

**Objective**

This study aim to examine **the combined SSP (Spatial Smoothing Processing) and MUSIC (Multiple Signal Classification) methodology**, based on the leading edge technology of radar signal processing, for estimating **the locations of high-correlation sound sources**.

**Back ground**

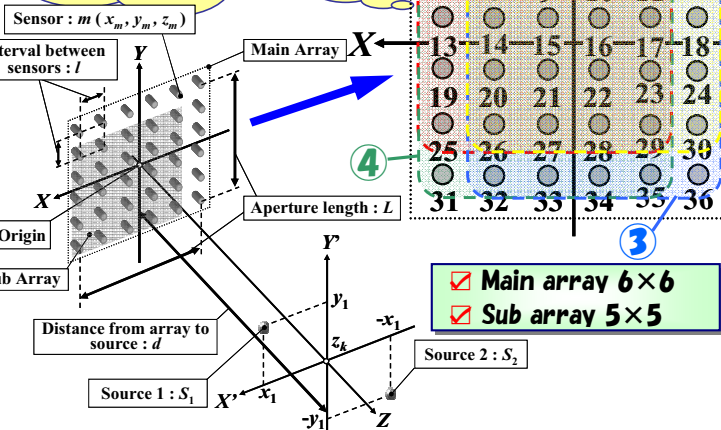
- ! It is difficult to visualize **the high-correlation sound source**.
- ! Sound sources emit **neighborhood frequency** occurred by such as **the reflection phenomena**.

- ⊙ We propose a technique based on **the location finding technique**.
- ⊙ We discuss the effectiveness of **SSP and MUSIC method**.
- ⊙ The performance tests discussed **under a series of the computational and experimental conditions**.

In this study

**Approach**

◇ We can make four sub arrays

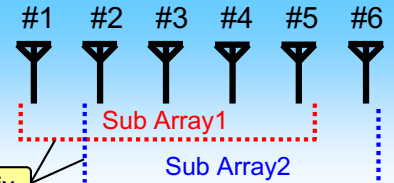


The configuration between the sound sources and the microphone array system

**The computational conditions**

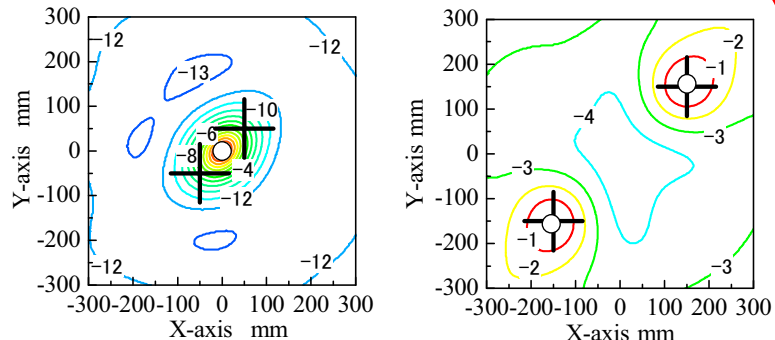
Array sensor	Uniform square array
Number of sensors	6 × 6
Number of sensors in sub array	5 × 5
Interval between sensors l [mm]	85
Distance from array to source d [mm]	500
Number of samples	10000
Sampling period [μS]	10
Source frequency f [Hz]	2000
Resolution of DFT [Hz]	1
Analytical method	Combined SSP and MUSIC
Coordinates of source position [mm]	(±50, ±50), (±150, ±150)

**Spatial Smoothing Processing**

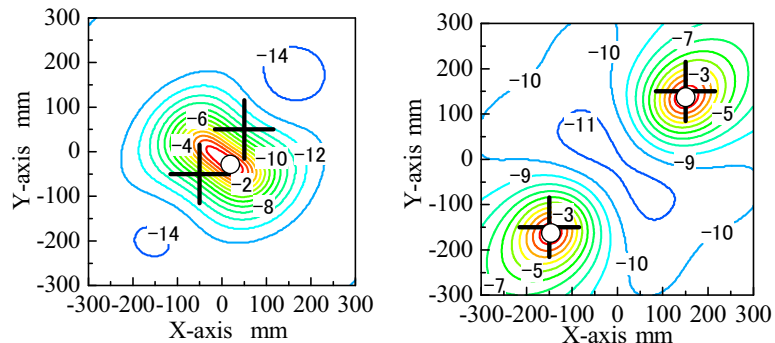


The averaged covariance matrix

**The computational results**



(a) (±50mm, ±50mm) (b) (±150mm, ±150mm)  
(I) The results without the SSP

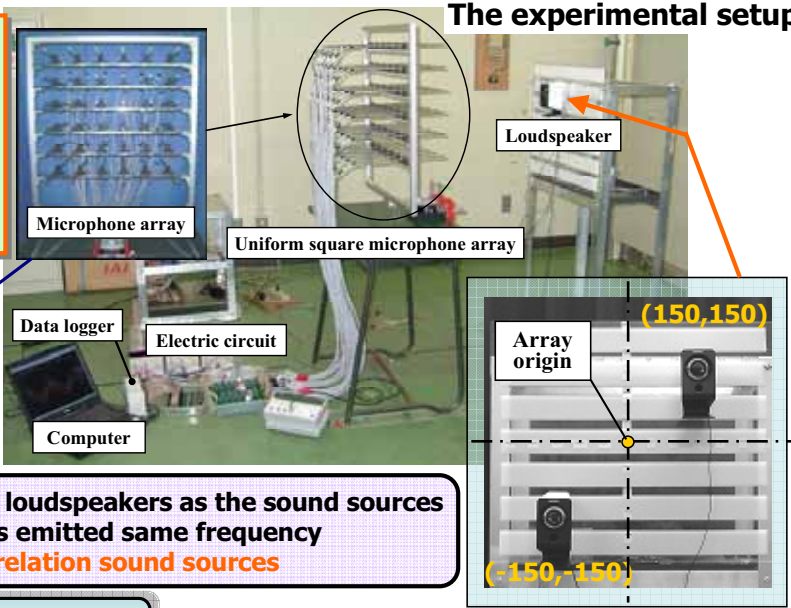


(a) (±50mm, ±50mm) (b) (±150mm, ±150mm)  
(II) The results with the SSP

⊙ With SSP ⇒ High sensitivity level

### Experimental method

- We demonstrate the location finding characteristics of the combined SSP and MUSIC method for the high-correlation sound sources by the computational examination.
- We discuss by the experimental examination using the prototype uniform square microphone array system.



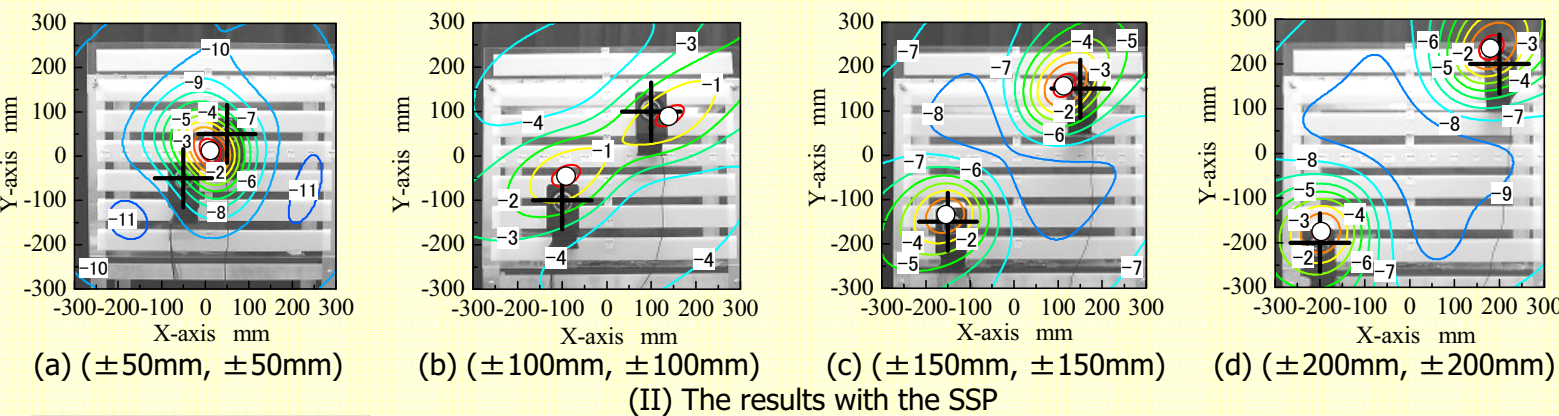
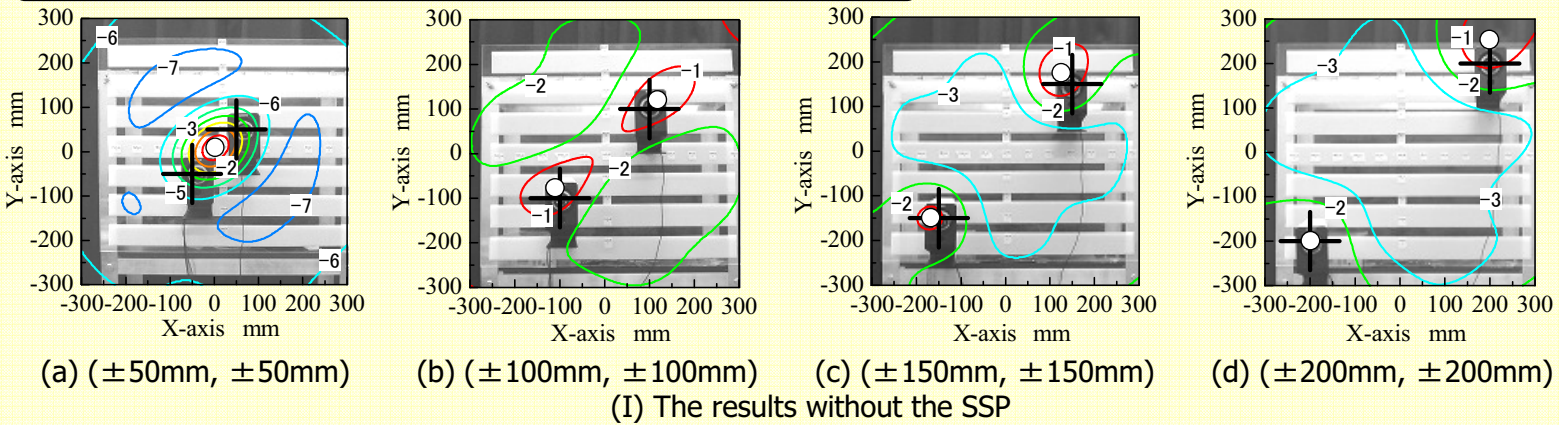
#### The main experimental conditions

Main array 6×6  
Sub array 5×5

Number of sources	2
Sources positions [mm]	(±50, ±50) to (±200, ±200) (step 50mm)
Sources pressure [dB]	80.4~84.3
White noise [dB]	44.2
Range of analysis [mm]	±300 × ±300
Analytical step interval [mm]	1.0

- ◇ We used two loudspeakers as the sound sources
- ◇ Loudspeakers emitted same frequency
- ⇒ The high-correlation sound sources

### The visualization results by experiment



### Conclusions

- Resolvable intensity using the combined SSP and MUSIC method are remarkably improve compared with the conventional methods.
- The combined SSP and MUSIC methodology is very effective method for the location finding.

