Dynamic Microphone Platform Array
Report on Simulation Results

University of Kentucky · EE595 Independent Research

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Abstract

Several simulations were run to test the performance of dynamic microphone platform arrays for use in an Steered Response Coherent Power (SRCP), source-localization, imaging scheme. Variables of interest during simulation were number of microphones per platform, number of platforms, distance to source (equi-distance setup), and pitch angle of platform. Results from a non-equidistance setup is also included. A github repository has been setup with all MATLAB scripts, images, figs, and movies made during these simulations. The files can be viewed at `https://github.com/michaelsikora/EE959sims`.

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Code Design

The testsprimage.m script found in the AudioToolBox library was used as a starting point for the code written for these simulations [1]. The directory **tools/** was made to modularize the functions needed for these simulations. The Platform object previously implemented was included in **tools/OOPstyle/**.

During the Simulations, the following parameters were varied.

1. Pitch of platforms (0 to 90 degrees)
2. Distance to Source
3. Number of Platforms
4. Number of Microphones per Platform

Simulations

For the following simulations, a chirp source was generated using the *simimp* function. The source position was set at the center of the room with xyz-coordinates 0, 0, 1.5. The adjacent mic-to-mic distance with the equally-spaced platform geometry is calculated by,

$$2 \cdot \sin\left(\frac{\pi}{\text{number of microphones}}\right) \cdot \text{radius of array}$$

The platform-to-platform distance can also be determined similarly.

Simulation 1 - 3 mics, 4 platforms

In this simulation, four platforms were defined with a three microphone array on each. The three microphones were defined to be equally spaced 10cm from the center of the platform. The platform arrays were initially oriented so that one microphone was on the line defined from the source to the center of the platform. The platforms were placed equally-spaced with varying distance to the source. The distance to the source was set by

iterating through the vector [0.5, 1, 1.5, 2, 2.5, 3, 3.5] with units of meters. The pitch angle of the platforms were iterated from 0 to 90 degrees using 8 angles. Figure 1 shows the SNR in decibels at each distance to source for the planar endfire orientation (0 degrees) and the broadside (90 degrees). Figure 5 shows the SNR in decibels for each distance to the source as well as each angle. Figure 3 shows the above view of the SRP image of the last iteration with distance to the source of 3.5 meters and the platform pitch angle of 90 degrees.

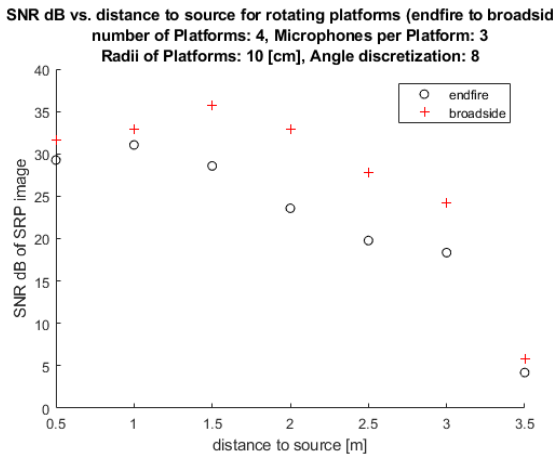

Figure 1: SNR dB of simulation 1

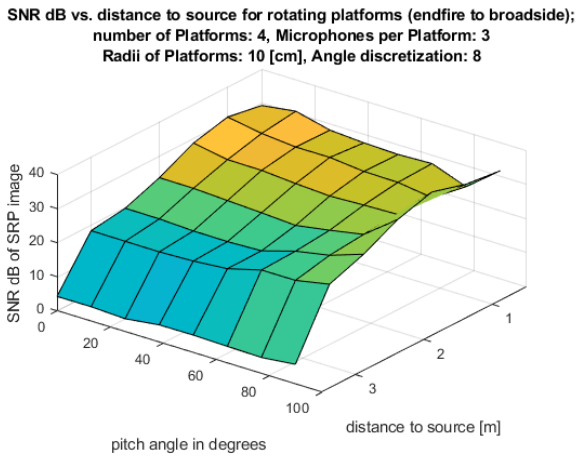

Figure 2: SNR dB surface of simulation 1

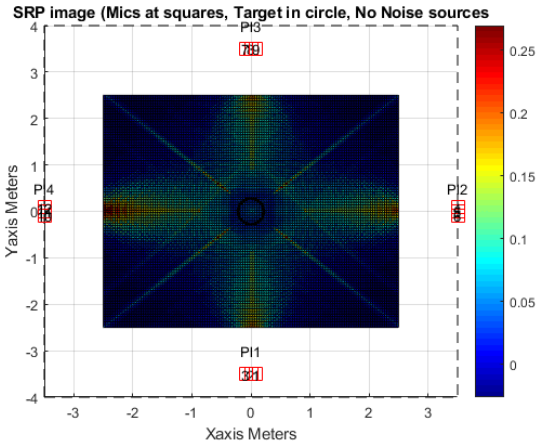

Figure 3: SRP image of last iteration of simulation 1

Simulation 2 - 3 mics, 3 platforms

In this simulation, three platforms were defined with a three microphone array on each. The microphones on each platform were setup the same as in the first simulation. The platform arrays were initially oriented so that one microphone was on the line defined from the source to the center of the platform. The platforms were placed equally-spaced with varying distance to the source. The distance to the source was set by iterating through the vector [0.5, 1, 1.5, 2, 2.5, 3, 3.5] with units of meters. The pitch angle of the platforms were iterated from 0 to 90 degrees using 12 angles. Figure 4 shows the SNR in decibels at each distance to source for the planar endfire orientation (0 degrees) and the broadside (90 degrees). Figure 5 shows the SNR in decibels for each distance to the source as well as each angle. Figure 6 shows the above view of the SRP image of the last iteration with distance to the source of 3.5 meters and the platform pitch angle of 90 degrees. For this geometry the broadside has higher SNR for all distances except at 0.5 meters to the source.

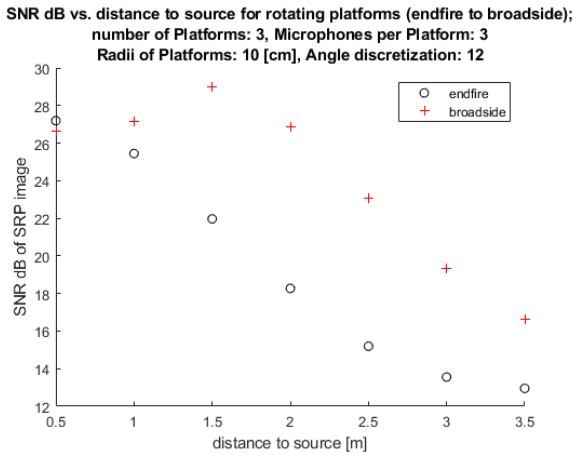

Figure 4: SNR dB of simulation 2

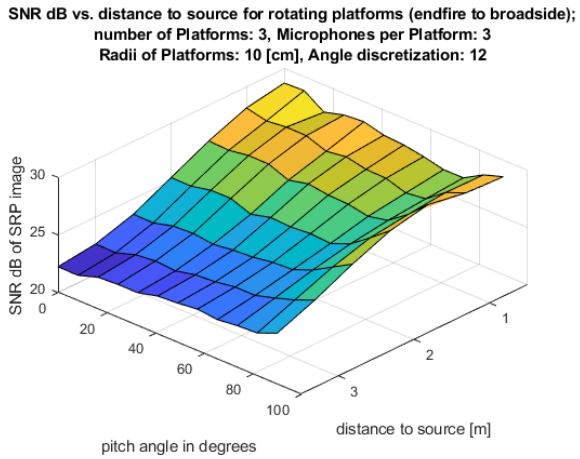

Figure 5: SNR dB surface of simulation 2

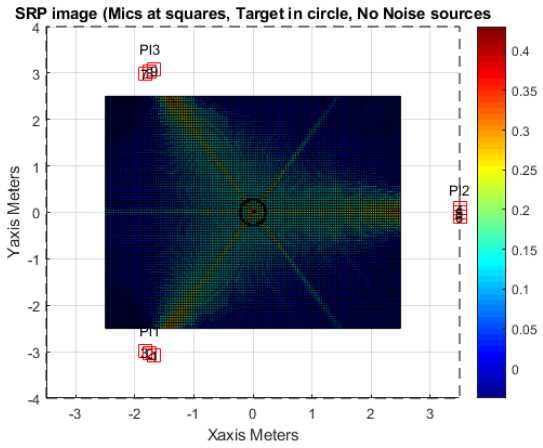

Figure 6: SRP image of last iteration of simulation 2

Simulation 3 - 3 mics, 2 platforms

In this simulation, two platforms were defined with a three microphone array on each. The microphones on each platform were setup the same as in the first simulation. The platform arrays were initially oriented so that one microphone was on the line defined from the source to the center of the platform. The platforms were placed equally-spaced with varying distance to the source. The distance to the source was set by iterating through the vector [0.5, 1, 1.5, 2, 2.5, 3, 3.5] with units of meters. The pitch angle of the platforms were iterated from 0 to 90 degrees using 12 angles. Figure 4 shows the SNR in decibels at each distance to source for the planar endfire orientation (0 degrees) and the broadside (90 degrees). Figure 5 shows the SNR in decibels for each distance to the source as well as each angle. Figure 6 shows the above view of the SRP image of the last iteration with distance to the source of 3.5 meters and the platform pitch angle of 90 degrees. For this geometry the broadside has higher SNR for all distances except at 0.5 meters to the source.

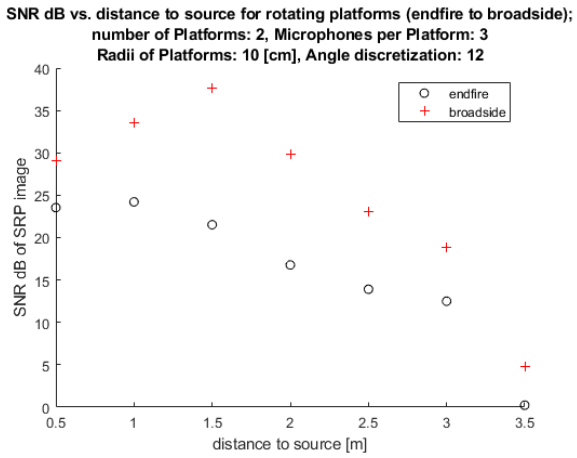

Figure 7: SNR dB of simulation 3

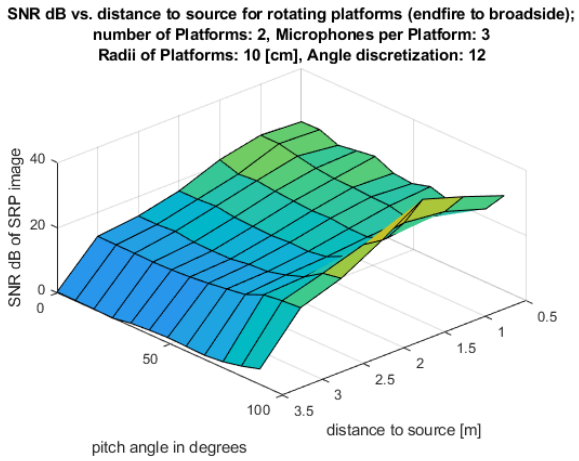

Figure 8: SNR dB surface of simulation 3

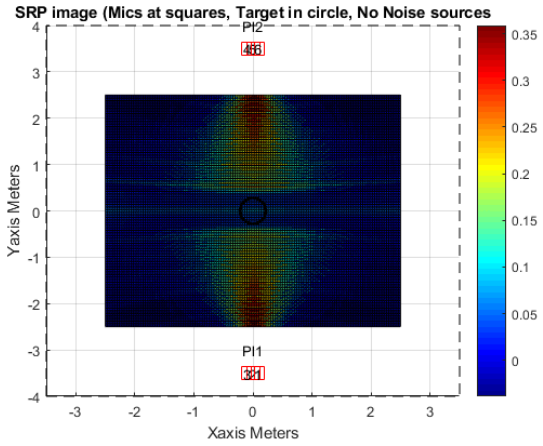

Figure 9: SRP image of last iteration of simulation 3

Simulation 4 - 4 mics, 3 platforms

In this simulation, three platforms were defined with a four microphone array on each. The four microphones were defined to be equally spaced 10cm from the center of the platform. The platform arrays were initially oriented so that one microphone was on the line defined from the source to the center of the platform. The platforms were placed equally-spaced with varying distance to the source. The distance to the source was set by iterating through the vector [0.5, 1, 1.5, 2, 2.5, 3, 3.5] with units of meters. The pitch angle of the platforms were iterated from 0 to 90 degrees using 8 angles. Figure 10 shows the SNR in decibels at each distance to source for the planar endfire orientation (0 degrees)

and the broadside (90 degrees). Figure 11 shows the SNR in decibels for each distance to the source as well as each angle. Figure 12 shows the above view of the SRP image of the last iteration with distance to the source of 3.5 meters and the platform pitch angle of 90 degrees.

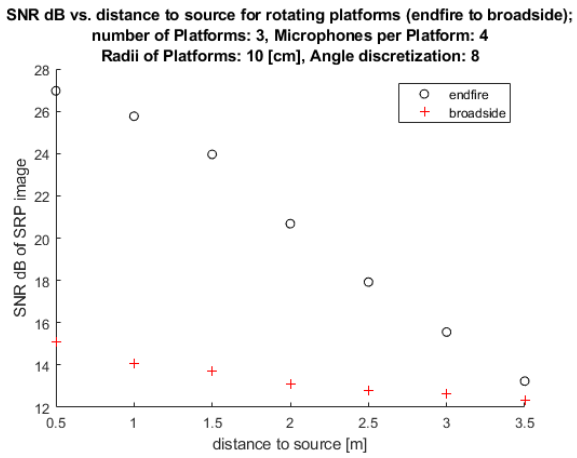

Figure 10: SNR dB of simulation 4

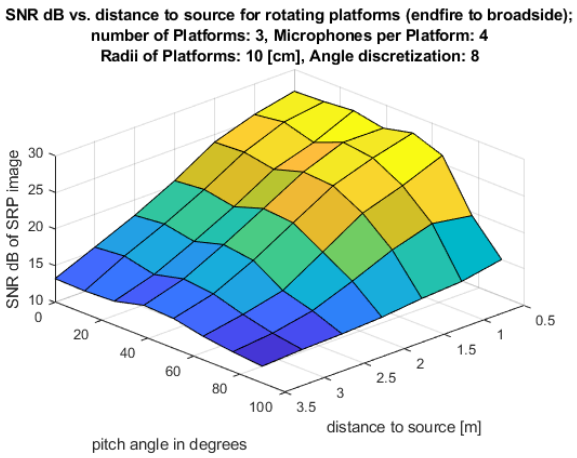

Figure 11: SNR dB surface of simulation 4

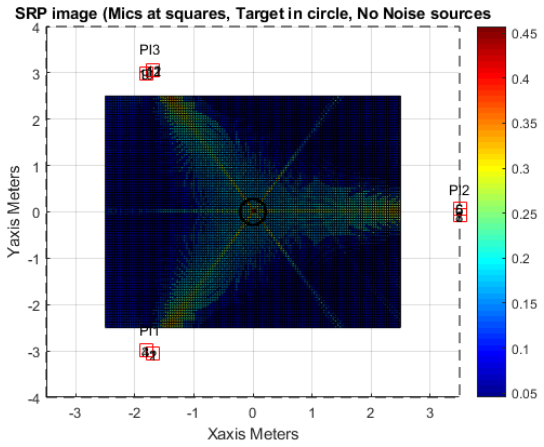

Figure 12: SRP image of last iteration of simulation 4

Simulation 5 - 3 mics, 3 platforms rotating heading

In this simulation, three platforms were defined with a three microphone array on each. The three microphones were defined to be equally spaced 10cm from the center of the platform. The platform arrays were initially oriented so that one microphone was on the line defined from the source to the center of the platform. The platforms were placed equally-spaced with varying distance to the source. The distance to the source was set by iterating through the vector [0.5, 2, 3.5] with units of meters. The heading angles of the platforms were iterated from 0 to 90 degrees using 16 angles. Figure 13 shows the SNR in decibels at each distance to source for the planar endfire orientation (0 degrees) and the broadside (90 degrees). Figure 14 shows the SNR in decibels for each distance to the source as well as each angle.

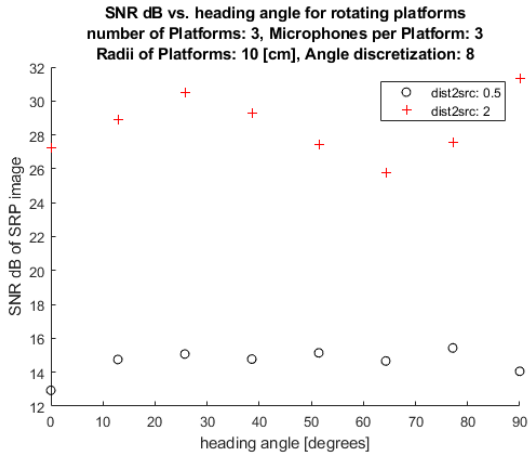

Figure 13: SNR dB of simulation 5

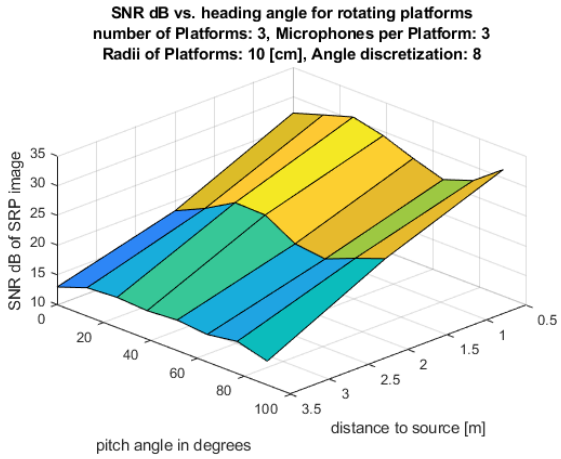

Figure 14: SNR dB surface of simulation 5

Simulation 6 - 1 mic, 3 platforms

In this simulation, only one microphone was defined for each platform. The three platforms were arranged as in the other simulations. The distance to the source was set by iterating through the vector [0.5, 1, 1.5, 2, 2.5, 3, 3.5] with units of meters. Figure 15 shows the SNR in decibels at each distance to source. Figure 16 shows the above view of the SRP image of the final iteration.

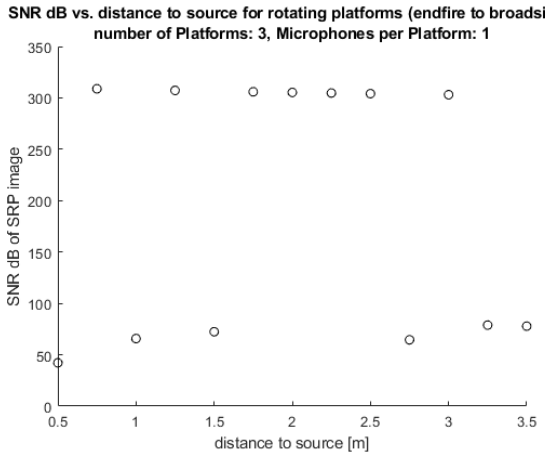

Figure 15: SNR dB of simulation 6

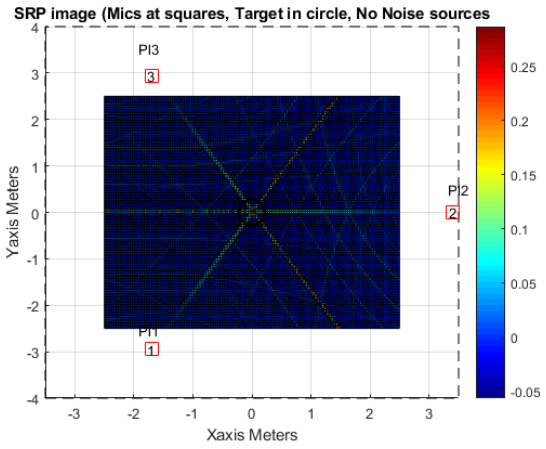

Figure 16: SNR dB surface of simulation 6

References

[1] K. Donohue, PhD, "Audio array toolbox." [Online]. Available: http://vis.uky.edu/distributed-audio-lab/about/

[2] Natan, *FastPeakFind Function.* MATLAB Central File Exchange, January 2018. [Online]. Available: https://www.mathworks.com/matlabcentral/fileexchange/37388-fast-2d-peak-finder