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SSMN Spatial Taxonomy

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Preliminary considerations

- The SSMN Spatial Taxonomy is a systematic representation of all musical relevant features of sound spatiality. It is intended as a basis for their symbolic representation within a musical notation context for composition and performance purposes.
- The basic units of the SSMN spatial taxonomy are called *descriptors*. There are two kinds of descriptors: room descriptors and descriptors of sound sources.
- Descriptors can be simple or compound and are assumed to be perceptually relevant although definitive perception is dependent on the interaction between the actual sound and the actual spatial configuration.
- Although descriptors are primarily defined in structural (geometrical, mathematical, acoustical) terms, they have been conceived in view of musical practice.
- Simple descriptors are the basic atoms of the SSMN spatial taxonomy. They are able to denote all single primary features relevant to sound spatiality and can be represented as symbols.
- Compound descriptors are arrays of simple descriptors. They are used to represent more complex spatial configurations and processes (E.g. patterns, figures, motives, etc.) and can be represented as symbols.
- Descriptors can have several properties that are finally defined through numeric parameters and flags. (E.g. the descriptor »Position of loudspeakers« can have the properties »internal« or »external« and »fix« or »variable«).
- *Structural operations* and *behavioral interactions* can be used to transform elements previously defined using descriptors or to generate new elements.
- *Global operations* can be used to generate relationships between complex unities.
- *Cross-domain interactions* can be used to rule relationships between different media.
- The SSMN spatial taxonomy is intended as being generic and universal. Not all descriptors will be actually implemented within the project. Implementation issues like symbolic

representation, editing and rendering will be addressed in a separate document.

- All projected audio in movement can be rendered using Doppler effect. This can be specified using a Doppler flag.
- Although the taxonomy is classifying and describing sound in a three-dimensional space, some objects and symbols are, for practical reasons (rendering, standard formats, etc.), represented in two dimensions. This will be specified using a 2-D/3-D flag.

1. Room descriptors

a. Disposition

i. Shape of the room (generic shapes)

1. Cube

- *Length*
- *Width*
- *Height*

2. Hemisphere

- *Diameter*
- *Height*

3. Church (cross form)

- *Length*
- *Width*
- *Height*

4. Other shapes

- *Dimensions*¹

ii. Placement of performers, objects and audience

- *Label*
- *Position (xyz)*

iii. Position of Microphones

1. Referred to an instrument

- *Name of instrument*

2. Referred to the space

- *n* (number of microphones)

¹ According to a detailed description and depending on edit and rendering

- *labels*
- *xyz* (coordinates)
- *Yaw* (direction)

iv. Position of loudspeakers²

1. Fixed

- *n* (number of LS)
- *labels*
- *xyz* (coordinates)
- *Yaw* (direction)

2. Variable

a. Horizontal displacement (mechanic driven)

i. Line

- *Distance*
- *Speed*

ii. Arc

- *Distance*
- *Curvature*
- *Speed*

b. Vertical displacement (mechanic driven)

i. Up

- *Distance*
- *Speed*

ii. Down

- *Distance*
- *Speed*

iii. Palindrome

- *Min/max height*
- *Speed*

c. Pendular movement

- *Length*
- *Initial height*

d. Other (mechanic driven movements)

² Depending on their location, loudspeakers can have the flag Interior/Exterior.

- e. Choreography (Human driven movement, see 1.a.ii.1.b)

- b. Spatial quality of the room

- i. Space definition

- 1. Open/close (without/with reverb)
 - *Open/close*

- ii. Reverberation

- 1. Interaction source–room
 - *Enveloppement* (energy of first reflections related to direct sound)
 - *Présence de la salle* (energy of late reverberation)
 - *Réverbération traînante* (decay time of primary reflections)
 - 2. Room perception (related to late reflections)
 - *Réverbération tardive* (decay time of late reflections)
 - *Heaviness* (change of decay time of low frequencies)
 - *Liveness* (change of decay time of high frequencies)

2. **Descriptors of sound sources**³

- a. Types of sound sources

- i. Sound points

- 1. Physical sound source – *root sound*⁴ (RS)
 - *Label* (Name)
 - 2. Projected audio signal⁵ (PA)
 - *Label* (Name)

- ii. Groups

Definition: A group is a collection of sound points

³ 2-D/3-D see preliminary considerations

⁴ Acoustic instruments, voices, etc.

⁵ Microphone signal, audio files, streamed audio

with common spatial features. A group is defined by a circular perimeter wherein the single elements can be found. Position and movement of single elements within the perimeter can be defined in the same way as single points.

1. Physical root sound sources

- *Label* (name of group)
- *Number of sources*
- *Diameter*
- *xyz(n)* or *aed(n)* (coordinates of point n)

2. Projected audio signal

- *Label* (name of group)
- *Number of sources*
- *Diameter*
- *xyz(n)* or *aed(n)* (coordinates of point n)

iii. Planes

Definition: A plane is a homogenous sound spread out in space.

1. Projected audio signal

- *Label* (Name)
- *Number of sources*

b. Spatial quality of single sources

i. Réverbérance (PA)

- *Présence* (relation between sound energy of direct sound and that of the first reflections.)
- *Brilliance* (change of high frequencies of first reflections)
- *Chaleur* (change of low frequencies of first reflections)

c. Dimension of single sources

i. Scale (PA, perception of «bigger or smaller» than real sound source)⁶

- *Scale* (%)

d. Localization of sound sources

i. Localization of single points

- *xyz* or *aed* (rectangular or polar coordinates, PA, RS)

⁶ Magnification of a single point can be implemented generating a plane.

- *Aperture* (PA)
- *Yaw* (heading) (PA, RS)
- *Pitch* (elevation) (PA, RS)

ii. Localization of groups

- *Shape of perimeter* (circle, rectangle, triangle)⁷
- *xyz* or *aed* (geometrical center of the perimeter)
- *xyz* (for each element, within the perimeter)

iii. Localization of planes (foreground, background, etc.)

- *aed*, *spread angle* or
front, center, back, left, right, above, below

e. Simple trajectories of sound points, groups or planes⁸

i. Open (a → b)

1. Line

- *xyz(a)* or *aed(a)*
- *xyz(b)* or *aed(b)*
- *Speed/acceleration*

2. Curve

a. Bezier curve

- *Start point xyz(a)* or *aed(a)*
- *End point xyz(b)* or *aed(b)*
- *curvature* (e.g. *n* control points *xyz* or *aed*)
- *Speed/acceleration*

b. Other (Generic curves, arc, spiral, helix (e.g. "slinky"), free, etc.)

- *xyz(a)* or *aed(a)*
- *xyz(b)* or *aed(b)*
- *Curvature*
- *Speed/acceleration*

ii. Closed (periodic)

1. Circle

- *Radius*
- *Speed/acceleration*
- *Nr. of reiterations*

2. Other (Generic closed curves Lissajoux, etc.)

⁷ The perimeter can be a 3-D space: sphere, cube, etc.

⁸ See 3.a.i for operations on single trajectories

- *Curvature*
 - *Speed/acceleration*
 - *Nr. of reiterations*
- iii. Gap (muted trajectory)

- *Duration*

f. Compound trajectories (PA) (Movement patterns)

i. Open

1. Compound using simple trajectories (e.g. polygonal chain or. polyline, Bezier spline, etc.)

- *Speed/acceleration*

2. Free hand using 3D interface

- *Speed/acceleration*

ii. Close

1. Generic polygons (selection of basic shapes), e.g. triangle, hexagon.

- *Speed/acceleration*

2. Compound using simple trajectories (except generic polygons), e.g. closed polygonal chain, polybezier.

- *Speed/acceleration*

3. Free hand using 3D-interface

- *Speed/acceleration*

3. Operations (transformation or generation of new trajectories from preexistent single or compound trajectories)

a. Structural operations

- i. Operations (on position of single sound sources, groups and planes; simple or compound trajectories)

1. Repetition (loop)

- *Nr. of reiterations*

2. Scaling (change of one or more parameters. E.g. augmentation, diminution, speeding up or

down, etc.)

– *Scaling function*

3. Shift

– $\Delta x, \Delta y, \Delta z$

4. Rotation

– *roll, yaw, pitch*

5. Mirror

– *Mirror flag x, y, z*

6. Reverse (crab)

– *Reverse flag y/n*

7. Palindrome (returns to the starting value:
e.g. a -> b -> a)

– *Palindrom flag y/n*

8. Modulation (changing periodically one or more
parameters) e.g. sinus, triangle, sawtooth

– *Frequency, amplitude, phase shift*

9. Random (changing randomly one or more
parameters) e.g. jitter, random walk, random
permutation, gaussian distribution, urn, etc.)

– *Random function*

10. Algo (other complex functions)

– *Label*

ii. Operations on compound structures

1. Sequencing

2. Permutation

3. Interpolation (morphing)

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Appendix
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b. Behavioral interaction⁹ (between trajectories of two or more sound sources affecting their spatial behavior)

i. Behavioral attributes

1. Trend-setter
2. Follower (number of follower may vary)
3. Indifference¹⁰ (Within a behavioral context. See: »dispersion«: "non-uniform or random motion, opposite to concurrence", bid. p.8)

ii. Behavioral relationships

1. Imitation (See »concurrence«: "same values of motion attributes at a certain instant or duration", e.g. synchrony.)", ibid. p.7)
2. Co-incidence (similar positions, full or lagged, ibid. S.8, after Andrienko)
3. Opposition (bi- or multi-polar arrangement, e.g. spatial splitting, ibid. p.8)
4. Constancy ("Movement patterns remain the same (...) for a particular duration", ibid. p.8)
5. Convergence (synchronous or delayed, "movement to the same location". See also »encounter«, ibid. p.9)
6. Divergence (synchronous or delayed, movement away from the same location. See also »breakup«, ibid. p.9)
7. Attraction (See also: »pursuit«, ibid. p.10)
8. Repulsion (See also: »evasion«, ibid. p.10)

c. Global operations

i. Global scaling (space, time)

1. Linear
2. Non-linear

⁹ S. Dodge, Somayeh, Weibel, Robert, Lautenschütz, Anna-Katharina: *Towards a taxonomy of movement patterns*. In *Information Visualization* (2008), Palgrave/Macmillan Ltd., p. 1–13.

¹⁰ Autonomous (non-uniform) & random movement s. 3.a.i.

ii. Sequence (Horizontal)

1. Loop
2. Cross
3. Tight
4. Pause

iii. Superposition (Vertical)

1. Synchronous start
2. Delay
3. Synchronous end

d. Cross-domain interaction

- i. Scaling (time)
- ii. Synchronous start
- iii. Delay
- iv. Synchronous end

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End
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