RAZR tutorial

Get started

If you haven't done yet, read the **README**. Start MATLAB and change the working directory to the tutorial root directory. Then, run **tutorial_addpath** to add all required paths. Please store your own scripts later in the folder **user_files**.

Becoming familiar with RAZR

1 A basic example

A good start to become familiar with RAZR is to look at the provided example scripts. You'll find them in the folder **razr/examples**.

- Start with **example_default.m**. Go through the script and run it.
- Have also a look at the room definition **get_room_L**. In the example script, try also **get_room_A** instead of **get_room_L**.
- Have a look into **example_options.m** to see how to use options in RAZR. Look into **get_default_options.m** if you'd like to see all available options and their descriptions. In addition, **sop** is a search function for options. See **help sop** for usage.

2 Design and simulate your own room

- Estimate the dimensions of the room you are currently in. If it is not rectangular, choose a suitable approximation. Choose suitable wall materials. A list of available materials can be found in **base/abscoeff/get_abscoeff_hall.m**. The search tool **smat** works similar as **sop** and might also be convenient. During the design process, you can always visualize the room using **scene** as demonstrated in the examples.
- Synthesize a binaural room impulse response (BRIR) for your defined room. Set the option **op.return_rir_parts = true** to obtain the early and late reflections as separate signals.
- Have a look at **example_hrtf.m** for demonstration how to use head-related transfer functions (HRTFs) for spatial rendering. Use HRTFs when simulating your room. If you'd like to test other spatial rendering methods, use the option **op.spat_mode**. Available modes are: **'hrtf'**, **'ild'** (broadband interaural level differences), **'diotic'**, **'shm'** (spherical head model simulating the effects of HRTFs; it's the default setting).

3 Analyze the synthesized BRIR

- Have a look at **`example_analysis.m`** for demonstration of some BRIR analysis tools.
- Use the tools from **`example_analysis.m`** to analyze the BRIR of your room (**`plot_ir, plot_irspec, schroeder_rt, soundir, apply_rir`**). Since you have set **`op.return_rir_parts = true`**, you can plot the early and late reflections separately using **`plot_ir(ir, 'del')`**. This works also with **`plot_irspec`** but with a slightly different syntax (see **`help plot_irspec`**).
- Calculate the estimated reverberation time (RT) of the room using **`estimate_rt`** and compare it with the RT calculated from the actual BRIR (**`schroeder_rt`**).

4 Vary room properties

- Save your room for later purposes and create a copy of it.
- Vary the source and receiver positions and listen to the differences. Vary other room parameters and listen to the results. How does, e.g., the perceived speech intelligibility change for different room sizes, wall absorptions, source-receiver distances, or distances of the receiver to a wall? You can also simulate more than one sound source. See **`example_multiple_src.m`** for details.

Advanced exercises (choose the ones you like)

5 Simulate a room based on a measured BRIR

Write a script that takes a measured BRIR and synthesizes it.

- Load a measured BRIR of your choice from the folder **`material/measured_brirs`**. Load the according room from **`material/rooms`**. These rooms are not complete: the wall materials are missing.
- Calculate the reverberation time (RT) using **`schroeder_rt`**. Use octave-band center frequencies from 250 Hz to 8 kHz. Using the option for Lundeby noise floor truncation is not required since the noise floors have already been removed from the measured BRIRs.
- From the RT, calculate the mean wall absorption coefficient using **`estimate_abscoeff`**.
- Add the calculated absorption coefficient and the used frequency base to the room structure. Use the fieldnames **`materials`** and **`freq`**, respectively. Make sure to store **`materials`** as a row vector.
- Synthesize the BRIR. (For better comparability, you can set **`op.len`** to the length of the measured BRIR.)
- Compare the measured and synthesized BRIRs. Listen to the BRIRs (**`soundir`**), as well as to auralizations (**`apply_rir`**). Where do you hear larger differences?

- Compare energy deceay curves (EDCs) and RTs (**`schroeder_rt`**).

- The measured BRIR represents one specific source-receiver arrangement. However, in the simulation, you are now able to freely choose their positions as desired.

6 Vary synthesis options

- Vary the maximum image source order (**`op.ism_order`**) and compare the different results. Note: If you set the option **`op.return_rir_parts = true`**, you can plot the early and late reflections separately using **`plot_ir(ir, 'del')`**.

- Synthesize a BRIR using only image sources. Use the option **`op.ism_only`** as demonstrated in **`example_ism_only.m`**. Start with a small maximum image source order < 10 and increase it step by step. (Note that the number of reflections grows with third power of image source order!) What maximum image source order is sufficient to get enough reflections for acceptable reverberation? Does this number depend on the chosen room?

- In the implemented image source model, a random jitter is applied on all image source positions, which prevents »sweeping echo« artifacts. Vary the amount of jittering using the option **`op.ism_jitter_factor`** (the default is 0.05). Synthesize BRIRs with the **`ism_only`** option and with **`op.ism_jitter_factor = 0`**. Listen to the resulting BRIR and compare it with the default setting. Auralize the BRIRs with different signals, e.g., speech and noise, **`apply_rir(ir, 'src', {'olsa1', randn(1e3, 1)})`**. What signal is more prone to artifacts?

- If you would like to play around with other options, see all available options in **`razr/base/get_default_options.m`**.

7 Use RAZR for AFC experiments

Set up an alternative-forced-choice (AFC) experiment to measure just noticeable differences (JDNs) for a room acoustical parameter (or a synthesis parameter) of your choice. For this exercise, the AFC package for MATLAB is required *(www.aforcedchoice.com).* Investigated parameters might include: Absorption coefficient, source-receiver distance, ISM jitter factor (see exercise 6), …

- In **`material/afc_experiment`** you can find a pre-configured AFC experiment called »rap« (»room acoustical parameter«). It is defined by the three files **`rap_cfg.m`**, **`rap_set.m`**, and **`rap_user.m`**. Have a look into these files. For details, please see the AFC documentation. What for what parameter will the JDN be measured in this experiment?

- Go to the directory where you stored the **`afc`** package and type **`afc_addpath`**.

- The AFC procedure is then started with
  `>> afc('main', 'rap', 'subject_name', cond);`
  where **`cond`** is either **`'speech'`** or **`'noise'`**. Results are written to **`afc/results`**.

- Create your own copies of the three files **`rap_*.m`** and set up a similar experiment to measure the JND for another room acoustical parameter or a synthesis parameter of your choice.

8 Simulate coupled rooms

In addition to the room you designed in exercise 2, estimate a shoebox approximation of a neighbor room that is connected to the current room by a door.

- Have a look into **`example_coupled_rooms.m`** for a demonstration how to define a coupled-rooms scene.
- Connect your own two rooms in a similar manner and run a simulation.