21M.380 · Music and Technology
Recording Techniques & Audio Production

Stereo recording techniques

Session 9 · Wednesday, October 5, 2016

1 Student presentations (PA1)

- [redacted]

2 Review: EQs

Exercise in attached handout:

- Given are the settings of a parametric EQ on a mixer
- What does the resulting frequency response look like?

3 What is stereo?

3.1 Loudspeaker stereophony

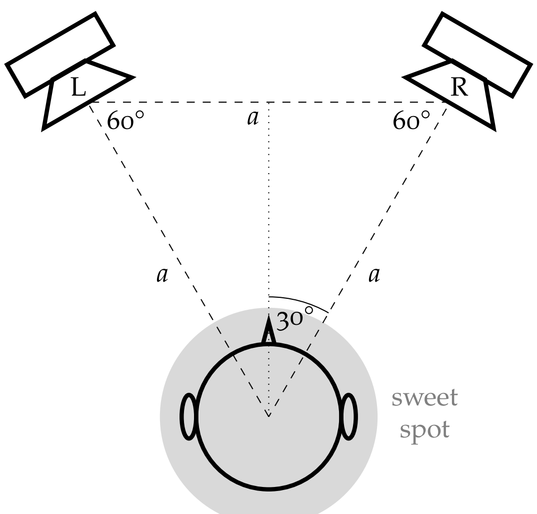

Figure 1. Standard stereo loudspeaker setup

- Standard stereo setup: Equilateral triangle between 2 loudspeakers and listener in *sweet spot*
- Tweeter of a nearfield monitor loudspeaker usually aligned with listener's ears (even if that means flipping the speaker upside down)
- Ear decodes *interchannel level* (ΔL) *and time differences* Δt (correspond loosely to *interaural differences*; cf., Mon, 9/19 lecture)

3.2 Stereophonic recording techniques

	Coincident	Mixed	Spaced	Binaural
Loudspeaker compatible?	✔	✔	✔	✘
Mono compatibility	☺	😐	☹	☹
Spaciousness	☹	😐	☺	☺
Depth	☺	😐	☹	☺
Localization	☺	😐	☹	☺
Omnis an option?	✘	✘	✔	✔

Table 1. Families of stereophonic recording techniques (cf., Schoeps 2004)

4 families of stereophonic recording techniques, characterized by:

- Angle β and/or distance d between (usually 2) microphones
- Presence or absence of a solid body between the microphones

4 Coincident stereophony

- $\beta > 0$, $d = 0$: 2 angled mics in 'same' location (vertically stacked)
- Captures interchannel level (but not time) differences
- Mics *must* be directional (otherwise you just record same signal twice)
- Stereo width adjustment through panpot is possible ☺

4.1 XY

- 2 coincident (potentially hyper-/super-) cardioids pointing ±45°
- Some engineers prefer wider microphone base angle $\beta > 90°$

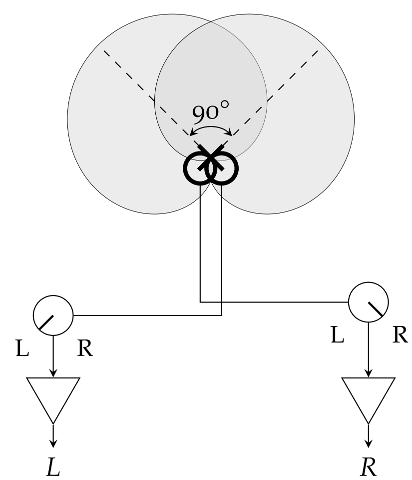

Figure 2. XY stereo recording

4.2 Blumlein pair

- 2 coincident fig-8s pointing ±45° (same as XY, except fig-8s)
- More reverbant sound than XY (due to pickup from rear)

4.3 Mid/side (M/S)

- 2 coincident mics:
  - Mid-channel M: Omni (or cardioid) facing source at 0°
  - Side-channel S: Fig-8 pointing *sideways* (+90° or −90°)
- Mic signals M, S first *need to be decoded* to loudspeaker signals L, R!

$$L = \frac{M + \overset{\leftarrow}{S}}{2}$$

$$R = \frac{M - \overset{\leftarrow}{S}}{2}$$

Equation 1. M/S decoder

- Sign in decoding equations depends on $\pm$ orientation of fig-8!
  - $\overleftarrow{S}$ … positive fig-8 polarity left
  - $\vec{S}$ … positive fig-8 polarity right
- M/S allows post-recording adjustments of stereo image width ☺
  - S signal effectively encodes *differences* between left and right
  - Higher S/M ratio gives wider stereo image
- Reaper demo:
  1. Insert › Media file… M/S example recording from LMOD
  2. Add plugin to track: FX › JS › JS: Mid/Side Decoder
  3. Lower `Center level (dB)` to increase S/M ratio
- Reaper demo: Plugin-free DIY M/S decoder

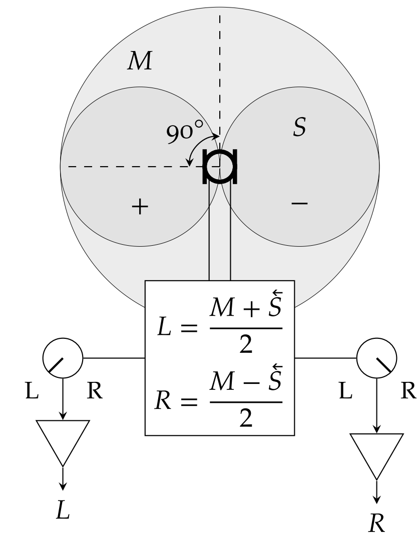

Figure 3. M/S stereo recording

5 Spaced stereophony

- $\beta = 0$, $d > 0$: 2 mics placed at some distance from each other
- Omnis are an option ☺: $d > 0$ yields interchannel time differences Δt
- But $p \propto \frac{1}{r}$, so level differences ΔL are also captured (even with omnis)
- Hard L/R panning only (don't mix out-of-phase signals on panpot!)

5.1 AB

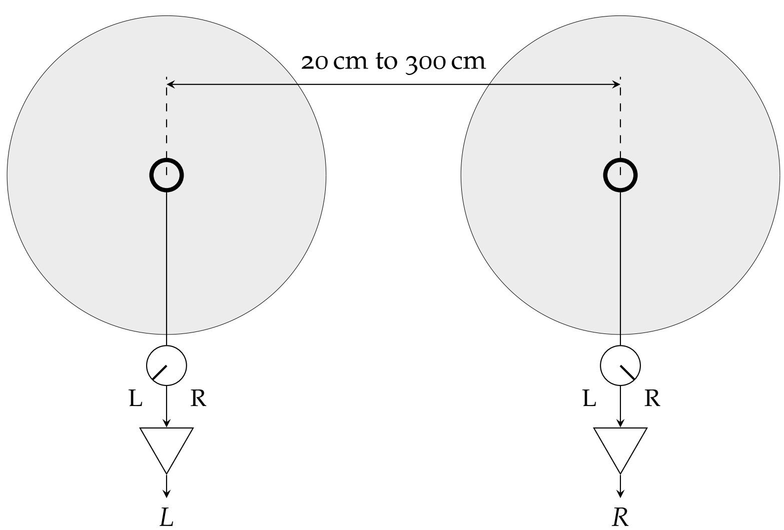

Figure 4. AB stereo recording

- 2 spaced omnis
- Distance d varies to taste (say, 20 cm to 300 cm)
- Danger of *hole in the center* for $d \gg$ ☹

5.2 Faulkner pair

- Two forward-pointing fig-8s at $d = 20\,\text{cm}$

5.3 Decca tree

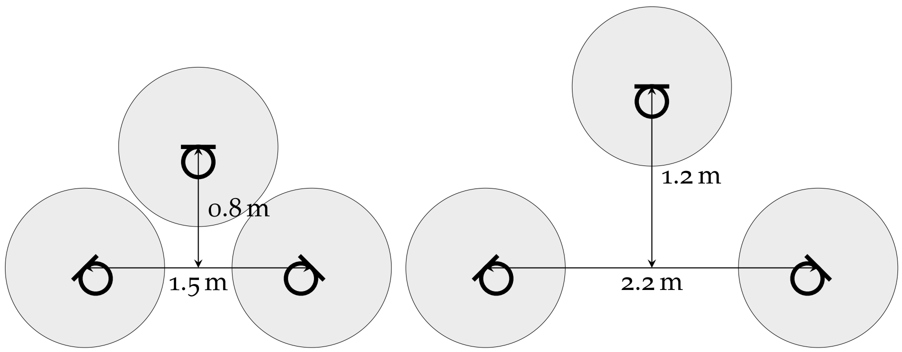

Figure 5. Two Decca trees of different dimensions (after Sengpiel 1994)

- Characteristic: Uses 3 mics, not 2
- 3 omnis in triangular configuration, with center mic brought forward
- L and R mics angled outwards (even though they are omnis!)
- Dimensions vary (cf., figure 5)

6 Mixed stereophony

- $\beta > 0$, $d > 0$: 2 angled *and* spaced directional mics
- Captures interchannel level and time differences
- Compromise between advantages of coincident and spaced techniques
- Hard L/R panning only (don't mix out-of-phase signals on panpot!)

6.1 ORTF

- 2 cardiods at $\beta = 110°$ and $d = 17\,\text{cm}$
- Only mixed technique whose geometry you should remember

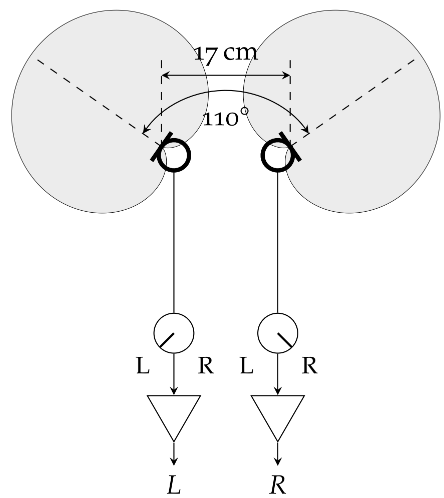

Figure 6. ORTF stereo recording

6.2 Other mixed stereophonic techniques

- Other dual-cardioid configurations exist (cf., table 2)
- Used by and named after different European broadcasting corporations
- No need to learn mixed geometries other than ORTF by heart

Table 2. Mixed stereophonic recording techniques (all using two cardioids)

Technique	$\beta/°$	d/cm
ORTF	110	17
NOS	90	30
EBS	90	25
RAI	100	21
DIN	90	20
Olson	135	20

7 Aural comparison: XY, AB, ORTF, Decca tree

- Same performance recorded by XY, AB, ORTF & Decca tree
- Sound examples (unfortunately no longer online) by Danish Pro Audio
- Let's gather groups of 3 in the classroom's sweet spot

8 Binaural stereophony

- $\beta = 0$, $d > 0$: 2 mics (often omnis) separated by solid object
- Captures interchannel time, level, *and spectral* differences (due to reflections from solid object, which mimicks human head)
- Excellent (3D!) localization when played back on headphones
- Loudspeaker playback: undesirable filtering effects (doubled HRTF)
- Hard L/R panning only (don't mix out-of-phase signals on panpot!)

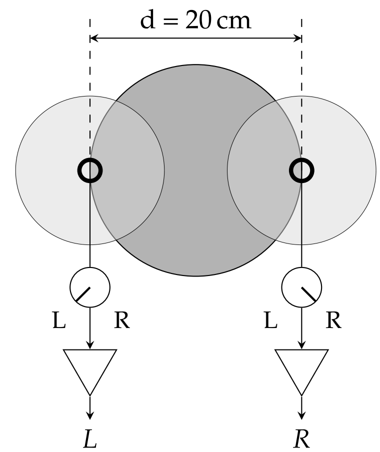

Figure 7. Schoeps KFM 6 geometry

8.1 Dummy head

- 2 mics (often omnis) in ears of a fake human head

8.2 Schoeps KFM 6

- Kfm … *Kugelflächenmikrofon* (spherical surface microphone)
- 2 omnis embedded into surface of a solid sphere of $d = 20\,\text{cm}$

8.3 Oss (Jecklin disk)

- Oss … optimum stereo signal
- 2 omnis separated by sound-absorbing disk
- Invented by Jürg Jecklin (Swiss broadcasting engineer)
- Originally proposed dimensions later revised

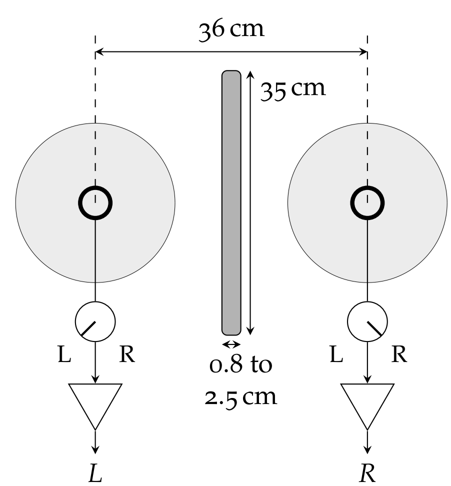

Figure 8. Revised oss dimensions by Jürg Jecklin

9 Recording angle

Every stereo microphone (β, d) has an (invisible) recording angle α.

- $\alpha \neq \beta$ (not the same as visible microphone base angle!)
- Can be compared to utility angle of a torch (invisible if torch is off)

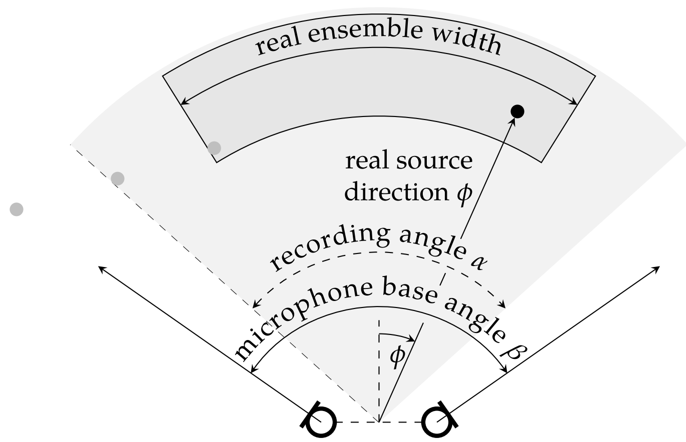

Figure 9. Stereo recording

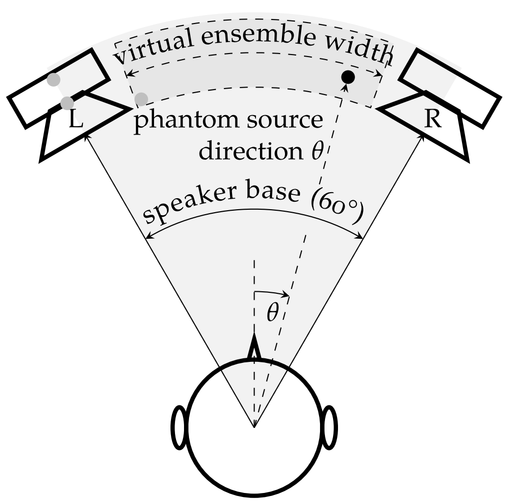

Figure 10. Stereo playback

9.1 Interpretation of the recording angle

Knowledge of α allows to predict how a real sound source at direction ϕ will translate to a *phantom source* from perceived direction θ :

- $|\phi| < \frac{\alpha}{2} \rightarrow |\theta| < \frac{60°}{2}$ (within recording angle → between loudspeakers)
- $|\phi| \geq \frac{\alpha}{2} \rightarrow \theta = \pm\frac{60°}{2}$ (beyond recording angle → from 1 speaker only)

9.2 Determining the recording angle

How to determine recording angle α of a given stereo configuration (β, d)?

1. Derive interchannel time difference Δt for real source at ϕ from
   - Geometry
   - Speed of sound c
2. Derive interchannel level difference ΔL for real source at ϕ from
   - Geometry
   - Inverse distance law $p \propto \frac{1}{r}$
   - Microphone directivity $A = A_p + A_{\nabla p} \cdot \cos\phi$ (cf., Wed, 9/14 lecture)
3. Conduct listening tests to determine how combination of ΔL, Δt translates to perceived phantom source direction θ
4. Generalize to recording angle α as a function of microphone distance d and microphone base angle β (*Williams curves*; cf., Williams 1987)

References & further reading

Eargle, John (2004). "Classical stereo recording techniques and practice." In: *The Microphone Book*. 2nd ed. Focal Press. Chap. 13, pp. 194–216. ISBN: 978-0240519616. MIT LIBRARY: 002015037.

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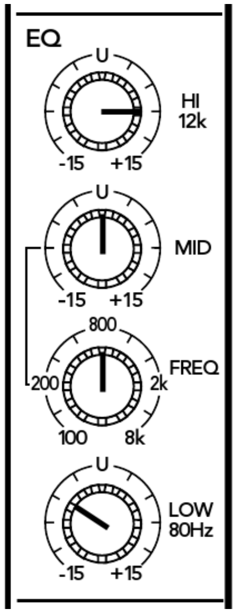
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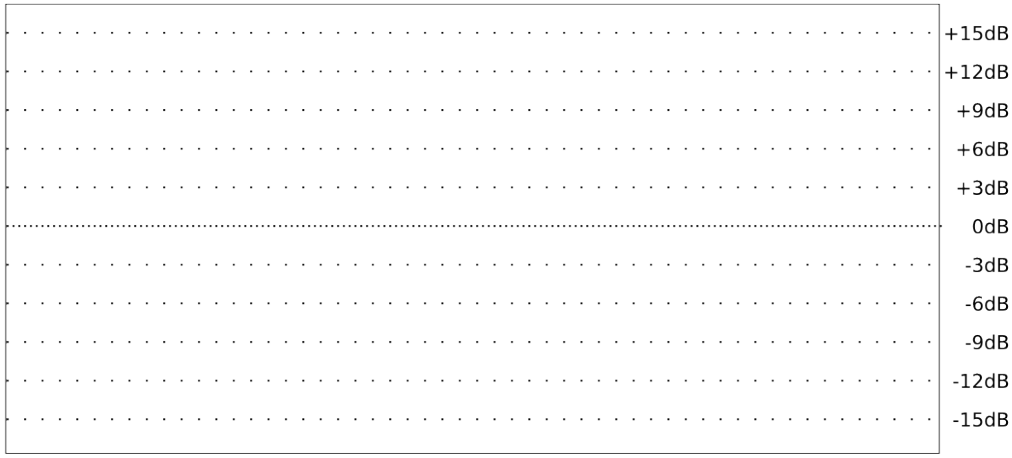
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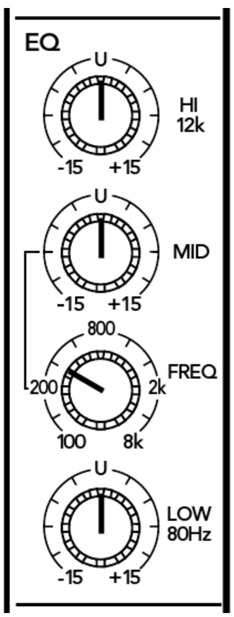
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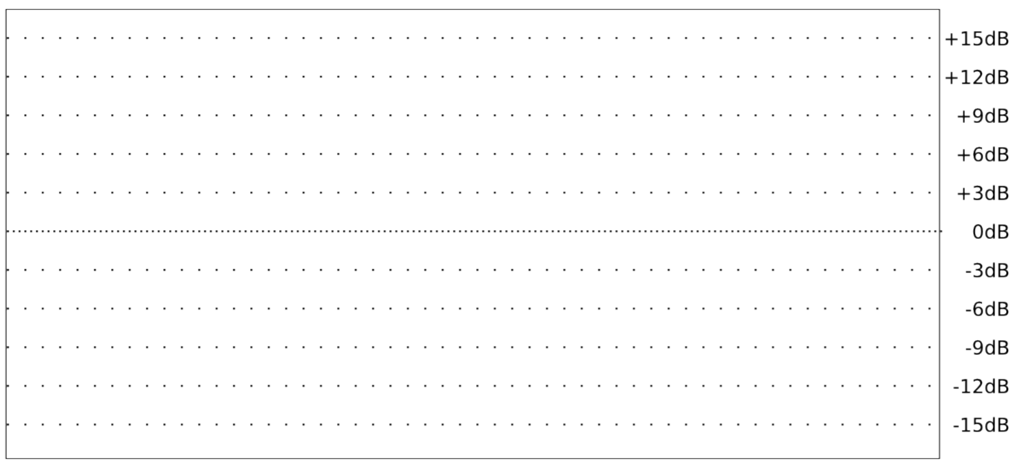
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