Sensor Signal Processing for Defence Conference 2016

Multiple Spherical Arrays Design for Acoustic Source localization

Xi Pan, Huayang Wang, Fangzhou Wang and Chengtian Song

School of Mechatronical Engineering, Beijing Institute of Technology, Beijing, China

Introduction

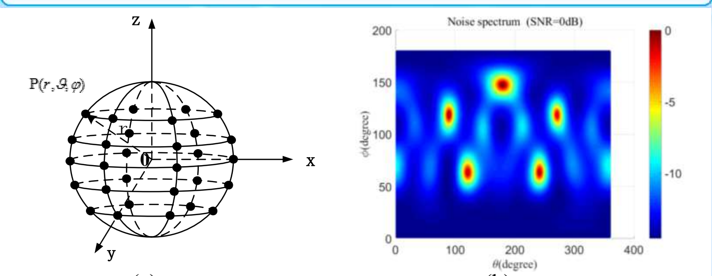
Passive acoustic detection has strong anti-interference ability, all-weather work at night and in adverse weather conditions, small influence of topography, which is widely used in the field of radar, intelligent thunder bombs, sonar and other military.

This poster considers the design and analysis of multiple spherical arrays for acoustic source localization. The proposed multiple spherical array structures are based on the **spherical harmonic multiple signal classification (MUSIC) algorithm** for multiple acoustic sources localization. The new structures consist of several identical spheres with uniform placement of microphones on each sphere. In this poster, the influence of the size and the distributions of the multiple spheres have been evaluated by using the direction of arrival (DOA) estimation method for multiple sources in order to obtain some rules about the spherical array design.

Multiple Spherical Arrays Design And Analysis

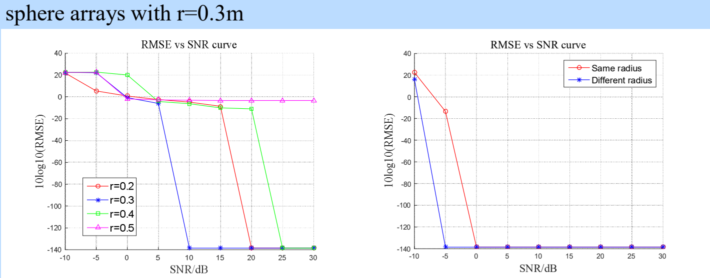
For all the following simulations, five sound sources were used, which directions are(90°,120°), (120°,60°), (180°,150°), (240°,60°) (270°,120°) respectively, and their frequency range are from 0.8 kHz to 1 kHz. The comparison of performance is given in terms of root mean square error (RMSE) (averaged over the sources).

1. single sphere arrays with different radius



(a) (b)

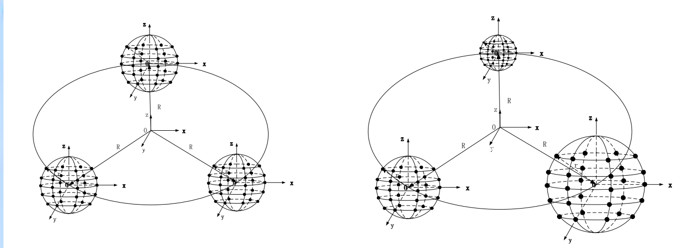
Fig.1 (a) The microphones distribution on a single sphere array in T×H : where T depicts the latitude numbers on the sphere while H indicates the number of microphones on each latitude. (b) DOA estimation results of single sphere arrays with r=0.3m



(a) (b)

Fig.2. Azimuth angle RMSE under different SNR (a) single sphere arrays with different radius (b) multiple spherical arrays with same and different radius

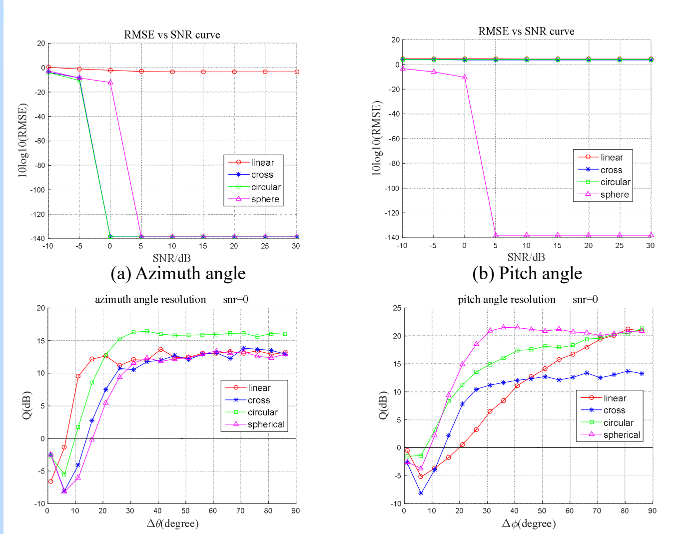
2. multiple spherical arrays with same and different radius



(a) Same radius (b) Different radius

Fig.3. Multiple spherical array structures with same and different radius

3. multiple spherical arrays with different distribution



(a) Azimuth angle (b) Pitch angle

(c) Azimuth angle (d) Pitch angle

Fig.4. (a) Azimuth angle RMSE of four arrays under different SNR (b) Pitch angle RMSE of four arrays under different SNR (c) Azimuth angle resolution of four arrays (d) Pitch angle resolution of four arrays

Conclusion

According to the above mentioned simulations, the design rules for multiple spherical array structure are:

(a) for open spherical structure, the radius of the spherical structure should be in a certain range due to the influence of the zeroes of the Bessel's function.

(b) By placing the spherical structures with different radius in MAS arrays, the estimation accuracy can be improved and the frequency bandwidth of sound sources can be increased.

(c) For the distribution of the multiple spheres in MSA arrays, the better spatial symmetry of the array structure will result in improved estimation accuracy.

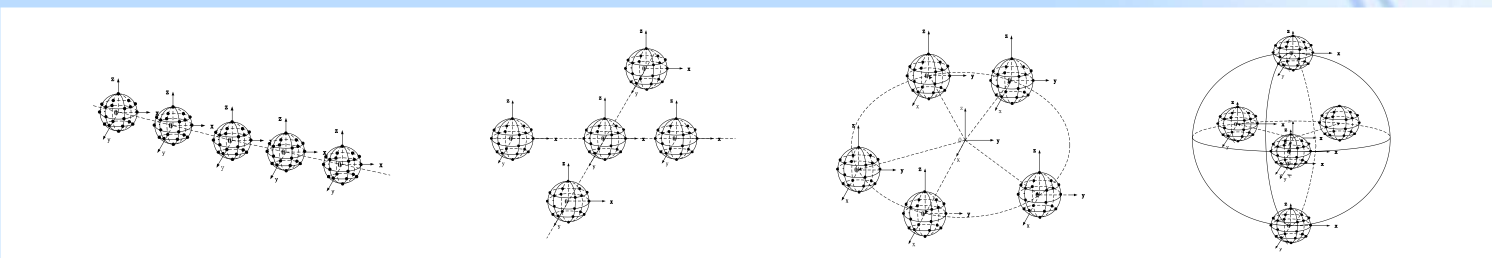


Fig.5. Spherical structure arrays with linear, cross, circular and spherical distributions