Virtual Reality & Psychophysics

OSC Namespace Specification

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Contents

1 Introduction

1.1 Overview

Virtual Reality (VR) technologies have great potential use in creating experimental paradigms that would ordinarily be impossible to execute in practice. Test conditions can be presented that would otherwise include uncontrollable or confounded variables and would otherwise suffer from ambiguous behavioral measurement. This specification outlines an OSC namespace suitable for psychoaphysical experimentation using VR.

This **namespace** bridges a UDP data layer between **Unity**'s VR graphics programming environment and IRCAM's spatial audio engine **Spat~**. The **namespace** provides a control interface for object oriented soundfield synthesis and spatially accurate auditory stimulus presentation. The artificial room and sources can be controlled in terms of independent perceptual attributes derived from psychacoustic research carried out at IRCAM. The system can be configured according to the reproduction setup, and is decoupled from the specific reproduction format. This enables experimental paradigms using speaker arrays of varying speaker resolutions (multichannel systems, stereo pairs of loudspeakers or headphones).

Perceptual controls are divided into four categories of parameters, to be outlined in detail in this specification; those related to:

1. **Source Models**
2. **Room Models**
3. **The Listener Model**
4. **Output Options**

1.2 System Diagram

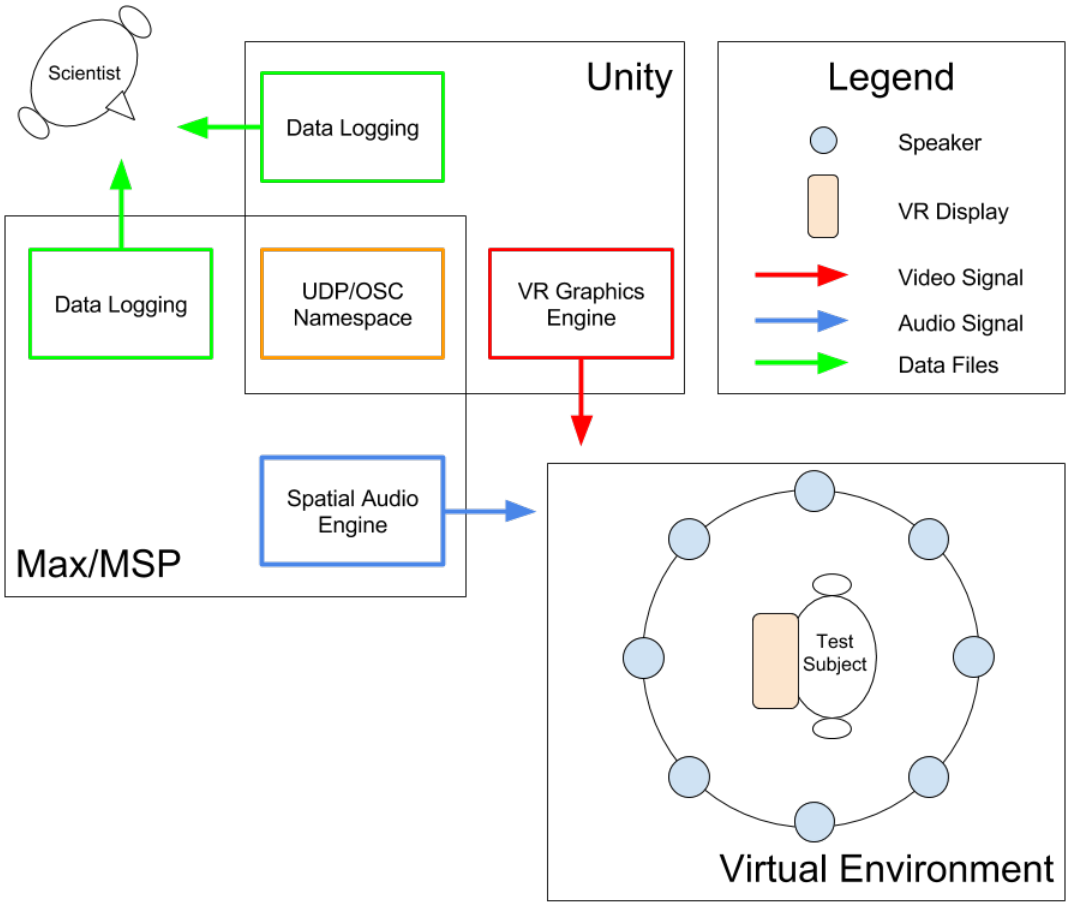

Figure 1: System diagram: VR Experimental Environment

The VR graphics and spatial audio streams are generated in separate processing environments and are bridged over the OSC namespace. This creates a modular system which enables the adaptive configuration of countless experimental paradigms, providing a seamless way to timestamp and log data events with out the need to integrate both of these systems onto one processing stack.

2 The OSC Namespace

2.1 OSC Address Syntax

All parameters in the namespace can be accessed by binding OSC addresses in the following format:

target_object_type/target_index/property_name [property_value]

Elements of the address are of the following data types:

1. **target_object_type** [symbol]
2. **target_index** [int]
3. **property_name** [symbol]
4. **property_value** [list of int or float or symbol]

Manipulatable target object types include the following:

1. **room**
   Addresses a room model
2. **source(s)**
   Addresses a virtual source model (pluralization will address all sources simultaneously [an ordered list of values is expected])
3. **speaker(s)**
   Addresses a speaker object (pluralization will address all speakers simultaneously [an ordered list of values is expected])
4. **virtualspeaker(s)**
   Addresses a virtualspeaker object (pluralization will address all virtualspeakers simultaneously [an ordered list of values is expected])

An extensive list of manipulatable property values is covered by target object type in this specification.

2.1.1 Compatible Position Formats

A property that is common to all target object types (except room) is position. Object position can be set in many formats including:

1. **xyz**: x,y,z 3D Cartesian coordinates
2. **xy**: x,y 2D Cartesian coordinates

3. **aed**: azimuth, elevation, distance
4. **ade**: azimuth, distance, elevation
5. **ad**: azimuth, distance
6. **ae**: azimuth, elevation
7. **x**: sets x, and keep y and z unchanged
8. **y**: sets y, and keep x and z unchanged
9. **z**: sets z, and keep x and y unchanged

2.1.2 Examples

1. source/2/xyz/ 0. 1. 0. ⟶ sets x,y,z (Cartesian) position of source #2
2. speaker/1/xy/ -1. 1. ⟶ sets the x,y coordinates (z unchanged) for speaker #1
3. source/3/dist/ 2. ⟶ sets distance, elevation and azimuth are unchanged.
4. source/10/aperture/ 80. ⟶ sets source #10's aperture to 80 degrees
5. room/1/infinite/ 1 ⟶ sets room #1 to infinite reverb mode

2.2 Source Model Parameters

Controls for the perceptual description of a source's acoustic quality, virtual localization, orientation and directivity.

2.2.1 Source Radiation

1. **aperture** [float] [range: 20.00 - 180.00] (default: 80.00)

   Sets source aperture angle in degrees

2. **az** [float] [range: -180.00 - 180.00] (default: 0.00)

   Sets source azimuth angle in degrees

3. **dist** [float] [range: 0.10 - 100.00] (default: 1.00)

   Sets source distance from the listening position in meters

4. **elev** [float] [range: -90.00 - 90.00] (default: 0.00)

   Sets source elevation angle in degrees

5. **early width** [float] [range: 10.00 - 180.00] (default: 30.00)

   Sets width/angle of source early reflections in degrees

6. **pitch** [float] [range: -90.00 - 90.00] (default: 0.00)

   Sets source pitch angle in degrees

7. **position** [float]

   See section 2.1.1

8. **yaw** [float] [range: -180.00 - 180.00] (default: 0.00)

   Sets source yaw angle in degrees

2.2.2 Source Perceptual Factors

1. **bril** [float] [range: 0.00 - 60.00] (default: 30.00)

   The source brilliance is a perceptual factor that was derived from psychoacoustic research on the characterization of the acoustic quality of concert halls.

   Source brilliance represents the variation of early sound at high frequencies.

2. **env** [float] [range: 0.00 - 50.00] (default: 24.00)

   Envelopment is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

   Envelopment represents the energy of early room effect relative to direct sound.

3. **prer** [float] [range: 0.00 - 120.00] (default: 48.00)

The room presence is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

Room presence represents the late sound i.e. the energy of later reflections and reverberation.

4. **pres** [float] [range: 0.00 - 120.00] (default: 90.00)

   The source presence is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

   Source presence represents the early sound (energy of direct sound and early room effect). A variation of the source presence creates a convincing effect of proximity or remoteness of the sound source.

5. **revp** [float] [range: 0.00 - 50.00] (default: 34.00)

   The running reverberance is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

   Running reverberance represents the early decay time. The term "reverberance" refers to the sensation that sounds are prolonged by the room reverberation. Late reverberance differs from running reverberance by the fact that it is essentially perceived during interruptions of the message radiated by the source. Running reverberance, on the contrary, remains perceived during continuous music.

6. **warmth** [float] [range: 0.00 - 60.00] (default: 30.00)

   The source warmth is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

   Source warmth represents the variation of early sound at low frequencies.

2.2.3 Source Options

1. **air** [int] [range: 0, 1] (default: 1)

   Enables/disables air absorption effect (for a single source)

2. **doppler** [int] [range: 0, 1] (default: 0)

Enables/Disables Doppler effect

3. **drop** [float] [range: -10.00 - 30.00] (default: 6.00)

   Drop attenuation for distance attenuation law in dB

4. **dropmode** [symbol] [linear, log2] (default: log2)

   Distance attenuation law

5. **mute** [int] [range: 0, 1] (default: 0)

   Mute source

6. **pan_rev** [float] [range: 0.00 - 1.00] (default: 0.00)

   pan/rev proportion (dry/wet)

7. **radius** [float] [range: 0.20 - 30.00] (default: 1.00)

   Sources radius in meters

8. **solo** [int] [range: 0, 1] (default: 0)

   Solo source

2.3 Room Model Parameters

Controls for the perceptual description of a virtual room's acoustic quality

2.3.1 Room Response

1. **size** [float] [range: 10.00 - 15000.00] (default: 2000)

   Sets room size in cubic meters

2. **reverb modaldensity** [float] [range: 0.20 - 4.00] (default: 0.86)

   Sets reverb modal density

3. **Much more to be added later**

2.3.2 Room Perceptual Factors

1. **heaviness** [float] [range: 0.00 - 50.00] (default: 25.00)

   Heaviness is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

   Heaviness represents the relative decay time at high frequencies. The term "reverberance" refers to the sensation that sounds are prolonged by the room reverberation. Late reverberance differs from running reverberance by the fact that it is essentially perceived during interruptions of the message radiated by the source. Running reverberance, on the contrary, remains perceived during continuous music.

2. **liveness** [float] [range: 0.00 - 50.00] (default: 35.00)

   Liveness is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

   Liveness represents the relative decay time at high frequencies. The term "reverberance" refers to the sensation that sounds are prolonged by the room reverberation. Late reverberance differs from running reverberance by the fact that it is essentially perceived during interruptions of the message radiated by the source. Running reverberance, on the contrary, remains perceived during continuous music.

3. **reverberance** [float] [range: 0.00 - 100.00] (default: 65.00)

   The (late) reverberance is a perceptual factor that was derived from psychoacoustic researches on the characterization of the acoustic quality of concert halls.

   Late reverberance represents the mid-frequency decay time. The term "reverberance" refers to the sensation that sounds are prolonged by the room reverberation. Late reverberance differs from running reverberance by the fact that it is essentially perceived during interruptions of the message radiated by the source. Running reverberance, on the contrary, remains perceived during continuous music.

2.3.3 Room Options

1. **air** [int] [range: 0, 1] (default: 1)

   Enables/disables air absorption effect (in the reverb tail)

2. **infinite** [int] [range: 0, 1] (default: 0)

   Enables infinite reverb (Yay! =))

3. **active** [int] [range: 0, 1] (default: 1)

   Enables/disables late reverberation

2.4 Listener Model Parameters

Controls for the perceptual description of the listener's virtual location and orientation

2.4.1 Listener Orientation

1. **listenerpitch** [float] [range: -90.00 - 90.00] (default: 0.00)

   Sets listener pitch angle in degrees

2. **listenerposition** [float] (default: 0.00)

   Sets listener position using chosen position format in meters/degrees

3. **listenerroll** [float] [range: -180.00 - 180.00] (default: 0.00)

   Sets listener roll angle in degrees

4. **listeneryaw** [float] [range: -180.00 - 180.00] (default: 0.00)

   Sets listener yaw angle in degrees

2.5 Output Options

Controls for the loudspeaker setup (position, equalization, time alignment, etc.)

To be added later

2.6 Global Controls

Global controls for the max msp environment

To be added later

2.7 GUI Options

Controls for display feedback in max msp.

To be added later

2.8 Angle Definitions

The spatial alignment and angle definitions adopted by Spat~ and by Ambisonic convention.

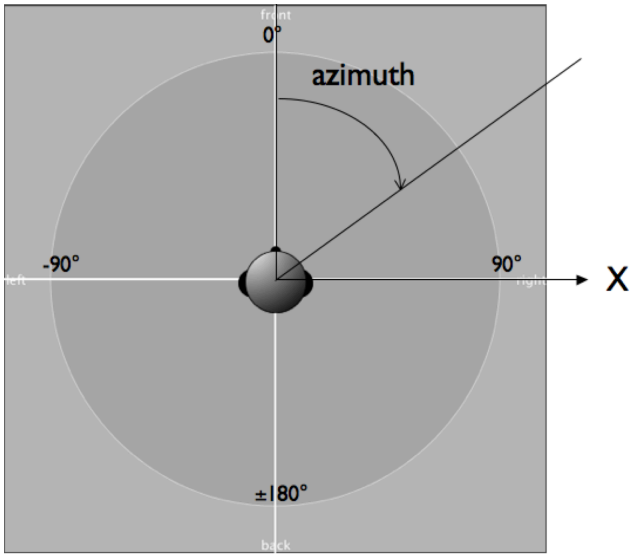

Figure 2: Azimuth Angle Definition

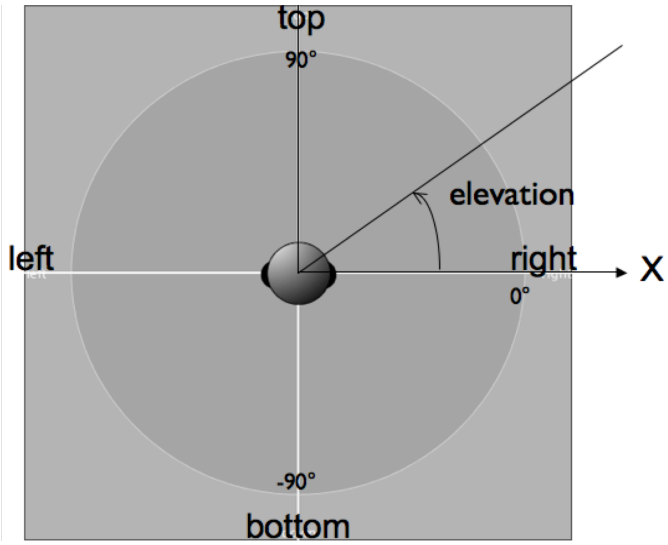

Figure 3: Elevation Angle Definition

2.9 Additional Information and Comments