

# Scale

## Conducting Psychoacoustic Experiments with Dynamic Binaural Synthesis

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### Introduction

Dynamic binaural synthesis has become a popular subject in research and it is often used to perform listening experiments in virtual acoustic environments. A software tool is presented that combines classic listening experiment paradigms with dynamic binaural rendering. The creation, presentation and the analysis of results are performed using *Scale* [1], a software tool for listening experiments. The rendering of the audio signals is performed with the *SoundScape Renderer (SSR)* [2].

### Scale

*Scale* is a software tool that covers the full chain of setup, conduction and analysis of psychoacoustic experiments. It offers several testing procedures and the interaction between researcher or subjects and the software is done via a graphical user interface (GUI) and does not require any programming skills. Test setups or results can be easily ported from one instance of the program to another. Thus everything is portable and exchangeable between different computers and researchers. The first version of *Scale* was presented at the DAGA Conference in 2013 in Merano, Italy.

### SSR

The *SoundScape Renderer (SSR)* [2] is a tool for real-time spatial audio reproduction, which includes several rendering methods. It is free open source software running on *UNIX*-based systems and using the *JACK* [3] audio framework. The *SSR* can be controlled either using a graphical user interface (GUI) or a TCP/IP network interface. Sound source positions and other attributes represented in a spatial audio scene, as shown in Figure 1, can be imported or exported using audio scene description files (.asd) [6].

### Scale-SSR extension

*Scale* is designed for an easy and integrated workflow. The entire process of test generation and spatial audio scene setup is completely managed using *Scale*. Thus, listening experiments using dynamic binaural rendering can be created and performed with little effort and interacting with only one software.

As shown in Figure 2, *Scale* processes subject's inputs

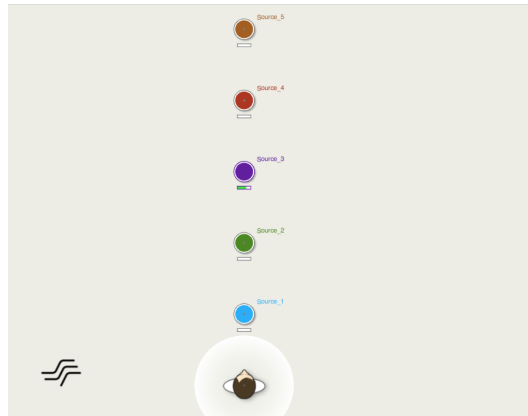


Figure 1: SSR user interface

and operates the *SSR* using its network interface via TCP/IP protocol while the test is performed. The *SSR* runs in the background generating stimuli with the combination of the incoming audio signal, the tracker data and the corresponding head related impulse response (HRIR) or binaural room impulse response (BRIR) set.

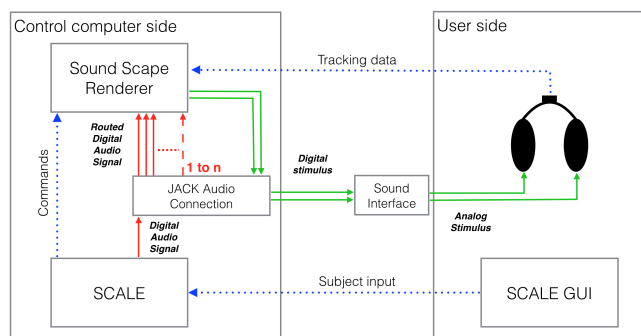


Figure 2: System architecture

### Test Creation

During test creation the researcher selects the dry source signals, the HRIR/BRIR sets, the tracker device and specific source parameters (i.e. position and volume). In a next step *Scale* automatically generates the audio scene description files for the *SSR*. Procedure-specific settings, the number of scenarios and instructions appearing during test performance are also configured in this module.

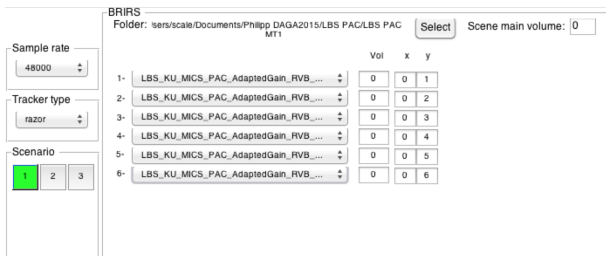


Figure 3: *Scale*'s HRIR/BRIR Selection Window

## Implemented tests

The initial version of *Scale* included a selection of frequently used test procedures like simple or transformed staircase adaptive procedures, semantic differential, double blind triple-stimulus with hidden reference and rating tests. A description of the latter can be found in [1]. In the current version two additional procedures, MUSHRA and SAQI, are implemented.

### MUSHRA

The aim of a multi-stimulus test with hidden reference and anchor (MUSHRA) test [4] is to rate global differences between several audio stimuli. All stimuli are presented in a single trial and have to be compared to a given reference. Each stimulus has a continuous scale (continuous quality scale) which goes from 0 (bad) to 100 (excellent), as shown in Figure 4. Reference and stimuli can be switched over instantly. The order of the stimuli is randomized and every trial has to include a hidden reference and an anchor.

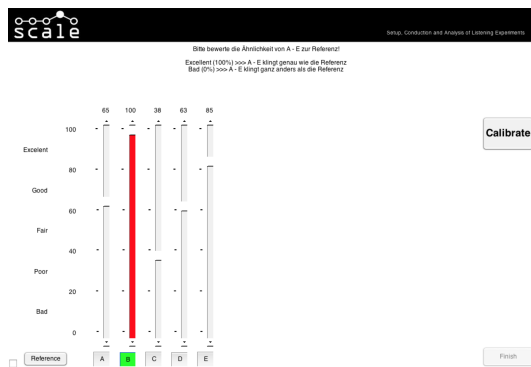


Figure 4: *Scale*'s interface during a MUSHRA test

### SAQI

The spatial audio quality inventory (SAQI) test [5] has been specifically designed for the perceptual evaluation of virtual acoustic environments. In every trial a reference and a stimulus are presented together with 48 verbal descriptors of perceptual qualities that are assumed to be of practical relevance when comparing virtual auditory environments. Each descriptor comprises a rating scale with a pair of opposed adjectives in its scale ends.

The subject's task is to compare the stimulus to a given or inner reference and give a rating for each perceptual quality.

## Results analysis

The results can either be evaluated internally using *Scale* or exported to different file formats like text, excel and *Matlab* figure and dataset. The dataset format, which is defined in the scope of *Matlab*'s *Statistics Toolbox*, is the most straightforward approach to work with the results directly in *Matlab*. Furthermore, metadata and information about the subjects (i.e. age, sex or experience in listening tests) is included. As shown in Figure 5, different visualisation options (i.e. individual results, averages and confidence intervals) are available for internal evaluation.



Figure 5: Internal evaluation of results in *Scale*

## Running environment

Three main components have to be installed in an *OSX* computer in order to use the presented solution:

- *Matlab* version R2014a or greater (needed to run *Scale*)
- *SoundScope Renderer (SSR)* version 0.4.2 or greater
- *JACK Audio Connection (JACK)* version 0.124.1. or greater

## Funding

*Scale* was implemented in the scope of the research projects *MARA* (Microphone Arrays for Room Acoustics and Auralization) and *MoNRA* (Modifikation der Nachhallanteile von Raumimpulsantworten). Both projects are funded by the Federal Ministry of Education and Research in Germany. Support Codes: 17009X11-MARA, 03FH005I3-MONRA. The author thanks for the support.

## Download and Release

*Scale* version R2015-0415 and its documentation will be made available at: <http://www.audiogroup.web.fh-koeln.de/>. The latest release of the *SSR* is available at: <http://www.spatialaudio.net/>.

## References

- [1] Vázquez, A., “Scale, a Software Tool for Listening Experiments,” In: Proceedings of the DAGA, 2013.
- [2] Geier, M. Ahrens, J. Spors, S., “The SoundScape Renderer: A Unified Spatial Audio Reproduction Framework for Arbitrary Rendering Methods,” In: Proceedings of the 124th Convention of the AES, Convention Paper 7330.
- [3] Davis, P. et al., “JACK Audio Connection Kit,” software, <http://jackaudio.org/>, licensed under the GNU General Public License (GPL) and GNU Lesser General Public License (LGPL).
- [4] ITU, “Method for the subjective assessment of intermediate quality level of coding systems,” in Tech. Rept. Rec. ITU-R BS.1534-2, 2014.
- [5] Lindau, A. Erbes, V. Lepa, S. Maempel, H.-J. Brinkmann, F. Weinzierl, S., “A Spatial Audio Quality Inventory (SAQI),” *Acta Acustica united with Acustica* vol. 100, pp. 984-994.
- [6] Geier, M. Ahrens, J. Spors, S., “ASDF: Ein XML Format zur Beschreibung von virtuellen 3D-Audioszenen,” In: Proceedings of the DAGA, 2008.