SPATIAL CODING BASED ON THE EXTRACTION OF MOVING SOUND SOURCES IN WAVEFIELD SYNTHESIS

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1. INTRODUCTION

Sound Field Auralization Based on Wavefield Synthesis
- Synthesis of wave fronts at the listening area according to Huygens principle
- The number of channel signals is very large

Spatial Coding Method Based on the Extraction of Sound Sources
- The amount of data transmitted
- The number of channel signals \(\rightarrow\) The number of sound sources
- Conventional studies: Sound sources are not moving

The amount of data transmitted needs to be reduced

New spatial coding method for moving sound sources is proposed

The amount of data transmitted \(\rightarrow\) The number of sound sources

2. ALGORITHM

Block Diagram

Encoding

Decoding

Calculation of Inverse Transfer Function

Calculation of Room Transfer Function Database

Calculation of Inverse Transfer Functions

Window Function

Original Sound Field
- 24 microphones (in the circle of radius 2[m])
- 1 moving sound source

Synthesis of Channel Signals
- Simulation by image method

Synthetic conditions of channel signals

Dry source Speech Flute

\(F_s\) (Sampling frequency) 48[kHz]
Duration of sound source 4[second]
Reflection coefficient 0.5 0.7
Maximum reflection order 6 10
Reverberation time 0.6[second] 1.0[second]

Calculation conditions of inverse transfer functions

Reverberation time 0.6[second] 1.0[second]
FFT frame length [sample] 65536 131072
Coding delay time \(T_d\) (\(=P_c/F_s\)) 20[ms]/\(=960[\text{sample}]\)
Inverse transfer function length [sample] 28800 48000

Convoluted Transfer Functions

Conditions of window function

Sampling frequency of position information \(P_m\)
(1600, 800, & 400 [sample])

Linear cross-fade time \(T_{cf}\)
(1, & 4 [ms])

Calculation conditions of inverse transfer functions

Spatial Coding Experiment

The number of sound sources

Calculation of Inverse Transfer Functions

Calculation of Room Transfer Function Database

Calculation of Inverse Transfer Functions
4. SUBJECTIVE ASSESSMENT

Experimental Design
- Subject... 8 male students
- Protocol... Double-blind triple-stimulus with hidden reference
- Practice trials... 12
  - 6 (Types of coding sound) x 2 (Either “A” or “B”)
- Main trials... 24
  - 6 (Types of coding sound) x 2 (Either “A” or “B”) x 2 (Repetition)

Subjective Assessment
- Evaluation
  - Session 1: Order (Randomized, Speech or Flute)
  - Session 2: Practice (12 trials), Main (24 trials)
- Types of the coding sound
  - $F_p = 30$ Hz
  - $F_p = 60$ Hz
  - $F_p = 120$ Hz

Selection of Subjects
- The number of the correct response
- Grading of the stimulus assigned the original sound as 5.0
- Further analysis data set
- Top 3 subjects of each session (shown by color)

Discrimination results of each subject

5. CONCLUSION

Spatial coding method based on the extraction of moving sound sources was proposed
- The amount of data to be transmitted
  - The number of channel signals → The number of moving sound sources
- A coding experiment with a reverberant sound field synthesized by an image method was performed
  - Reduction of the amount of data to be transmitted by the experiment
  - 24 channel signals → 1 moving sound source signal
- The subjective assessment was performed to evaluate the performance of the proposed method
  - The perceptual quality obtained with the proposed method was acceptable
    - when appropriate parameters for moving sound source were applied according to the type of sound sources
    - Parameters
      - Switching time of the position of sound sources
      - Cross-fade time to smooth the waveform of the extracted source signals
- Future works
  - Evaluation of recoding channel signals in a real environment
  - Interpolation method of the position of moving sound sources by the low-cost position detection system
  - Estimation method of room transfer functions from the shape of the room