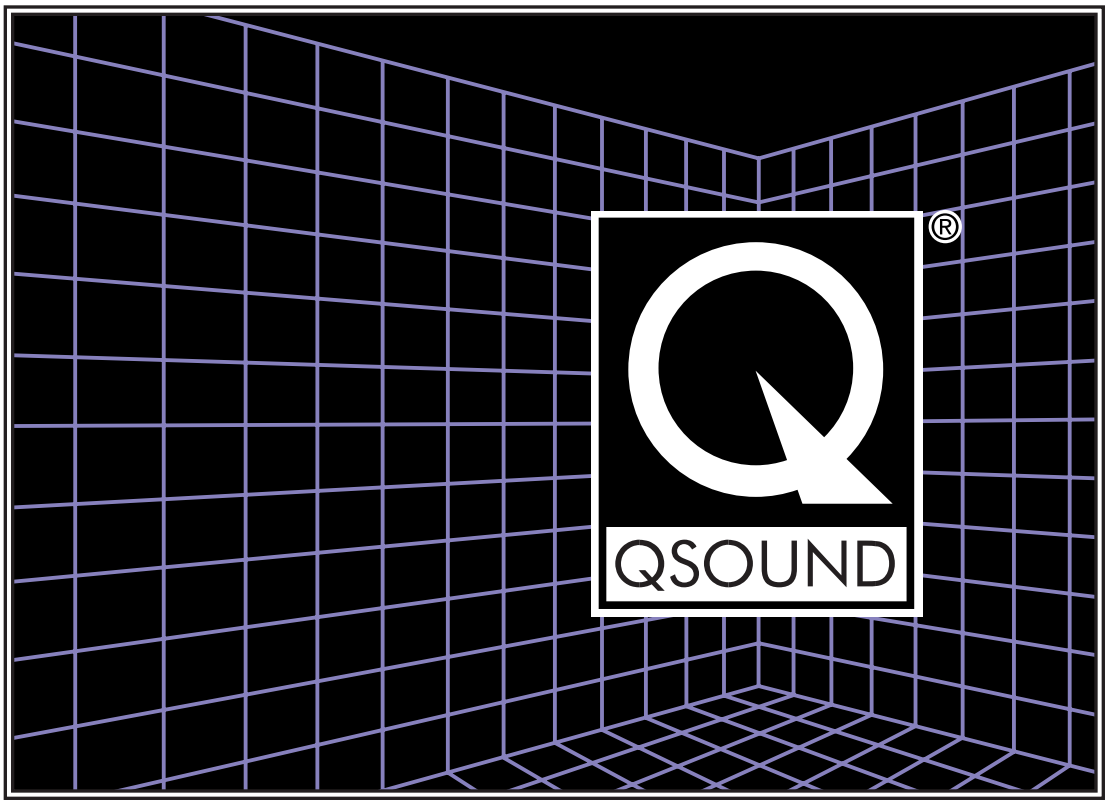
OEM Guide To

QSound® Q3D Positional 3D Audio

QSound Labs, Inc.



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QSound Q3D
Positional 3D Audio

Abstract

This document provides an introduction to QSound Labs' positional three-dimensional (3D) audio processes.

Intended Audience

The document is directed primarily to original equipment manufacturers (OEM's). For our purposes this also includes designers of software digital audio tools, operating systems and the like. Audio recording professionals, entertainment software vendors and end users will likely find other reference materials from QSound Labs to be more appropriate to their fields of interest. Contact QSound Labs for our Pro Audio or Software Developer information kits.

A general overview of 3D audio principles and QSound technologies may be found in The OEM Guide to QSound 3DAudio.

Q3D Processes

Q1™ and Q2™

Q1 and Q2 are QSound's primary positional audio algorithms. Each is designed to accept arbitrary monophonic signals and apply 3D localization filters, resulting in a stereo output incorporating positional cues in the form of time, phase and amplitude differentials between the two channels. The result is that the listener perceives the sound as originating from a specific location in space. Q1 is desiged for speaker playback, while Q2 is targeted for headphone playback and therefore employs substantially different processing.

By adjusting the filtering parameters appropriately, control over the perceived location of the sound source is achieved. In most cases, it is desireable to be able to make such adjustments in real time. In the general case it is advantageous to implement positional 3D audio as a realtime digital signal process.

Several individual channels of data may be positioned and their respective stereo output signals summed to a single stereo signal which maintains the positioning of individual sound elements. If the positioning algorithms are tightly coupled to the mixing process, substantial processing overhead can be spared. This innovative approach is one of the reasons for the remarkable efficiency of QSound's processes. Q1 and Q2 are characterized by a basic system overhead and a small incremental cost per processed channel.

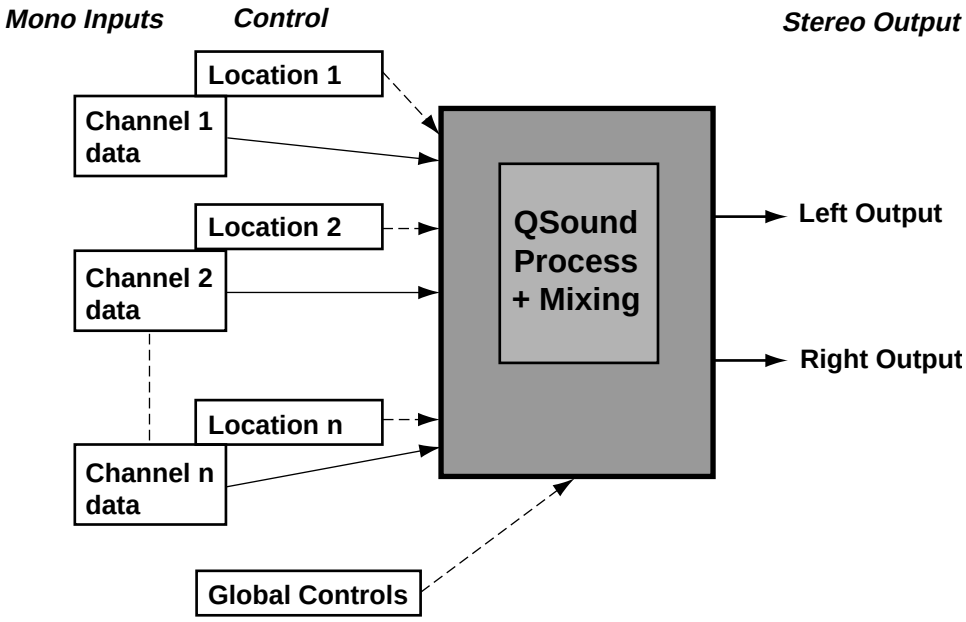

Figure 1: *Multi-channel QSound Positional 3D Audio Mixer*

Figure 1 is a simple representation of a multi-channel positional mixer.

Secondary Parametric Control

In addition to basic positional processing, a complete solution for positional 3D audio may take into account other controllable parameters, particularly in multimedia sound systems or virtual reality applications.

For example, when a sound-generating object is in motion with respect to the listener, the perceived pitch (frequency) of the sound is affected; this is the well-known 'Doppler shift' phenomenon. To reproduce the sound of moving objects realistically it is therefore necessary to control the rate of sound sample playback in order to mimic Doppler effects.

There are other reasons to control the rate of sample playback. For example, in a video game, many sounds such as those of automobile engines are most efficiently produced with a short sample which is continuously looped, i.e. played over and over again seamlessly. Controlling playback rate creates the impression of such an engine running at different speeds.

Realtime control of the volume (relative signal level) of individual sounds is a basic necessity of the mixing function.

With sampled data streams, producing high-quality time-variant control of parameters such as volume and pitch without significant audible artifacts requires interpolation algorithms. QSound's positional audio processes deliver this level of sophistication.

Environmental Factors

Environmental effects such as adjustable reverberation can be provided to create a realistic virtual acoustic space.

Microsoft DirectSound3D API

Microsoft Corporation provides an open standard 3D audio application programming interface (API) in its DirectX Windows game development system. Since the release of version 5 of DirectX, this API, called DirectSound3D (DS3D) has supported third-party rendering engines / accelerators, principally implemented on DSP-based sound cards or as driver-level host CPU functions. “Acceleration” achieved by sound-card 3D is measured relative to the DS3D hardware emulation layer (HEL), a software 3D engine that is intended to provide rudimentary 3D effects for users lacking hardware 3D features.

Microsoft’s effort was intended to encourage content producers to program 3D sound effects into their game and multimedia titles for the PC. (In the past, rare instances of positional 3D capability in computer sound cards has not been widely supported by developers due to the lack of such a standard.) At the time of this writing (Fall, 1998) DS3D is clearly successful; the majority of leading game developers are incorporating support for DS3D-compatible hardware into their new titles.

High-quality positional 3D audio capability has therefore become an essential feature of PC sound architectures.

QSound Positional 3D Audio API’s

QMixer™

In the prior absence of a 3D audio API supported by the operating system, QSound had been providing software developers with realtime host-based 3D positioning for a number of years. The most important product to result from this effort is the QMixer SDK (software development kit), a high-level API and realtime 3D mix engine which runs on either Windows or Power Macintosh platforms. The development of QMixer has given QSound Labs a profound technological advantage over its competitors, as well as providing the opportunity to gain insight into the audio priorities of software developers.

Because QMixer incorporates a software Q3D rendering engine, it is licensed to developers so that their titles can provide high-quality 3D even on non-accelerated systems.

However, QMixer fully supports hardware accelerators via the DS3D standard.

QMDX™

A special version of QMixer called QMDX is provided to developers free of charge, to ease the programming and performance challenges presented by DS3D coding. QMDX is identical to QMixer, except that its software engine mixes to stereo, rather than 3D, in the absence of 3D hardware acceleration. QMDX is freely available for download from the special software developer area of the QSound web site.

Environmental Audio

QSound Labs is contributing to the development of an industry-standard extension to the DS3D API. The purpose of this extension is to provide developers with a universal means for programming “environmental” or “ambient” audio effects in their titles. This allows the specification of certain types of acoustic environments (e.g. a large stone room) to further immerse the user in realistic audio space.

This API development is an ongoing effort of the Interactive Audio Special Interest Group, an association of 3D audio technology vendors and audio system and component manufacturers.

QSound Q3D Implementations

QSoft3D

QSound's QSoft3D is a host-based, realtime, positional 3D engine intended for custom integration with a codec or soundcard driver. This provides a DirectX-compliant 3D rendering engine for digital audio at incredibly low cost and without hardware modifications. QSoft3D provides both speaker and headphone 3D processing.

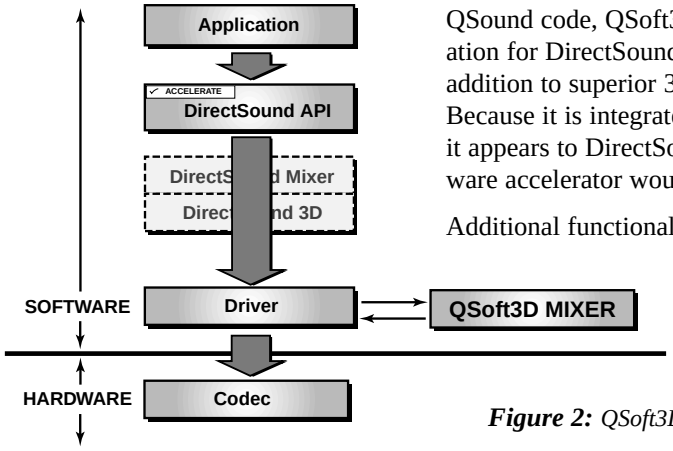

Figure 2: *QSoft3D*

Due to the remarkable efficiency of the QSound code, QSoft3D provides true acceleration for DirectSound3D applications, in addition to superior 3D audio effects. Because it is integrated with the codec driver, it appears to DirectSound exactly as a hardware accelerator would.

Additional functionality such may be supplied at the client's request. (See *Environmental Audio* & *Multi-Speaker Output* below.)

Introduced by QSound Labs in the fall of 1996, QSoft3D has already been licensed to several major codec and sound card vendors.

Custom DSP Ports

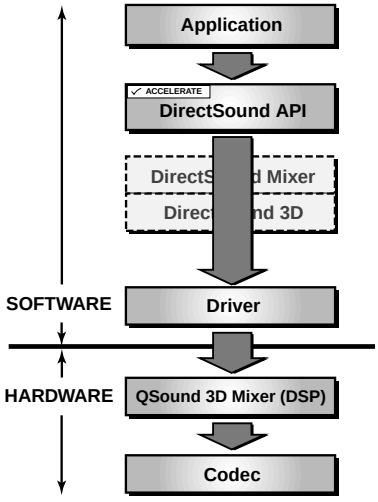

Figure 3: *Q3D positional algorithms in the form of DSP code for a DirectSound 3D audio accelerator*

QSound's positional 3D audio has been ported to many general-purpose DSP platforms including AD, Motorola, TI, Sierra, Pine and others. The requirements of the various processing modules are well characterized, thus, QSound Labs can quickly determine the feature set that can be supported by a given processing budget.

Integration of QSound positional 3D algorithms into the heart of a sound card design offers opportunities not possible in a host software implementation, such as the potential for 3D processing of hardware synthesizer voices.

QSound Labs has partnered in the design of both arcade and PC sound card architectures, and is intimately aquainted with wavetable synthesis engines as well as 3D audio.

Additional functionality such may be supplied at the client's request. (See *Environmental Audio* & *Multi-Speaker Output* below.)

Environmental or “Virtual Acoustic” Modeling

As mentioned in the description of software development API’s, a standard is emerging for programming and rendering “environmental” audio as an enhancement to positional audio on PC-compatible computers. This adds to the user’s impression of acoustic realism by creating appropriate “reverberation” and “occlusions” (the effect of sound reflecting off surfaces or being obstructed before reaching the listener) which are characteristic of the desired environment.

QSound Labs provides environmental audio effects in addition to positional 3D audio algorithms. The company has taken active roles in both the (ongoing) development of a standard API, and in market research with developers. QSound Labs is therefore well-positioned to stay abreast of current progress on the API and to provide solutions for environmental audio that will have the greatest software support.

Multi-Speaker Output

While many PC game enthusiasts find headphones or two speakers both adequate and appropriate for sound reproduction on home computers, a segment of the buying public has demonstrated a preference for multiple (i.e. >2) speaker systems.

Again, QSound Labs can offer solutions for all three scenarios (headphones, two speakers, multiple speakers), which are most often implemented as user-selectable output options on a given product.

Competitive Advantages

QSound Labs’ Q3D positional 3D audio processes offer the most flexible implementation and best cost / performance ratio in the industry.

Our engineering staff are very knowledgeable and highly experienced at porting QSound algorithms to a wide variety of platforms. They welcome the opportunity to get involved early in your design cycle and help achieve the best result.

The QSound name is widely recognized as the mark of audio quality.

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