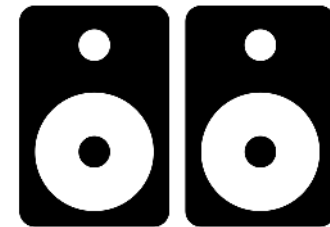
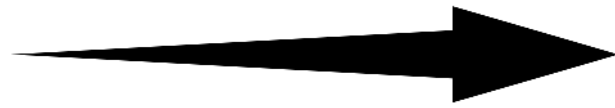


Real-time stereophonic sound using a ring of loudspeakers

m5251103: Sakuya Fujisawa
Supervisor: Julián Villegas

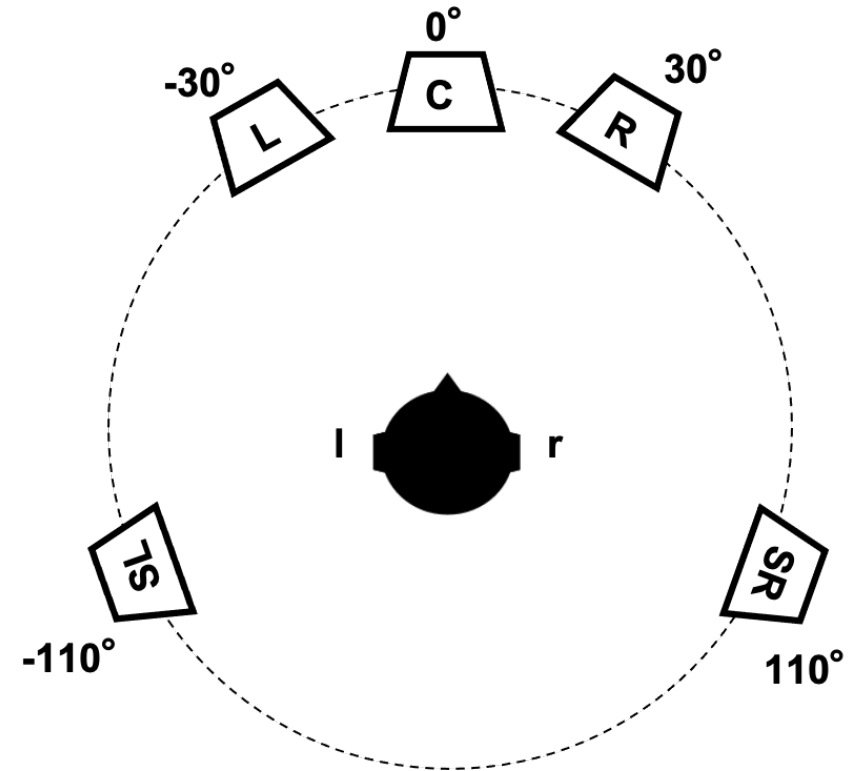
Background

- Currently, stereophonic sound is commonly used with headphones.
- Headphones can't share the sound with others.
- My research is on stereophonic sound using loudspeakers.



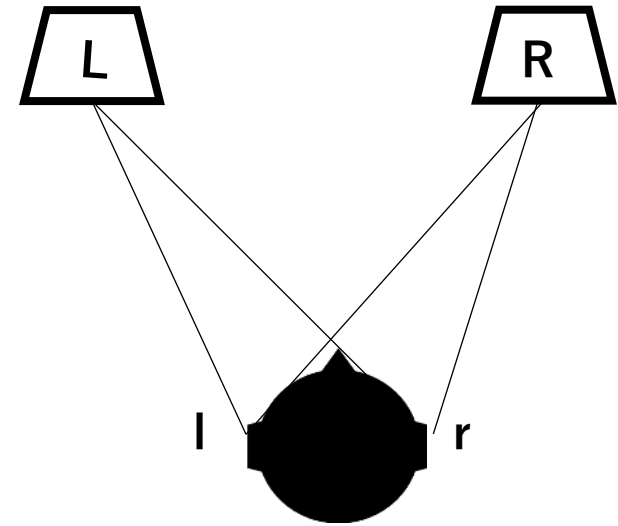
Background

- The most common loudspeaker arrangement is called 5.1 channels.
- Various systems for stereophonic sound by loudspeakers.



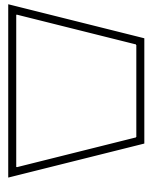
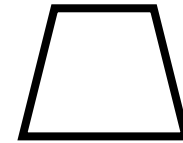
Trans-aural system

- Uses HRIR and convolution.
- Uses with fewer loudspeakers.
- Works only in the sweet spot.



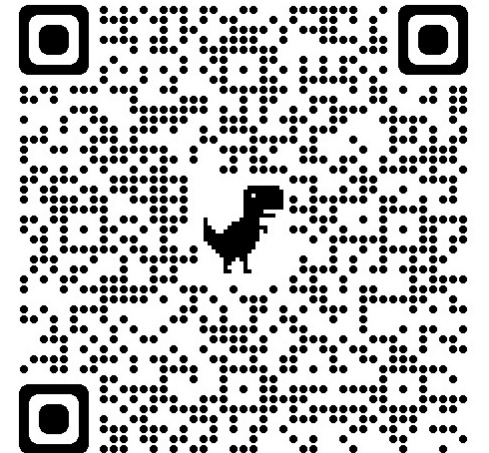
VBAP (Vector Base Amplitude Panning)

- Uses stereo panning and some loudspeakers.
- Computationally efficient.
- This system does not collapse if listener moves.
- This system requires loudspeakers above the listener for vertical localization.



Spatialization by equalizing filters and grouping

- My lab has original sound system.
- This system uses HRTFs, convolution, and crossfade.
- This system does not collapse if listener moves.
- This system uses few loudspeakers.
- This system is very computationally intensive.



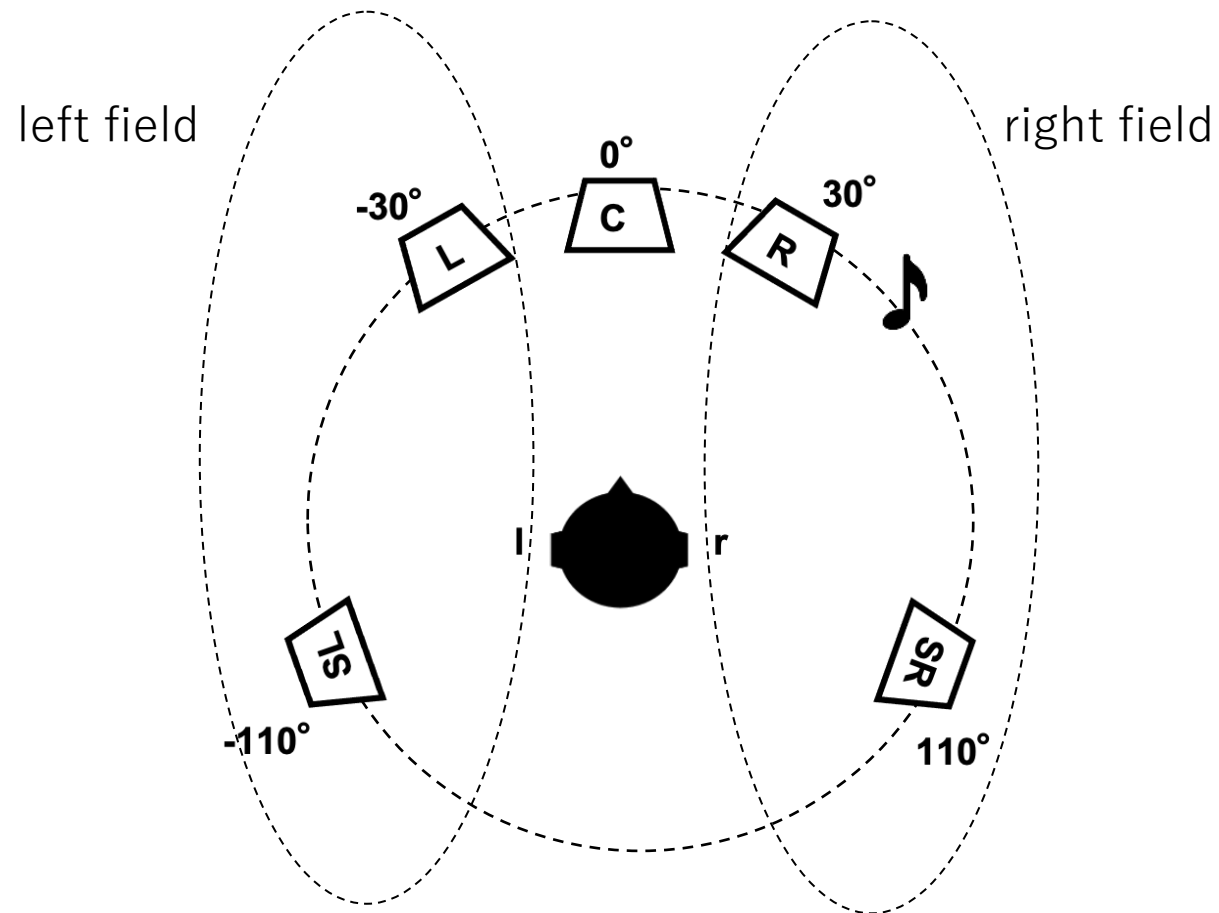


Goal

- This system is converted to a real-time system.

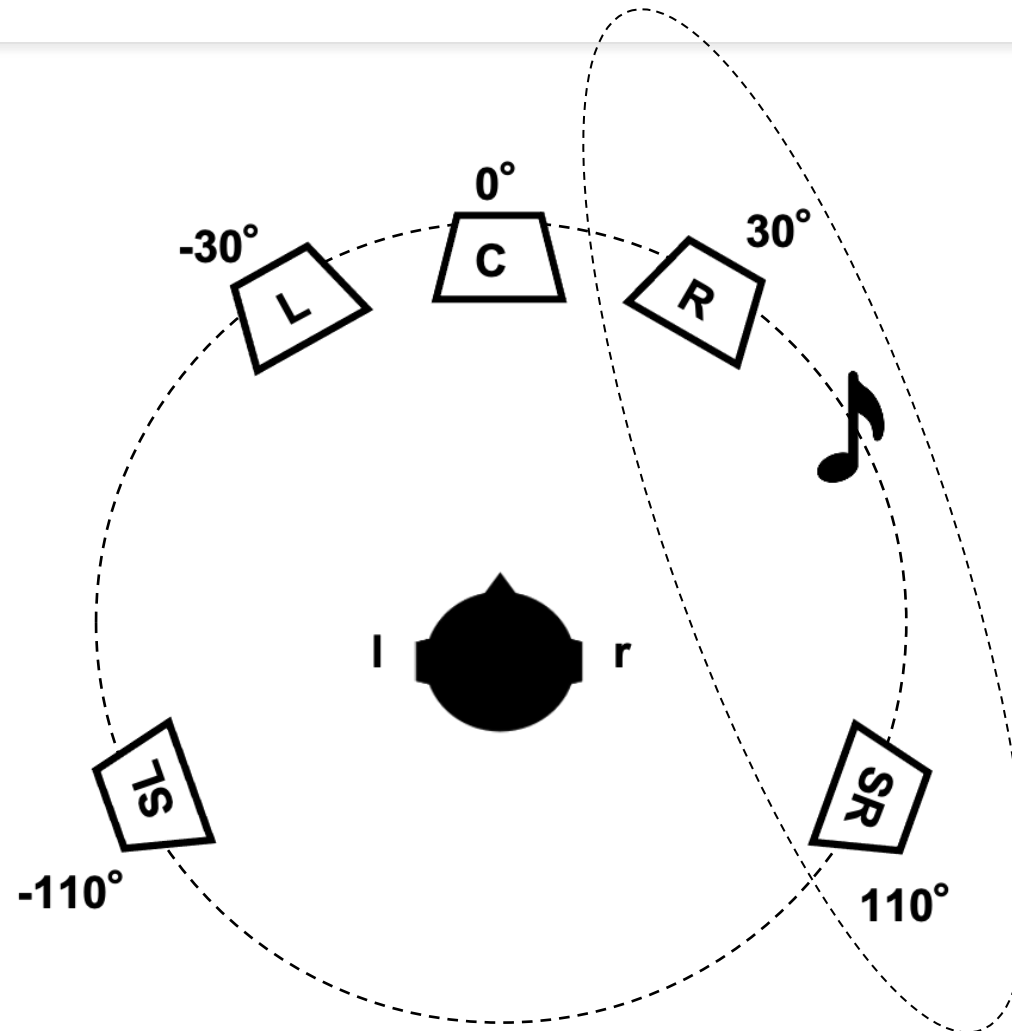
Loudspeaker grouping (vertical)

vertical

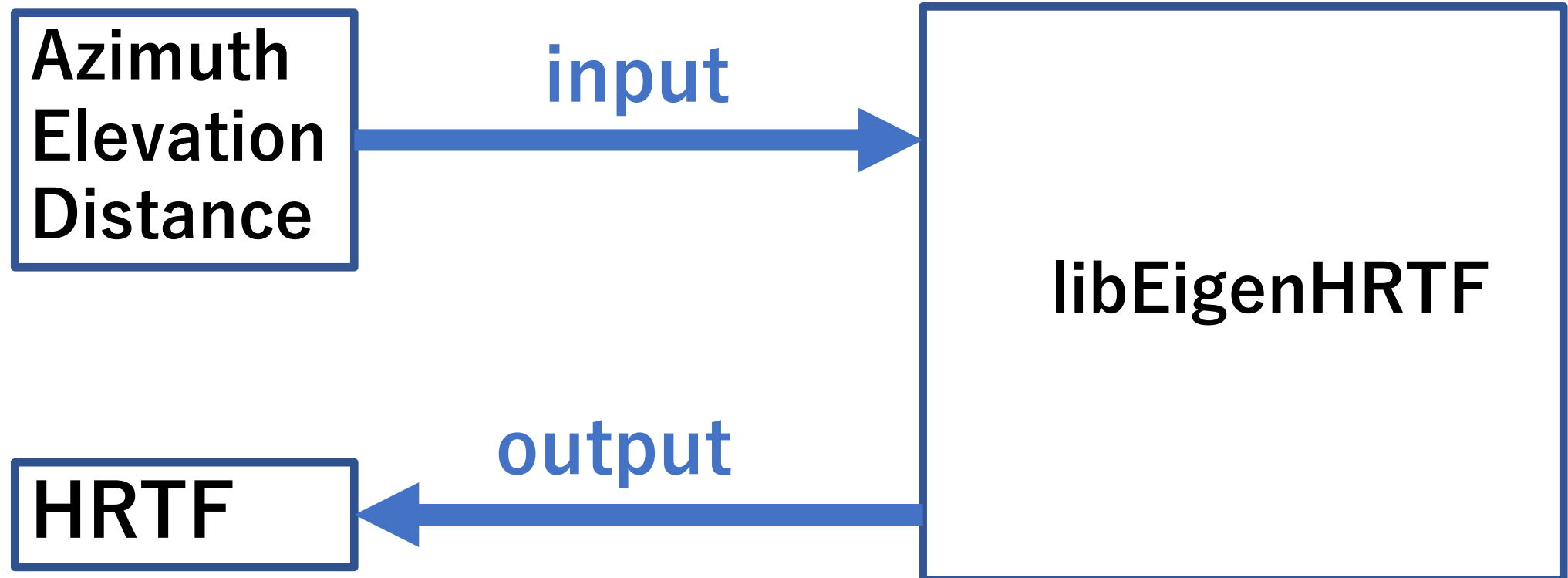


Loudspeaker grouping (horizontal)

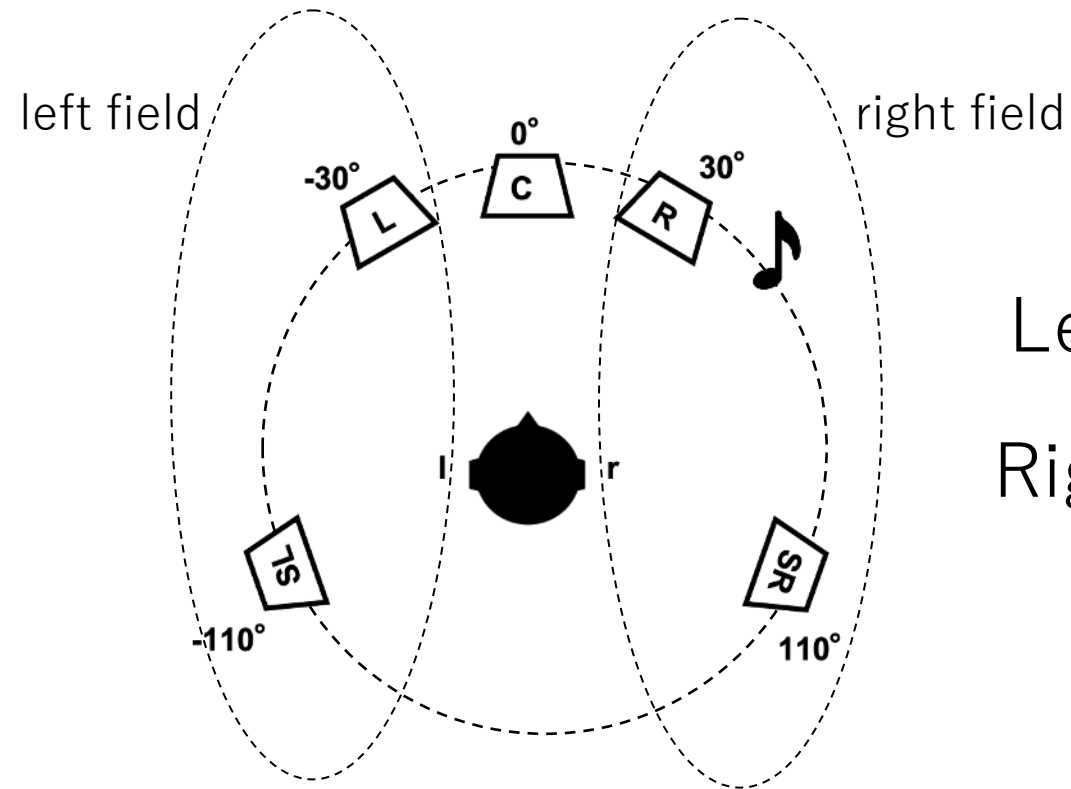
horizontal



HRTF (Head Related Transfer Function)

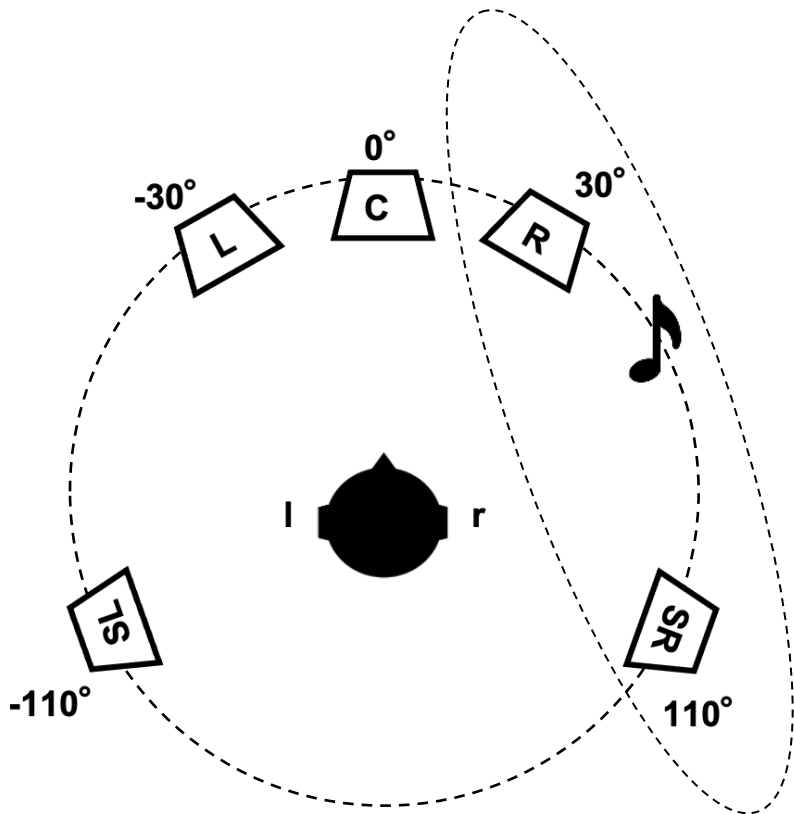


Convolution (vertical)



Left field = Convolution left IR and signal
Right field = Convolution right IR and signal

Convolution (horizontal)

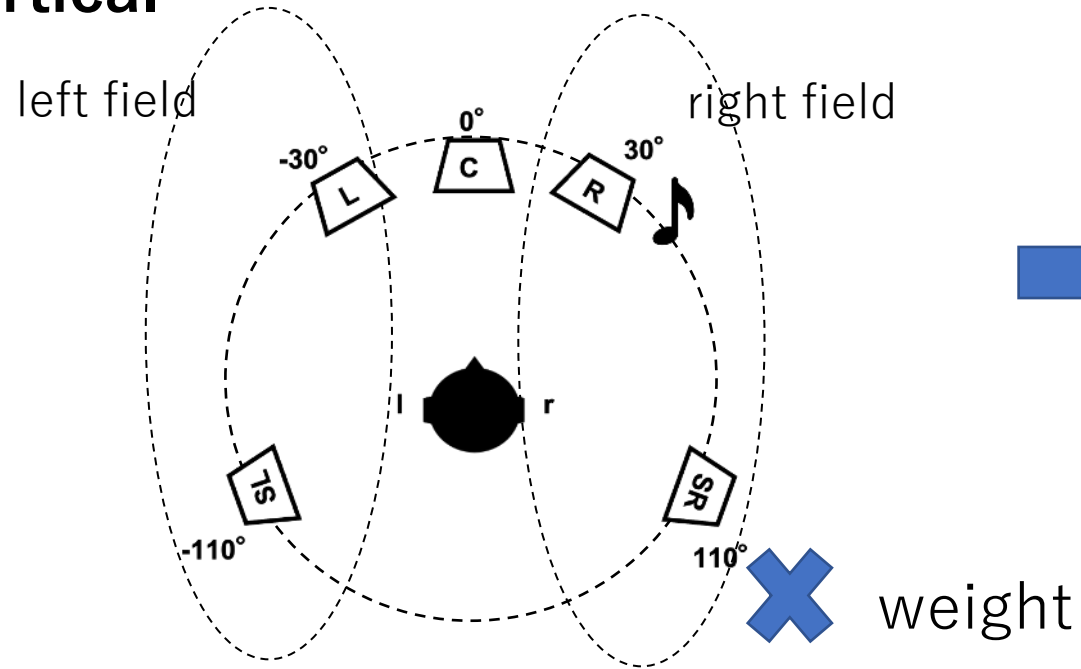


$$H_z = H_x / (H_l + H_r)$$

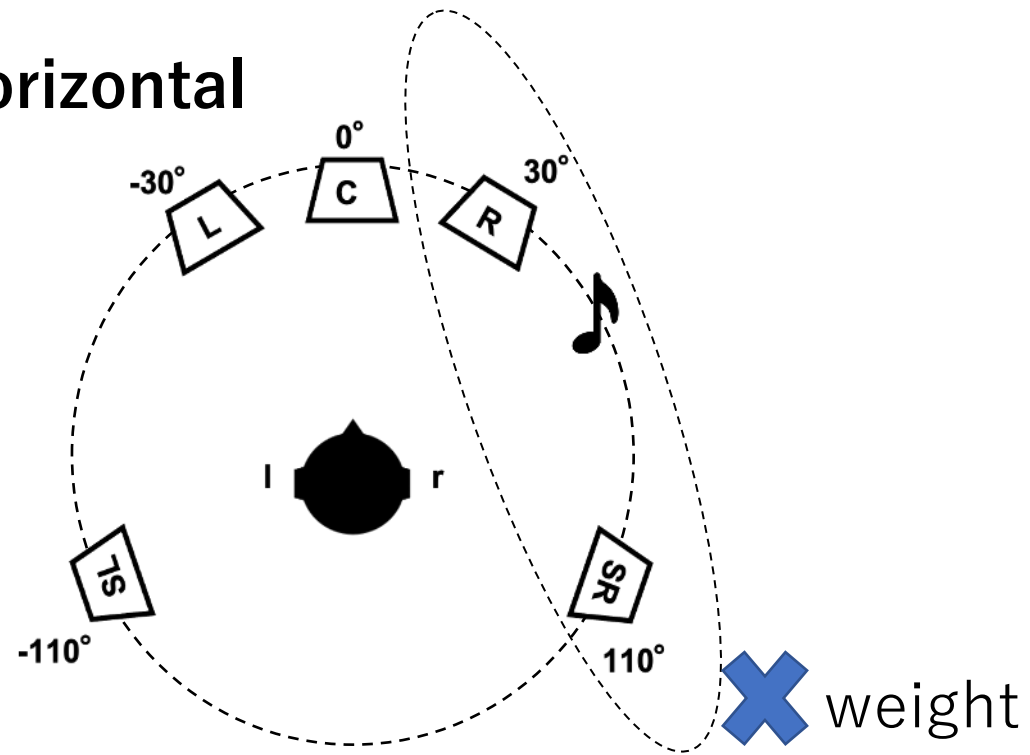
Inverse filter :
Convolution Hz and signal

Cross-fade

vertical



horizontal



Pure-data

- This system is converted to a real-time system.
- Pure-data is real time graphical programming language.

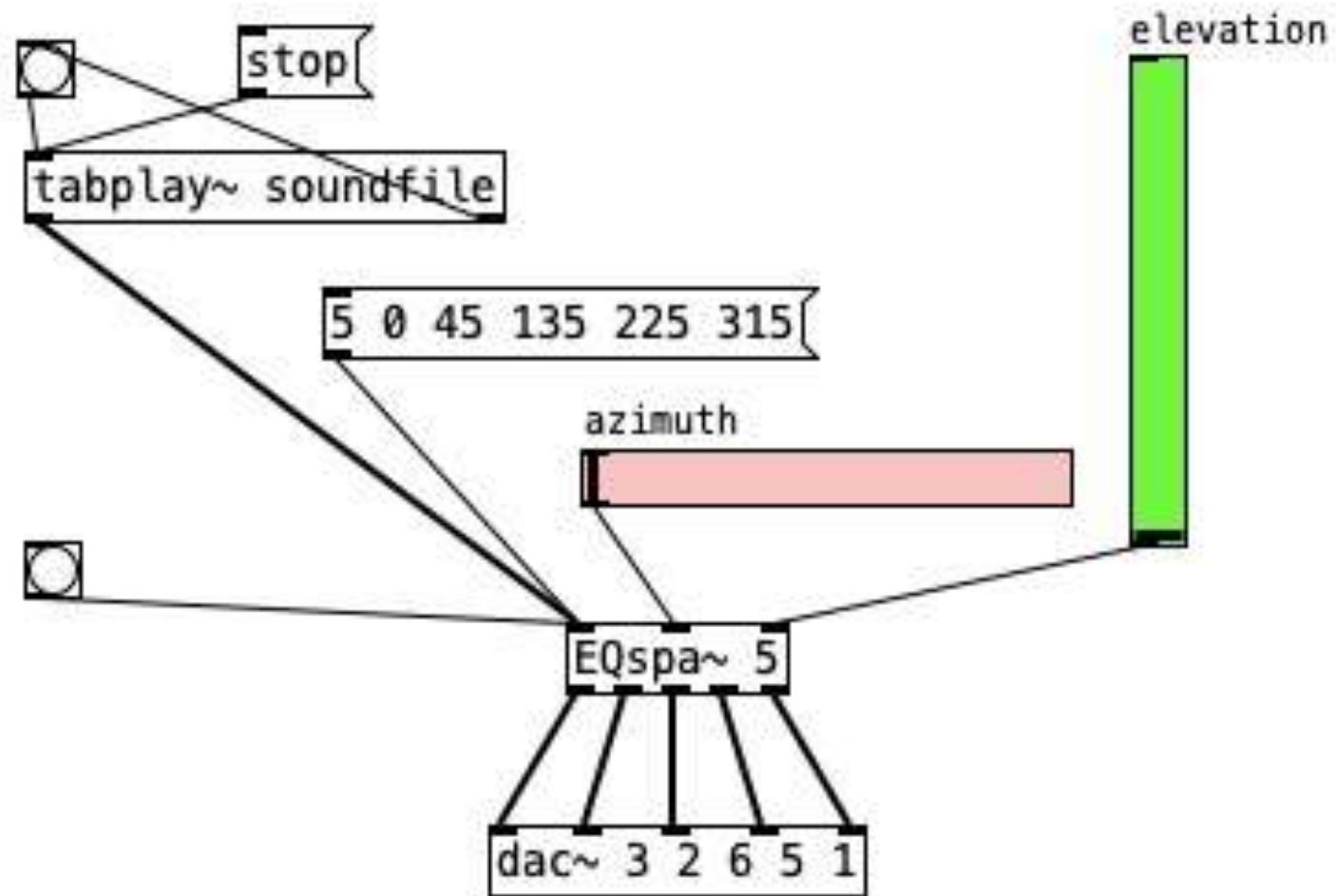




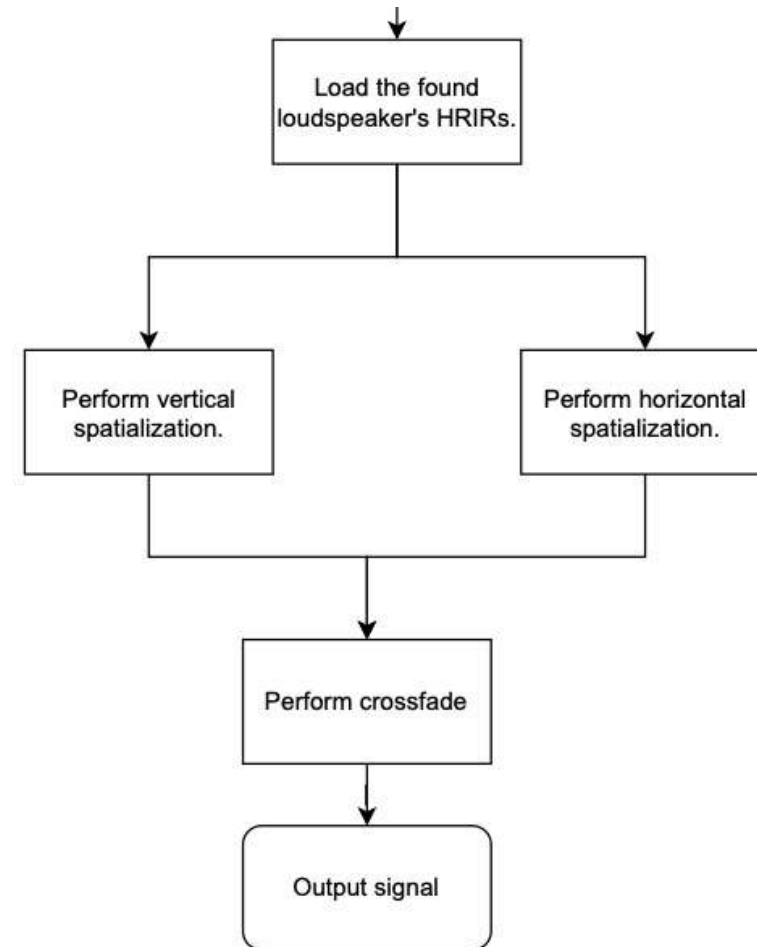
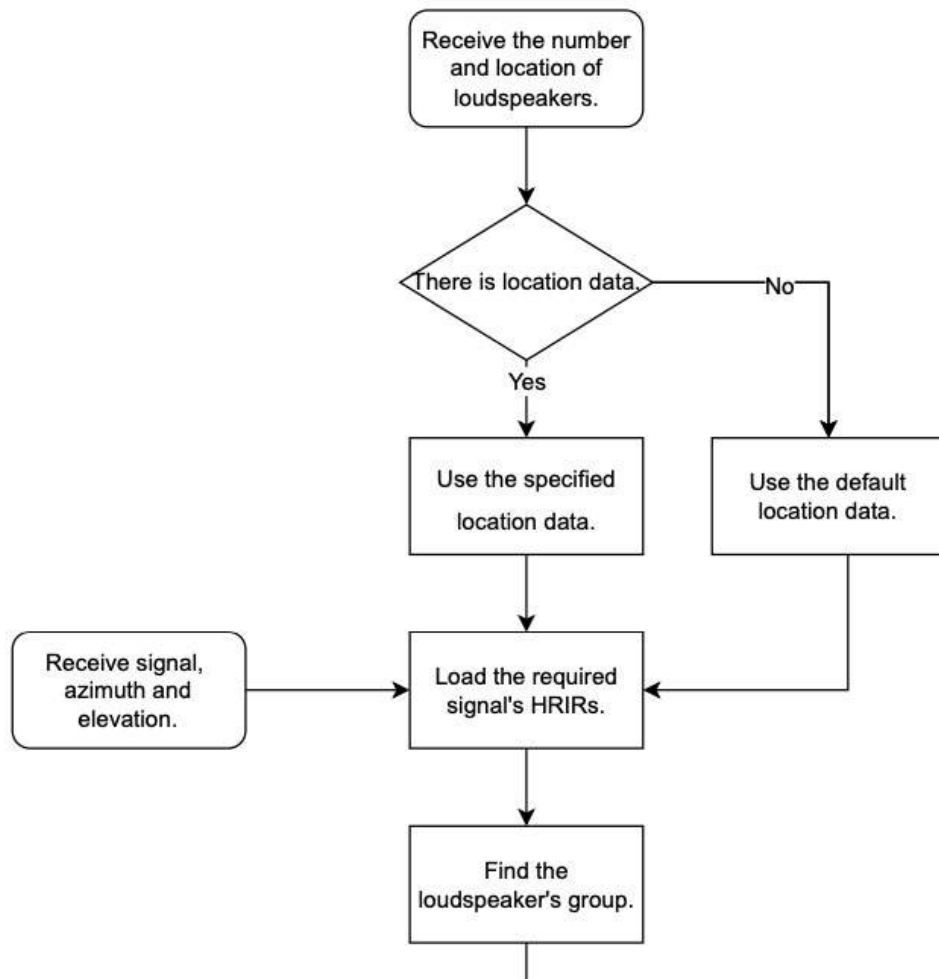
Pure-data external

- Pure-data has a many objects in default.
- There is a technology called Pure-data external creates new objects.

Object design

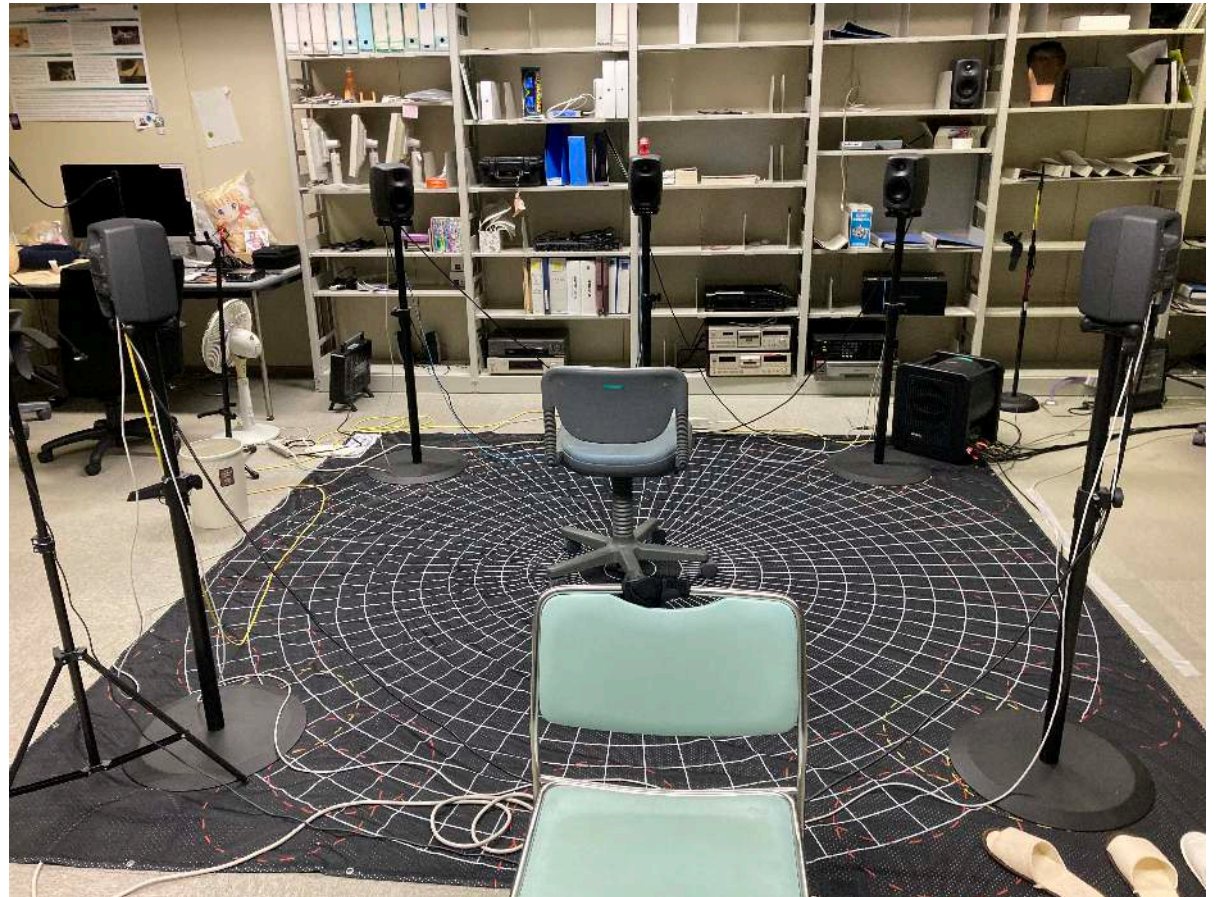


Object processing



Experiment

- 5.1ch in my laboratory.



OSC (Open Sound Control)





Future work

Experiment

- Compare the number of loudspeakers with different numbers of loudspeakers.
- Compare the using equalization and not using equalization.
- Compare the using Inverse filter and not using Inverse filter

References

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Thank you for listening !!

Ambisonic

- Ambisonic is a sound field sampling technology.
- This technology requires a special microphone or some microphones.
- The interpolation between loudspeakers is perfect.
- This system requires the listener to be in the sweet spot.
- This system is expensive.

About equalization

- Each loudspeaker is in a different location.
- Equalization is a technique that corrects or averages the audio.
- This technique remove the effect of location.

