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Sound algorithms

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We call sound algorithms the categories of algorithms that deal with digital sound signal. Sound algorithms appeared in the very infancy of computer. Sound algorithms present strong specificities that are the consequence of two dual considerations:

- The properties of the digital sound signal itself, and its uses, as compared to signal in general (e.g. sampling frequency, need for real time, etc.).
- The properties of auditory perception [→ Auditory perception].

One can distinguish roughly sound processing, sound spatialization, sound analysis and sound synthesis algorithms, which are reviewed briefly below.

Sound Processing

The terms digital sound processing refer to digital techniques involved in the transformation of a digital audio signal into another one, e.g. delay, reverb, filtering, equalization, ring modulation, distortion, pitch shifting, time-stretching, flanger, compression, etc. The biggest field of applications of sound processing is perhaps recording, musical production, and audio broadcasting. However, digital sound processing is also of major importance in music creation (it has a central role in some music styles), and in human-computer interaction, virtual reality, etc.

Sound Spatialization

Amongst sound processing algorithms, sound spatialization algorithms call for a special attention, given their importance in research in the recent years. Sound spatialization refers to a process by which audio engineers add features in the sound material in order to project sound events in space, so that the listener can perceive sound sources localization, and sound propagation environment (room effects, etc.).

Several features are used by auditory perception in a set of spatial cues to identify the position of the sound source, as well as some other information about the ambient in which the listener is. Interaural Intensity Differences (IID), Interaural Time Differences (ITD) and the direct/reverberation ratio are the most important cues concerning the position. Other cues, such as elevation of the source and back sources, are often rendered by using filtering techniques that simulate the effect of ears, head and body of the listener on sound waves before they reach the tympanum. Many techniques are used to render spatial effects according to the system used: headphones or loudspeakers. The most effective rendering technique using headphones is the Head-Related Transfer Function (HRTF). It respects Head Shadow and ITD, Shoulder Echo, Pinna reflections.

Sound spatialization gained a large attention in virtual environments recently because spatial cues of a sound, especially source position, are important for human hearing, and because the use of sound spatialization algorithms proved to be a valid mean to improve the subject sensation of immersion in the virtual immersive environment.

Sound analysis

Sound analysis corresponds to any operation used to extract information from a sound signal in order to give a signal interpretation. The aim is to give a characterization of the sound signal or to extract some fundamental parameters that characterize the signal. Given the time-domain signal that

represents a sound, it is possible to analyze it in several other domains in order to better investigate its properties.

The most commonly used techniques represent the sound signal in the frequency domain with the aid of the Fourier Transform. Other important techniques that are today topics for research are: pitch and tempo detection, score following, sound source extraction, etc.

The recent Music Information Retrieval (MIR) research domain offered a new vitality to the sound analysis topic. The goal is to accompany audio data with a series of music/audio descriptors, at various levels of abstraction (tempo, harmony, categories of instruments, musical genre...). These descriptors should most often be computed automatically from the audio data, hence necessitating new sound synthesis algorithms.

Finally, one can note that analysis and synthesis can be considered as one the counterpart of the other. Quite often, once a natural sound has been analyzed and the main characteristics of the sound found out, it is possible to apply specific sound algorithms to re-synthesize a modified version of the original sound.

Sound Synthesis

Given the importance of sound synthesis for enactive interfaces, a dedicated item [→ Sound algorithms - sound synthesis and sound models] treats this topic. Please, refer to this item.

References

- [Blauert, 1997] Blauert, J. P. (1997). *Spatial Hearing, The Psychophysics of Human Sound Localization*, rev. ed. Cambridge, MA: MIT Press.
- [Zolzer, 2000] Zolzer, U. (2000), *DAFX-Digital Audio Effects*, John Wiley & Sons, Ltd, ISBN 0471490784.

Related items

- Auditory perception
- Illusions, auditory
- Mapping, in digital musical instruments
- Physically-based modelling techniques for sound synthesis
- Sound algorithms – sound synthesis and sound models