General information

All available recordings were carried out in the anechoic chamber P22 of the Fraunhofer-Institute for building physics IBP in Stuttgart, Germany as part of a masters thesis aiming for extended reproduction of single instruments in immersive audio production (thesis attached for background information). For details about the recording room follow this link: https://www.pruefstellen.ibp.fraunhofer.de/content/dam/ibp/pruefstellen/de/documents/Akustik/Freifeld_P22.pdf.

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The recordings were made using the „MHV“ setup which is a multidimensional spot-microphone technique that was developed to reproduce the auditory width of an individual instrument in horizontal and vertical direction.

The MHV signals

„MHV“ stands for the three microphone components Mid (cardioid), Horizontal and Vertical (both figure of eight). The M microphone is aiming at the acoustic centre of the instrument to be recorded, whereas the sensitive sindes of the H and V microphones are facing to the left and the bottom, respectively. For further background information please take a look at the thesis provided in the folder.

Decoding and Panning

For the positioning in an immersive audio mix, the captured microphone signals have to be decoded. Our suggestion is to use MS-decoding two times to get two stereo signals LR (left / right) and BT (bottom / top), where L = M + H; R = M + (-H), B = M + V and T = M + (-V) applies (see figure 0.1). The negative sign corresponds to the inverted microphone signal. By positioning the two signal pairs in the exemplary 7+4 speaker system, a multidimensional phantom sound source with variable absolute width and height is created. The recording angle can be adjusted afterwards by varying the respective figure eight microphone levels.

Microphone positions

In preparation suitable positions for the MHV arrangements were determined taking into account the acoustic properties of the instruments to be recorded. The main focus was on a good balance between positions from which the M microphone alone records a

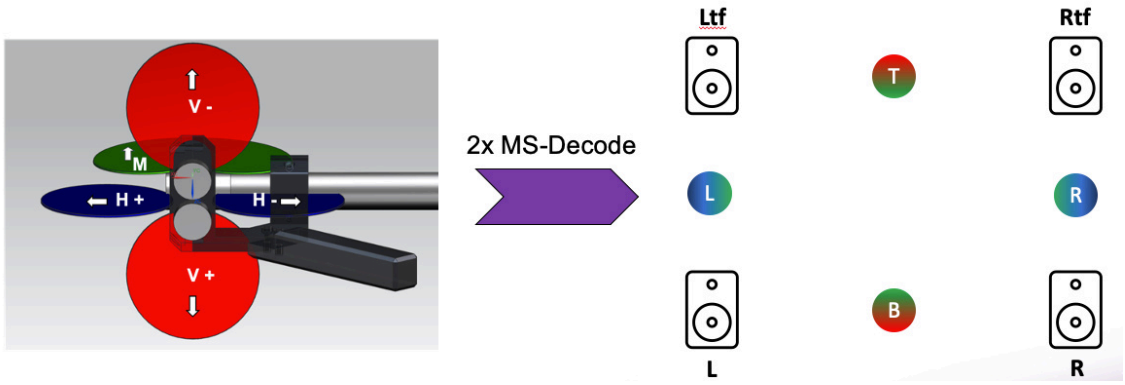

Abbildung 0.1: Decoding the MHV signals

balanced sound image (further away) and positions in which sufficiently decorrelated signals hit the sensitive sides of the H and V microphones so that the expansion in the mix is achieved (closer to the instrument). Particular attention was paid to the fact that the center of the virtual source - with the real instrument in rest position at the zero point - is displayed horizontally in the middle. The auditory image will then fluctuate around this position of rest, depending on the movement of the musician.

In table 0.1 you can find the final positions MHV_1 to MHV_3 used for the recordings on each instrument. The height of the instruments refers to the defined acoustic center of the instrument at the zero point and was measured from the ground. The distance describes the direct distance between the front edge of the M microphone and the zero point of the instrument. The two angles are given from the perspective of the musician, the zero point of the instrument representing the origin of the polar coordinate system. These are calculated values from measured cartesian positions. The last column of the table verbalizes the defined zero point of the instruments or, for the individual MHV arrangements, the part of the instrument where the main axis of the M microphone is directed to. The following sections explain the MHV positions on the respective instrument in detail. Additional documenting images can be found in the *Additional Pictures* folder.

Singers

Except for adjustment to the height of the mouth, the positions for the singers are the same (see figures 0.2 and 0.3). MHV_2 is located in central position with a small distance to the mouth, similar to conventional mono microphone systems in the studio. MHV_1 is positioned diagonally to the right below the mouth at the same distance. On the one hand, it should represent the tonal variant in the preferred direction of all frequency components and, on the other hand, movements forwards and backwards in the horizontal direction of the arrangement can be detected from this angle. MHV_3 represents a variant of MHV_2 at a greater distance.

Reed instruments

MHV_1 is located on the right side, pointing to the open end of the flute in one of the two preferred directions of the dipole-shaped radiation (see figure 0.4). It is assumed that even small movements with the flute from this angle produce dynamic effects in the extended image both vertically and horizontally. The two arrangements MHV_2 and

Abbildung 0.2: MHV positions mezzo-soprano

Abbildung 0.3: MHV positions tenor

Abbildung 0.4: MHV positions flute

MHV_3 are each positioned in the middle and are outside the preferred direction of the radiation. However, in this way the horizontal width of the instrument is recorded in a balanced manner. In addition, the positioning in the near field and the movements of the musician weaken the cancellation effect in the center of the dipole. MHV_2 is frontal at the height of the flute, while MHV_3 is positioned elevated and is supposed to record a larger proportion of the flap and blowing noises.

The three selected positions for oboe, clarinet and saxophone are similar due to the similar radiation characteristics (see figures 0.5, 0.6 and 0.7). MHV_2 assumes the central, frontal position, which is just below the bell for the oboe and clarinet and above the bell for the saxophone. As a result, the M microphone picks up the sound of the preferred direction from the bell. MHV_3 represents an elevated, tilted variant, which aims at an image which is marked by the radiating flaps. MHV_1 is located on the right side and represents an alternative for the dynamic effects through movement as well as a tonal variant.

Abbildung 0.5: MHV positions oboe

Abbildung 0.6: MHV positions clarinet

Abbildung 0.7: MHV positions tenor saxophone

Abbildung 0.8: MHV positions violin

Abbildung 0.9: MHV positions double bass

String instruments

MHV_1 of the violin is located centered in front of the instrument, with the intention of capturing the width symmetrically (see figure 0.8). Due to the tilted orientation of the violin when playing, the axis of the arrangement is aligned respectively and the position does not correspond to the frontal viewing direction, which in turn MHV_2 does at the height of the instrument. MHV_3 is located above, at a greater distance from the instrument.

The arrangement MHV_1 on the double bass is located at the side and approx. at the height of the bridge representing a tonal variant of the centered MHV_2 which is aligned to the point above the bridge where the bow is guided (see figure 0.9). Therefore it should create a symmetrical image of the instrument and especially the horizontal dynamics of the bowing. MHV_3 is slightly offset from the center, clearly elevated and is aligned with the lower part of the fingerboard. The aim was to obtain a sound image with more noisy components through plucking and string snarling.

Abbildung 0.10: MHV positions western guitar

Western guitar

MHV_1 and MHV_2 are arranged at different distances from the front of the guitar (see figure 0.10). The preliminary tests have shown that an alignment to the sound hole does not deliver the desired sonic result. The alignment on the bridge seemed more suitable and the displayed image of the guitar appeared more horizontally centered. With its elevated positioning, MHV_3 represents a tonal variant with less body resonance.

Percussion and drumset

The aim of miking the shaker was to capture the dynamically varying source locations through the shaking movement. For this reason, three different orientations of the arrangements were chosen. MHV_1 is located approximately at the height of the shaker on the left-hand side and captures the described movements in horizontal direction (see figure 0.11). MHV_2 is positioned directly above the rest position of the instrument and records the movements in the vertical direction. MHV_3 represents an intermediate variant from the right below.

The signals of the congas to be captured can be divided into the two areas of the beating

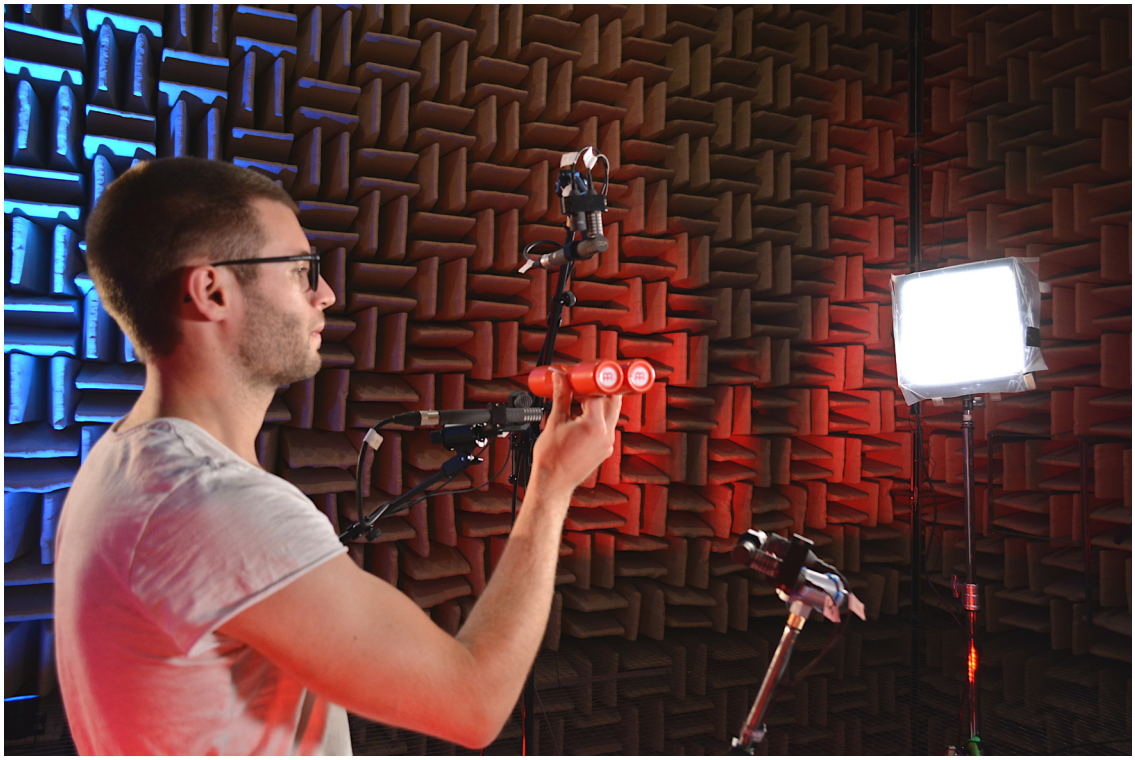

Abbildung 0.11: MHV positions shaker

Abbildung 0.12: MHV positions congas

Abbildung 0.13: MHV positions drumset

sound (above) and swinging out of the kettle (below). The beating with the hands, which varies in location depending on the desired sound, promises dynamic localisation in the reproduced display. For this reason, two close and one distant arrangements were chosen. MHV_1 is located slightly elevated near the edges of the batter heads and is intended to capture the vertical image of the sound from a centered point (see figure 0.12). MHV_2 is located above the batter heads and thus mainly captures the batter head. MHV_3 is positioned at a greater distance from the front and thus represents a variant of MHV_1.

The drums were captured with only two MHV positions (see figure 0.13). A third position was omitted because instead the kick drum and snare drum were each captured with an extra mono microphone as additional close signals for the mix. MHV_1 is in a classic overhead position above the drums, facing the snare drum, while MHV_2 is positioned between the kick drum, snare drum and cymbals while facing the snare drum from the front.

Tabelle 0.1: MHV positions per instrument

	height	**distance**	**azimut**	**elevation**	**alignment**
	[meter]	[meter]	δ [°]	ϕ [°]	**zero point**
mezzo-soprano	**1.50**				**mouth**
MHV_1	1.30	0.40	−46	−30	mouth
MHV_2	1.50	0.40	0	0	mouth
MHV_3	1.58	0.95	0	5	mouth
tenor	**1.60**				**mouth**
MHV_1	1.40	0.40	−46	−30	mouth
MHV_2	1.60	0.40	0	0	mouth
MHV_3	1.75	0.80	0	11	mouth
flute	**1.60**				**flute center**
MHV_1	1.45	0.30	−74	−30	flute center
MHV_2	1.60	0.25	0	0	flute center
MHV_3	1.85	0.35	0	46	mouthpiece
oboe	**1.30**				**oboe center**
MHV_1	1.30	0.25	−53	0	behind bell
MHV_2	1.00	0.35	0	−59	above bell
MHV_3	1.80	0.60	0	56	oboe center
clarinet	**1.30**				**clarinet center**
MHV_1	1.25	0.25	−55	−12	clarinet center
MHV_2	0.95	0.40	0	−61	bell
MHV_3	1.60	0.40	0	49	clarinet center
tenor sax.	**1.15**				**bell**
MHV_1	1.30	0.35	−39	25	behind bell
MHV_2	1.35	0.23	0	60	saxophone center
MHV_3	1.80	0.65	0	90	S-bocal
violin	**1.10**				**bridge**
MHV_1	1.25	0.30	−35	30	bridge; tilted axis

MHV_2	1.05	0.40	0	−7	bridge
MHV_3	1.60	0.70	0	46	bridge
double bass	**0.80**				**bridge**
MHV_1	0.95	0.50	−71	17	bridge
MHV_2	0.85	0.30	0	10	betw. bridge and fingerboard
MHV_3	1.50	0.80	−40	61	fingerboard lower half
western guitar	**0.80**				**soundhole**
MHV_1	1.15	0.70	0	30	bridge
MHV_2	0.90	0.35	0	17	bridge
MHV_3	1.20	0.42	−51	72	bridge
shaker	**1.55**				**neutral position**
MHV_1	1.50	0.20	90	−14	neutral position
MHV_2	1.70	0.15	0	90	neutral position
MHV_3	1.35	0.35	−44	−35	neutral position
congas	**1.00**				**betw. batter heads**
MHV_1	1.05	0.30	0	10	zero point
MHV_2	1.20	0.21	0	72	zero point
MHV_3	1.20	1.00	0	12	zero point
drumset	**0.70**				**snaredrum**
MHV_1	1.60	1.00	−27	64	snare; tilted axis
MHV_2	0.75	0.85	−21	3	Snare; tilted axis