Components of Space

Some aspects & definitions

presentation

Nordmix PLUS workshop, Vilnius 2016

HPST
Royal Danish Academy of Music

Explored Spaces

instrumental / electronic survey

Historical : Venetian Antiphony (Gabrieli, Frescobaldi),
on-stage trio (Mozart), off-stage musicians (Strauss, Mahler).

Instrumental : Schriabin, Varese, Henry Brant, Stockhausen, Grisey (etc)

Computer Music / Electro-acoustic : Chowning, Saariaho, IRCAM

Acousmatic / Acousmonium : Schaeffer, Bayle, GRM

Multichannel diffussion : Wishart, Smalley, BEAST

Space images

what defines the perception of "space" ?

Physical and physiological features followed by a cognitive processing allows us to mentally form "images of space".

Spatial imaging is by definition (at least) 3 dimensional, and can arise in both mono, stereo and multichannel setting.

Spatial properties can be found both internally in the sounds spectrum as well as applied externally to a sound source.

Spatial attributes may both define the space itself and the appearance a sound source may have in a given sonic environment.

Space unravelled

listing some percieved space features

Impression of loudness, localisation, echo density, spaciousness, depth and size, distance to the source, motion and mobillity, sound source's relation to its sonic environment, physical and psycho-acoustical characterisation of the space ("dry", "hard", "soft", etc).

None of these aspects are trivial or one-dimensional;
so exploration needs high level conceptualisation or controls
in order to create convincing impression of "space".

Localisation vs spatialisation

Localisation (has one meaning only) :

the mental estimation of the spatial position of sound source.
Also including the tracking of moving sound sources.

Spatialisation (has two possible meanings) :

a) the shaping of how a sound sources appears in a given space.

b) creating the sonic environment in which sound sources reside.

Stereo vs Binaural vs Ambisonics and beyond

Stereo : a method of creating audible "perspective"
(based on our di-phonic sound perception mechanism)

Binaural : a representation of how we "hear"
(a psycho-acoustic model based on the precedence effect)

Ambisonics : a representation of an ideal "space"
(defined as the planes of a sphere, closely linked to MS matrix)

Wavefield Synthesis : a representation of how a wavefront behave
(based on how sound propagate according to the physics of sound)

2 ears = stereo

Volume panning

Panning Laws
Volume vs distance
Volume vs effort

Timedelay panning

Precedence effect
Haas effect
Widener effect

Distance panning

volume as a function of distance
lowpass filtering as a function of airfriction
ratio of direct to reverberant sound (a.o.)

Ambisonics = multiple ears?

Ambinonic is a concept for full 3D spherical sound production and reproduction.

It is designed as a hierarchy of formats covering all aspects from recording, storage, manipulation to transmission and reproduction.

It is does not have a "hardwired" speaker layout (as surround formats do) and allows (in principle) for easy transport and recreation of spatialized files.

However, the more speakers the more precise (in terms of localisation, depth, spatial definition) your rendering will be.

Understanding the formats

A format : recording format
B format : storage and transformation
C format : consumer distribution format
D format : decoding and playback format

You may also encounter E and G formats
(which has no pratical use today)

Instead of an ambisonic A format recording you may *decode*
(almost) any signal of any number of channels into B-format.

For a good description of formats see :
ambisonic.info/ambisonics/channels.html

Ambisonics vs stereo, binaural, MS

Ambisonics signals are not directly compatible with stereo without special decoding.Thus we face the challenge to figure out a strategy of how to make easy playback of ambisonic signal when you do not have a multichannel setup.

One practical solution is to use binaural playback. It is a striking idea since conceptually ambisonics and binaural are both conceived as "spheres". However, technically they are built on different concepts (spherical harmonics versus HRTF) and they are thus only indirectly compatible (via decoding).

Ambisonic has a close link to the MS recording technique and can be seen as a generalisation hereof. Since the ambisonic B format XYZ coefficient all are figure-of-8 patterns you can think of the ambisonic encoding as a generalised MS matrix.

MS recording technique
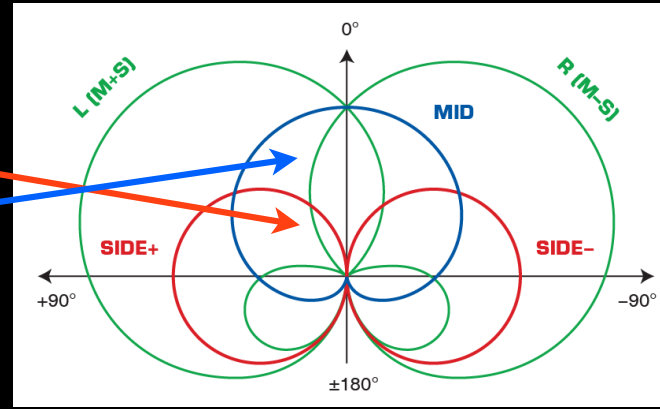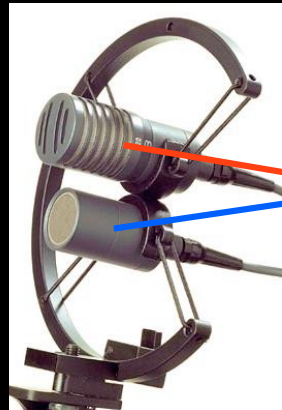
blue = mid signal

red = side signal

green = XY stereo

as recording technique : an alternative to XY stereo technique using a super imposed cardoid and a figure-of-8 microphone.

converting MS to LR : L = M+S, R=M-S isolating what is common in left and right respectively

converting LR to MR for mixing : reversed process so XY recording can be turned into MS for widening effect, then converted back to LR and listen to over normal stereo speaker setup (without any loss).

Ambisonic formats

A format

LF = left front up
RF = right front down
LR = left rear down
RR = right rear up
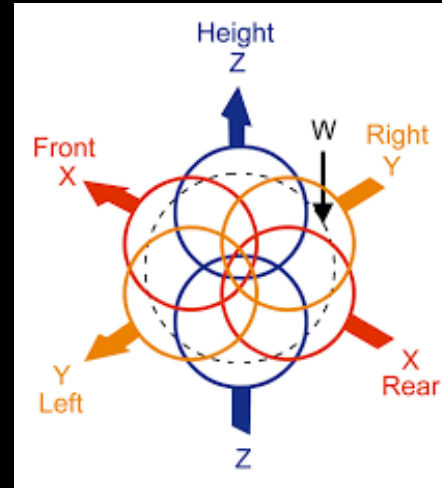
B format

W = omnidirectional
X = left-right axis
Y = front-rear axis
Z = up-down axis

ambisonic recording
using a soundfield sps200 microphone
that consists of 4 cardoids pointing in 4 directions
= *A format* (used for recording only)

converting A format to B format
isolating 3 dimensions X, Y, Z and the sum of all as W
= *B format* (used for manipulations only)

Ambisonic UHJ stereo

For the ambisonic to be practical (in a sterorized reality) the designers has proposed a solution of converting the ambisonic B format to Ambisonic UHJ hierarchy (C format). This format allows for the retrieval of a "wide stereo signal". As the B format signals W, X, Y, Z are converted to L, R, T, Q, where L and R are similar to conventional left-right stereo.

You may listen directly to L and R
or use a UHJ decoder to retrieve
full horizontal information (3 channels)
or full spherical image (4 channels).

For more info see :
en.wikipedia.org/wiki/Ambisonic_UHJ_format
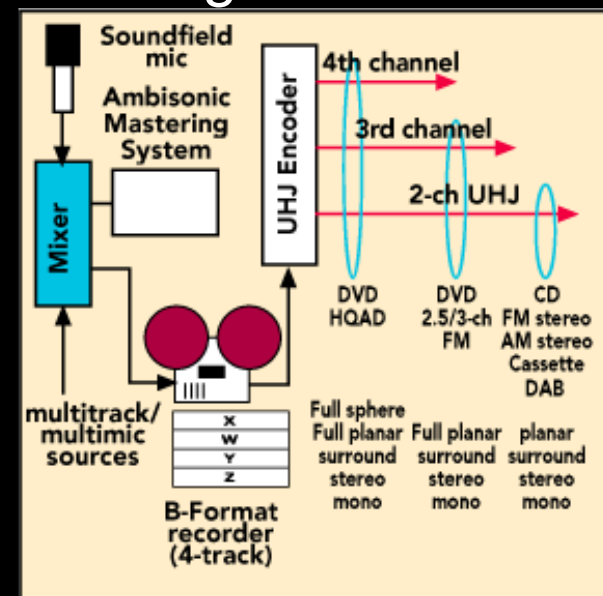
Ambisonic Links

bx_solo ("spread") : www.plugin-alliance.com/en/products/bx_solo.html
proximity ("distance panning") : www.tokyodawn.net/proximity

Harpex-B conversion site : harpex.net/convert.html
SurroundZone: www.tslproducts.com/soundfield/soundfield-surroundzone2

ICST (maxmsp externals) :
www.zhdk.ch/index.php?id=icst_ambisonicsexternals

Wigware (64 bit vst plugins):
www.brucewiggins.co.uk

IRCAM spat~ (maxmsp package) :
http://forumnet.ircam.fr/product/spat-en/

NOTES

things to show and explain

Ambinonic flow chart + UHJ stereo
relation to stereo, binaural, MS

Some Stereo examples
Some MS examples
Some SurroundZone examples
Some SPAT examples

Composed Spaces

examples of artistic use

Reverberant space (Saariaho)

Pitch space (Henry Cowell : harmony, colours)

Timbral space (Wishart)

Recreating acoustic space (IRCAM)