Directional patterns and recordings of musical instruments in auralizations

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Abstract

This paper outlines the developing ideas of the investigation started the 1st of September 2001.
The problem of the spatial representation of sound sources that vary their directional pattern in time in auralizations is introduced. Musical instruments are used as a reference for the discussion of the traditional representations with assumed fixed directional characteristics. A new method for representation of the spatial sound contributions in time is proposed using multiple-channel recordings and virtual sources in the simulations. Further developments and applications of the solution are outlined.

1 Introduction

Auralization is the analogous term to visualization introduced to describe rendering audible (imaginary) sound fields. The aim of a room auralization is to simulate as accurately as possible the binaural listening experience at a given position in a modeled space [1]. The directional characteristics of the sound source as well as the acoustical environment give important clues in auralization. Musical instruments, as any other acoustical sources, create a particular acoustical behavior in a room. The aim of this investigation is to study in deep this behavior and improve the auralization by optimizing the representation of the directional characteristics of musical instruments in order to model better the room/instrument interaction. It is also the goal of this work to make recordings and measurements of musical instruments that could be useful within the MOSART network.

2 Directional characteristics of musical instruments

Musical sounds require a complex acoustical analysis due to their particular features. Analyzing sounds produced by musical instruments involves a great deal of information such as harmonic structure, spectra, time transients, noise components, directional attributes and others. Like the sonic spectrum, the directional attributes of a musical instrument change with the different notes played on the instrument [2], the different performing intensities [3], the different techniques and also with the different performers of the same instrument. These changes, due to the complexities of the musical instrument itself as a multi resonating system and other more complex reasons, are different for the diverse families and types of musical instruments [2]. Figure 1 shows the measured directional characteristics of an alto saxophone at 1000 Hz for two different notes played in the same octave by the same player [4].

3 Auralization with musical instruments as sources

In order to consider musical instruments as sound sources for auralization one needs to include the directional characteristics of the source to be able to specify the source radiation characteristics. As we have seen, musical instruments are sound sources which have a complex radiation pattern that is difficult to describe with accuracy in a real performance case where there will always be directivity changes in time. If we assume a fixed directional characteristic for each of the frequency bands, like it would be the case of a loudspeaker, the representation of the directivity of the source would be very poor and inaccurate. The real directional characteristics would be changing in time and we would be having the wrong directional pattern most of the time, emphasizing or diminishing the level for certain frequencies of the particular spectra. Therefore, a better representation of the sound intensity changes in time is needed.

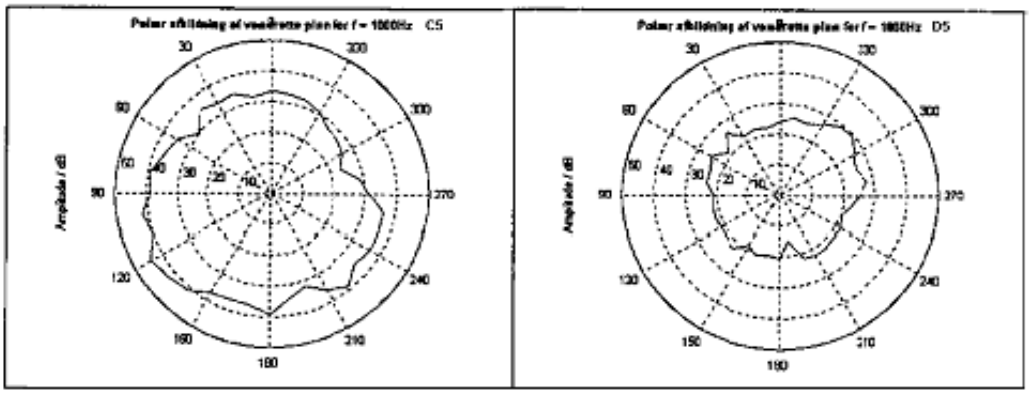

Figure 1 Polar diagram for 1000 Hz of an alto saxophone playing a C5 (left) and a D5 (right).

4 Improvement of the spatial representation of sound

A better description of the spatial sonic contributions of a musical instrument, or any source that changes its directivity in time, could be offered by considering the contributions of the acoustical intensity. One way to do this without referring to a determined fixed directional characteristic is to use several virtual sources in the simulation with fixed and neutral directional characteristics that do not overlap each other. The new source (all the virtual sources) should radiate a multi-channel recording of the source by each of the virtual sources simultaneously. This recording should be done in such a way that the different microphones achieve the sound from the source in different directions, as shown in Figure 3 for a 4-track recording. Also each of the virtual sources should reproduce the multi-track anechoic recordings corresponding to the orientation relative to the original source. That is, if for example we divide the radiation semi-sphere of the upper part of the instrument in 4 (assuming we have made a 4-channel anechoic recording), we can then simulate 4 discrete sources with a directional characteristic equal to a quarter of the semi- sphere in the direction of each anechoic recording. Figure 3 shows a room acoustic simulation using the software Odeon where an auralization considering 4 virtual sources was done, each source with an omnidirectional characteristic of a quarter of a semi-sphere and radiating in 0, 90, 180 and 270 degrees [5]. In this case the anechoic recordings include the sound pressure variations in time of the source, which were radiated by the virtual sources in their discrete sectors. The new source (constituted by the 4 virtual sources) radiates in a distinctive way in each of the 4 directions following changes in level, asymmetries and orientation of the original source.

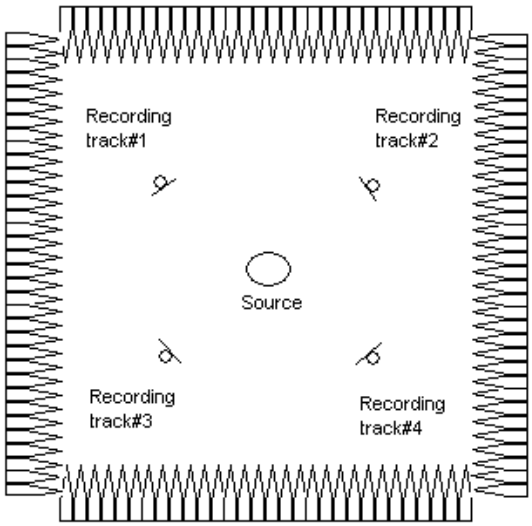

Figure 2 Setup for a 4-track anechoic recording of a source.

5 Further developments

In the near future we have planned to study in deep the relationship between the directional characteristics of musical instruments and auralizations applying the multi-channel recording method under different circumstances. The influence of the room acoustics characteristics, the kind of source used for the auralizations and the way the recordings are done are some of the points to be considered in our next steps. We would also like to expand the investigation to the study of auralizations with large sources (multiple musical instruments) using virtual sources in different positions.

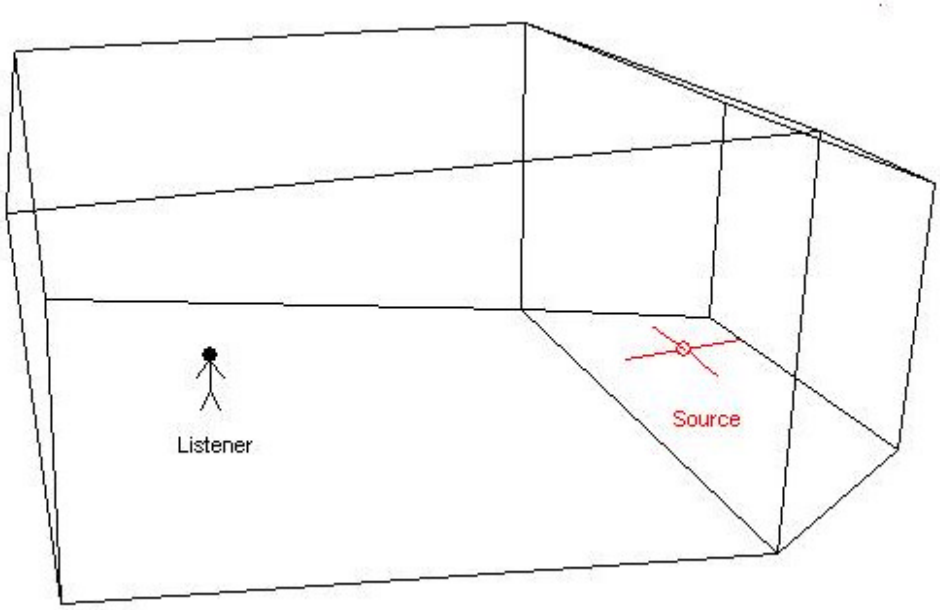

Figure 3 Room acoustic simulation with 4 virtual sources, each with a directional pattern, radiating in 4 different directions.

References

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