digital audio?
- Digital reproduction chain
- Magic numbers in digital audio and what they mean
- A/D conversion is a 2-stage process with interchangeable steps, usually in the following order:
  1. Sampling (at given sample rate)
  2. Quantization (at given bit depth)

3.2 Discussion: digital 'sound quality'

Poll: True or false? Discuss in groups of 2 or 3 (3 min)

1. A higher sample rate results in a higher dynamic range.
2. Sampling results in a loss of information.
3. Choosing the bit depth too low means that high frequencies cannot be accurately reproduced.
4. Choosing the sample rate too low means that high frequencies cannot be accurately reproduced.

3.3 Sampling

- A lossless process in itself
- Typical values for sample rate: 44.1 kHz, 48 kHz, 96 kHz
- Sampling theorem
- Nyquist frequency
- Violation of samping theorem results in aliasing

3.4 Quantization

- Always lossy
- Bit depth N allows to express 2^N different amplitude values
- N determines dynamic range $\Delta L \approx 6 \cdot N$
- Typical values for N: 16, 20, 24, 32

References and further reading

Farnell, Andy (2010). *Designing Sound*. Cambridge, MA and London: MIT Press. 688 pp. ISBN: 978-0-262-01441-0. MIT LIBRARY: 001782567. Hardcopy and electronic resource.

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Spring 2016