P6-1 Audio-visual Experiment for 3D Audio System Based on Multiple Vertical Panning

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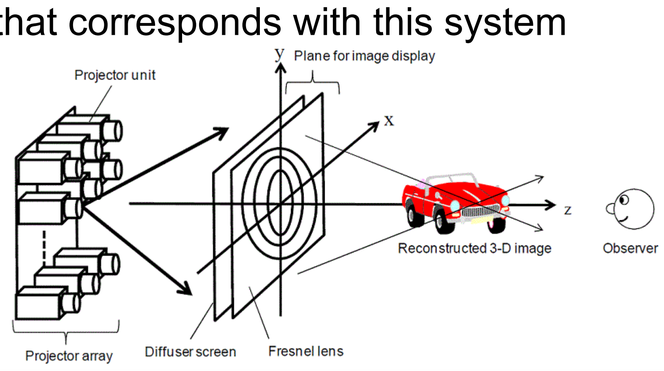
1. INTRODUCTION

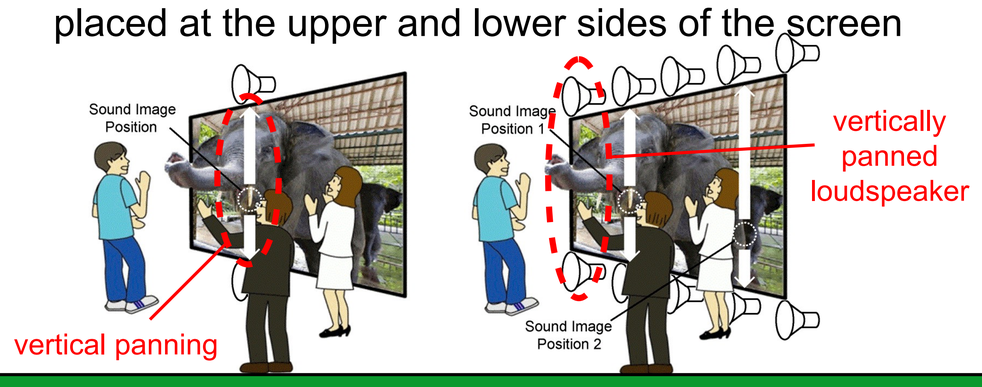
Multiview 3D video display system

- Presents only visual sensations
- 3D audio system must be developed that corresponds with this system



Proposed 3D audio system

- Sound is played by the “vertical panning”
- Multiple “vertically panned loudspeakers” are placed at the upper and lower sides of the screen



Aim of Study

- Past study
  + 3D audio system was proposed
  + The performance of vertical panning was evaluated by listening test
  + Panning curve was set based on the result of the listening test

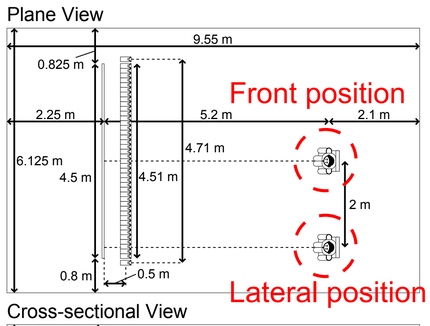
The audio-visual performance of the proposed system is evaluated

2. AUDIO-VISUAL EXPERIMENT

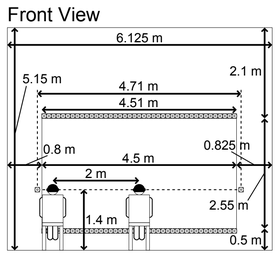
Experimental Environment

- Visual Experimental room
  + Reverberation time: 258 ms
  + Background noise level: 41 dBA
  + Viewing position: 2 positions
    + Front position
    + Lateral position
  + Viewing distance: 5.2 m from screen
  + Sound pressure level: about 70 dBA

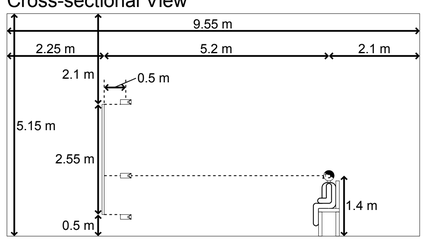
Plane View



Front View



Cross-sectional View

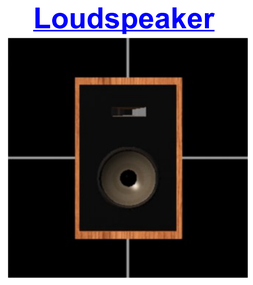


Experimental Condition

Index	Sound	3D video
(I)	Stereo	Sound only
(II)	Proposed system	Sound only
(III)	Stereo	Sound & video
(IV)	Proposed system	Sound & video

- 3D video condition
  + White noise sound
    + Loudspeaker image (4 seconds)
  + Speech sound
    + Character Movie (4 seconds)

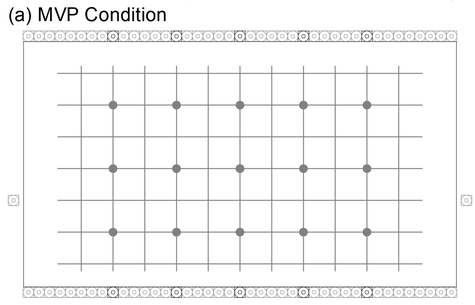
Loudspeaker



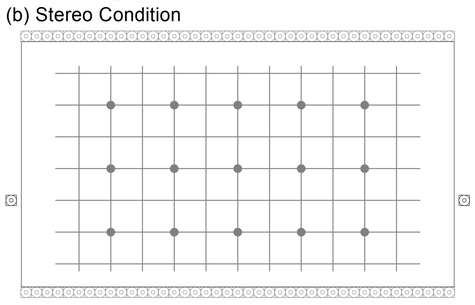
Character

- Sound condition
  + Proposed system condition (a)
    + Vertical panned sound is played from top-and-bottom loudspeakers
  + Stereo condition (b)
    + Horizontal panned sound is played from right-and-left loudspeakers

(a) MVP Condition



(b) Stereo Condition

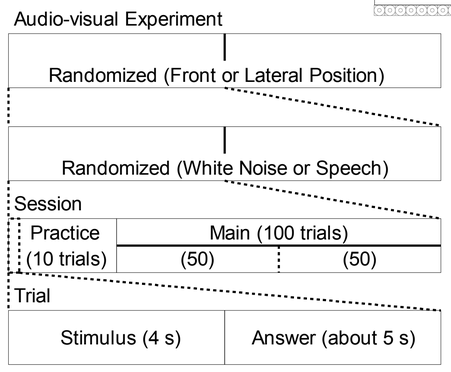


Experimental Design

- Viewers
  + 12 persons: 6 males & 6 females
  + Age: 21-40 years old
  + Audibility: Normal in daily life

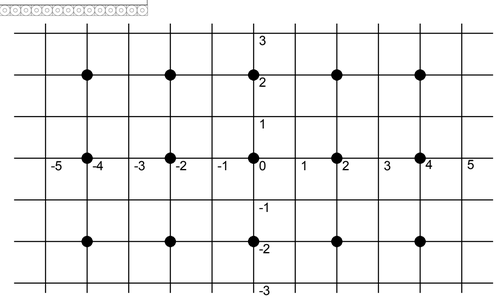
	Element	Note
Practice (10)	= 2 conditions × 5 positions	Condition (II) & (IV)
Main (100)	=[1 condition × 5 positions + 3 conditions × 15 positions] × 2 repetitions	Condition (I) Condition (II)-(IV)

Audio-visual Experiment



Experimental Procedure

- Instruction
  + Gaze at 3D object if 3D video is presented
  + Report the perceived position of sound images
  + List the index of positions in an answer sheet
    + Horizontal index: 11 patterns (from -5 to 5)
    + Vertical index: 7 patterns (from -3 to 3)
  + Be able to list multiple indexes if multiple images are perceived
  + Be allowed to move their head and upper body freely while listening to a sound



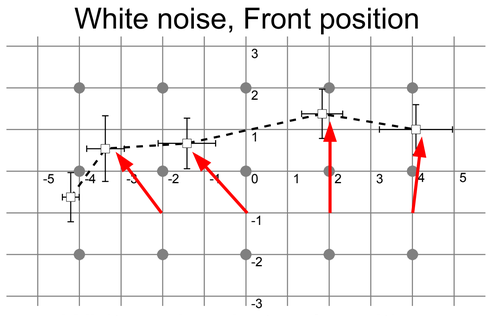
Experimental Results

- Sound only condition
  + Stereo
    + Front position: The vertical localized position is higher than the input position
    + Lateral position: The horizontal and vertical positions are not accurately localized
  + Proposed system
    + Front position: The vertical localized accuracy is improved
    + Lateral position: The horizontal localized accuracy is improved

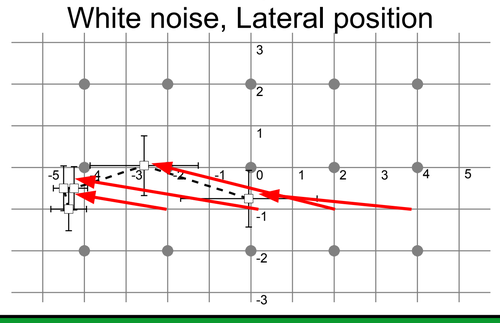
- Sound & video condition
  + Stereo
    + Front position: The localized position is generally accurate (ventriloquism effect)
    + Lateral position: The localized position is biases to the left side
  + Proposed system
    + Front position: The localized position is the same as the position of 3D object
    + Lateral position: The localized position is the same as the position of 3D object

Stereo

White noise, Front position

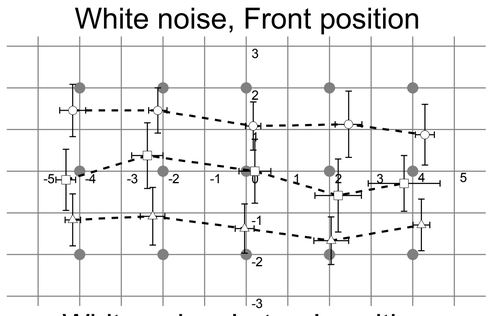


White noise, Lateral position

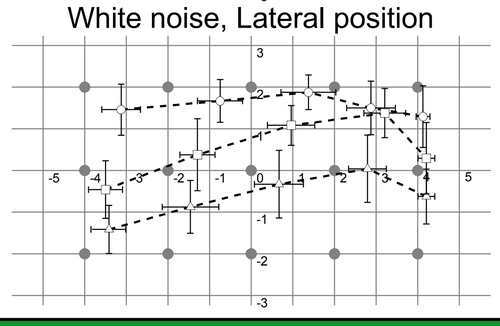


Proposed System

White noise, Front position

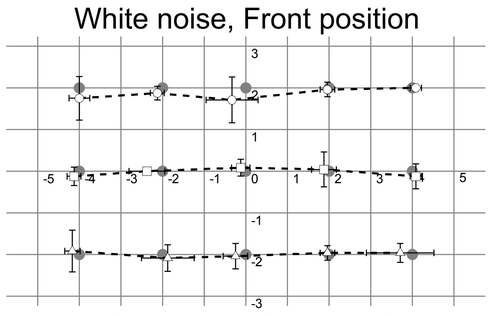


White noise, Lateral position

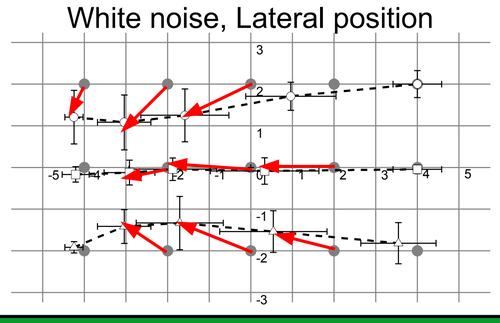


Stereo

White noise, Front position

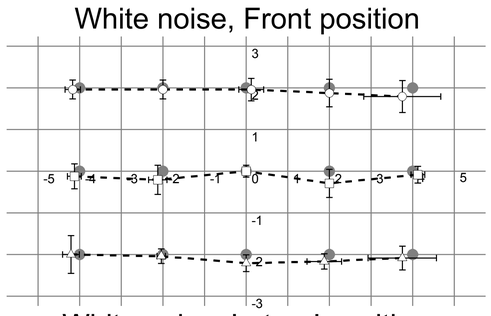


White noise, Lateral position

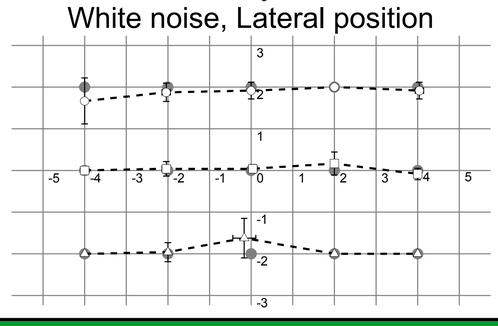


Proposed System

White noise, Front position



White noise, Lateral position



3. CONCLUSION

- Audio-visual experiment was performed for our proposed 3D audio system based on multiple vertical panning (MVP-audio)
- Loudspeaker array in which eighty-two loudspeakers were placed at the upper and lower sides of the 200-inch screen
- The proposed 3D audio system was effective as compared with a conventional system such as stereophonic audio
  + **Viewers could always perceive the synthesized sound images at the position of the 3D object at any viewing position**
- Future work: Feasibility of a practical realization of the proposed system
  + **Reducing the number of loudspeakers**
  + **Constructing the method of recording and transmission**