Eigenvalue Decomposition based Acoustic Source Localization

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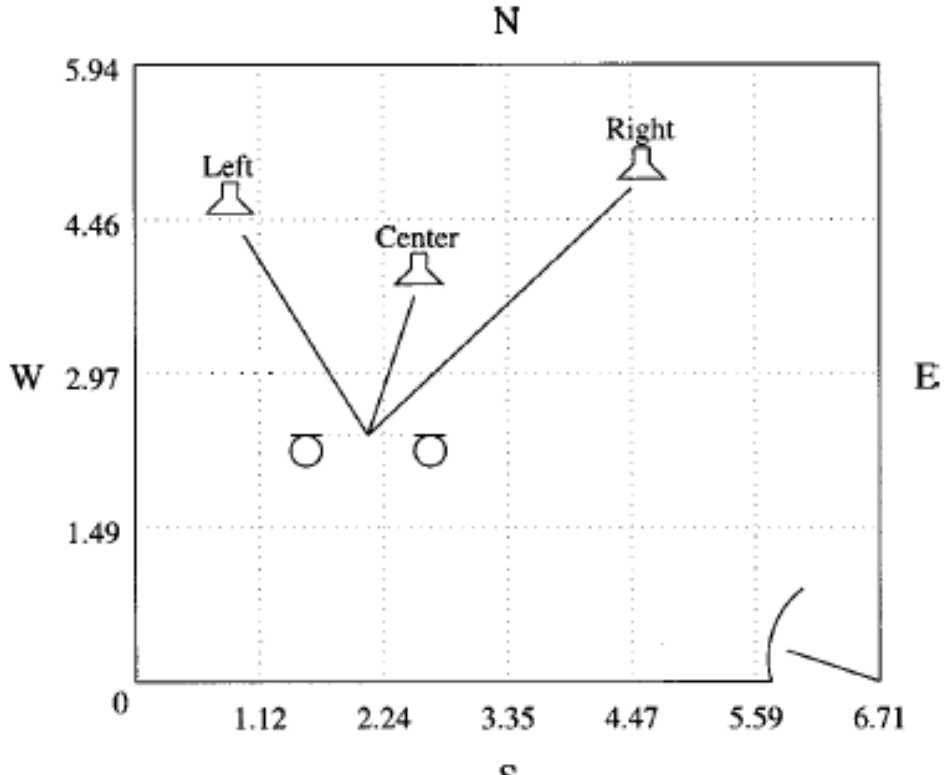
Objective and Setup

- Objective: To determine the location of acoustic signal source, i.e. TDE(Time Delay Estimation) given the observations and positions of microphones.
- Setup: Number of microphones depends on the dimension of the intended localization.



Introduction

- Models
  1. Ideal Model

$$x_i(n) = \alpha_i s(n - \tau_i) + b_i(n)$$

  2. Real Model

$$x_i(n) = g_i * s(n) + b_i(n)$$

- GCC(Generalized Cross-Correlation)

Adaptive Algorithm

- Define $\mathbf{u}$ as $[\mathbf{g}_2, -\mathbf{g}_1]^T$, and
  $\mathbf{R}$ as covariance matrix of microphone signals, x_1 and x_2
- Minimize $\mathbf{u}^T\mathbf{R}\mathbf{u}$ to obtain minimum eigenvalue with corresponding eigenvector as $\mathbf{u}$ using LMS algorithm,

$$\mathbf{u}(n+1) = \mathbf{u}(n) - \mu e(n) \nabla e(n)$$

where,

$$e(n) = \frac{\mathbf{u}^T(n)\mathbf{x}(n)}{\|\mathbf{u}(n)\|}$$

- Estimate Time Delay from eigen vector or impulse responses vector $\mathbf{u}$

1. J. Benesty, 'Adaptive Eigenvalue Decomposition Algorithm for Passive Acoustic Source Localization', Bell Labs Tech. Memo., 1998.
2. C. H. Knapp and G. C. Carter, 'The generalized correlation method for estimation of time delay', IEEE Trans. Acoust., Speech, Signal Processing, vol. ASSP-24, no. 4, pp. 320-327, Aug. 1976.
3. Yiteng Huang, J.Benesty and Gary W.Elko, 'Adaptive Eigenvalue Decomposition Algorithm for Realtime Acoustic Source Localization System', Proceedings of the Acoustics, Speech and Signal Processing, IEEE International Conference, vol. 2, pp. 937-940, 1999.