Chapter 5

Sound Spatialization
Application Programmer Interface

For the application programmer interface, the VRML97 standard [Bell et al., 1997] [Bell et al., 1996] [Carey and Bell, 1997] [Hartman and Wernecke, 1996] was chosen.

The VRML97 specification defines a file format and semantic interpretation. For sound support, only two nodes, Sound and AudioClip, are specified. It is assumed that the sink (i.e., listener) is at camera position and/or controlled by the viewer.

The VRML97 specification was extended by this research for nodes specified in this chapter to enable more sophisticated audio modeling and rendering. The nodes are

SfSoundSink sound sink, an independent receiver (e.g., dummy head, microphone),

SfSoundScape soundscape, scope limitation and room acoustics,

5.1 Audio rendering process

A scenegraph defines a scene with graphical, interactive, acoustical (Figure 5.1), and behavior nodes and can be constructed either by class instantiation or external files which can be created using other authoring tools. Each node is defined in its own local coordinate system. During an audio rendering pass all transformations are resolved and necessary audio control data passed
to the resource manager. Resource management and final rendering in a spatialization backend are calculated in world coordinates. Resource management involves mapping from source→sink channels to available mixels, spatialization channels, including a scheme to predict the perceptual relevance of a sound source in a given configuration. Resources are used economically by applying a clustering technique which mixes spatially proximate sound sources, representing them as a single sound (representative) source.

Figure 5.1: Scenegraph with sound objects

5.2 Sound source node

SfSoundSource {
    exposedField SfVec3f direction      0 0 1
    exposedField SfFloat intensity 1
    exposedField SfVec3f location 0 0 0
    exposedField SfFloat maxBack 10
    exposedField SfFloat maxFront 10
    exposedField SfFloat minBack 1
    exposedField SfFloat minFront 1
    exposedField SfFloat priority 0
    exposedField SfNode source NULL
    field SfBool spatialize TRUE
}

Figure 5.2: Sound source node specification
Figure 5.2 shows the specification of a sound source. Location and direction are defined within the object space. The intensity inside of the core range ellipsoid, which is given by minBack and minFront, is one.

**Fields in a sound source node:**

- **direction** specifies a primary sound-emission direction as "front," and specified as vector defining the major axis of the audible-sound ellipsoids.
- **intensity** adjusts the gain value of the sound source. An intensity of 0 denotes silence, and an intensity of 1 is the full gain as provided by the AudioClip node.
- **location** specifies the position of the sound source in object space.
- **maxBack** is the distance in the direction opposite the direction vector to which the audible range ellipsoid extends.
- **maxFront** is the distance along the direction vector to which the audible range ellipsoid extends.
- **minBack** is the distance in the direction opposite the direction vector to which the core ellipsoid extends.
- **minFront** is the distance along the direction vector to which the core range ellipsoid extends.
- **priority** is a hint to the sound spatialization resource management about how important the sound is. It should be left at 0 for background sounds, and set to 1 to ensure the display of important, short single-event sounds.
- **source** is an AudioClip node which specifies how the sound will be generated (not spatialized); if not specified, the Sound node emits no sound.
- **spatialize** indicates whether the sound should be played as if it's at a particular point in space (TRUE), or whether it should be rendered as ambient background sound (FALSE).

Taking a geometrical model into account, the resource management can calculate the volume at listener position from the direction and location fields. The spatialize and priority fields are used besides other indicators like loudness and scope for selecting sources which will get a channel assignment.
5.3 Sound sink node

Exocentric views and multiple sinks motivated the extension to the VRML97 standard with a node which represents a sound sink, similar to a camera description. The sound sink node shown in Figure 5.3 allows separate control of listening location and viewpoint and forms the basis of a general scheme for multiple sinks (see Section 2.2.3).

SfSoundSink {
  exposedField SFFloat orientation  0 0 1 0
  exposedField SFFloat sensitivity  1
  exposedField SFVec3f location  0 0 0
  exposedField SFFloat farDistance 10
  exposedField SFFloat nearDistance 1
  exposedField SFFloat priority 0
  field SFBool enable TRUE
}

Figure 5.3: Sound sink node specification

Fields of a sound sink node:

orientation is defined as a rotation of the sound sink direction from its default (0,0,-1) vector. The up direction is (0,1,0). This field, along with the current geometric transformation, specifies the orientation of the sound sink in world coordinates.

sensitivity adjusts the gain of the incoming sound signals; an intensity of 0 indicates total deafness, and an intensity of 1 indicates full gain.

location is the position of the sound sink in object space.

farDistance is the radius of the sensible range sphere.

nearDistance is the radius of the core sphere (inner ear distance in case of HRTF-based processing [CRE, 1994]).

priority is a hint to the sound spatialization resource management about how important this sound sink is, especially applicable in case of multiple sinks.

enable indicates whether the sink should contribute to the spatialization (applicable in case of multiple sinks).
5.4 Soundscape node

Inspired by the Java3D specification [Sowizral et al., 1997], the soundscape nodes (Figure 5.4 relates medium definition and space. The bounding box limits the range of aural attributes specifications.

SfSoundscape {
    exposedField SoSFVec3f min 0 0 0
    exposedField SoSFVec3f max 1 1 1
    exposedField SoSFAuralAttributes attributes NULL
}

Figure 5.4: Soundscape node specification

Fields of a soundscape node:

min is the first corner of the bounding box.

max is the second corner of the bounding box.

attributes SfAuralAttributes node specifying the aural attributes.

Bibliography


