INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

R&D SHOWCASE 2021

Sparse Bayesian Learning for Acoustic Source Localization

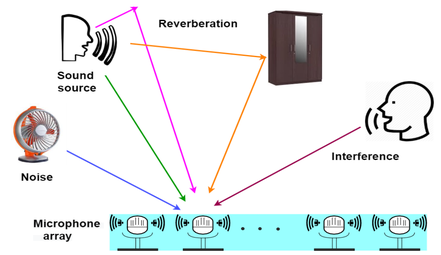
Acoustic source localization

- Estimation of source position in realistic acoustic environment

Applications

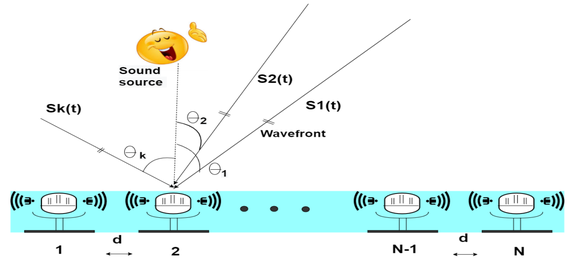
- To improve focusing on desired source
- Smart homes to interact with speaker
- Robots for awareness of occluded event
- Smart cars for detecting vehicles
- Intelligent monitoring system to recognize activity in their environment

Challenges



- Reverberation
- Interference and Noise
- Dynamic targets
- Finding the number of sources

Direction of arrival (DOA) estimation



For a ULA with N sensors, the steering vectors are defined by -

$$a(\theta_n) = e^{j2\pi\frac{d}{\lambda}[1\ 2..N]sin(\theta_n)}$$

where d is the uniform inter-sensor spacing and θ_n is the nth DoA with respect to the array axis

Localization algorithms

Sparsity in DOA estimation

Consider the signal model to be:

$$\mathbf{y = Ax + n}$$

$$\begin{bmatrix} y_1 \\ y_2 \\ . \\ . \\ y_N \end{bmatrix} = \begin{bmatrix} a(\theta_1) & a(\theta_2) & . & . & a(\theta_M) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ . \\ x_M \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ . \\ . \\ n_N \end{bmatrix}$$

where **y** – received audio signal from microphones
A – sensing matrix (steering vectors)
x – source amplitude assume to be sparse
n – additive noise in audio data

Sparse Bayesian Learning (SBL)

- SBL is a Compressive sensing method
- Uses Bayesian framework to solve sparse problem
- SBL formulates DOA estimation as a non-convex optimization problem and solves using fixed point iterations.
- It achieves high resolution and DOA estimates are reliable even with a single snapshot
- It performs well even in the most complex and noisy environment

Conventional Beamforming (CBF)

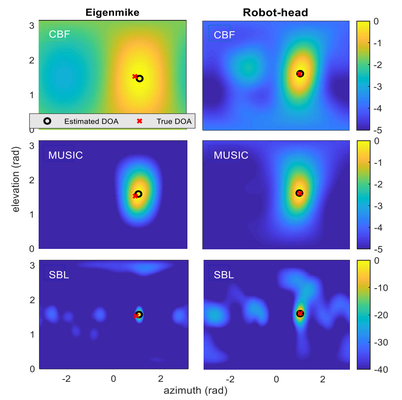
- CBF is the simplest method for source localization
- It is robust to noise and have low resolution

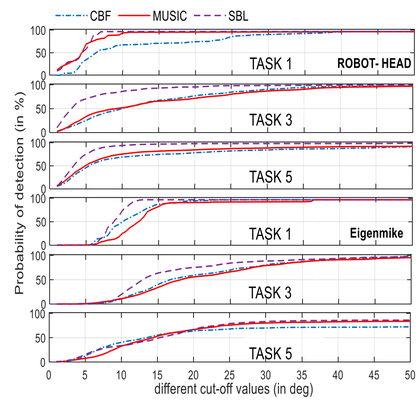
Multiple Signal Classification (MUSIC)

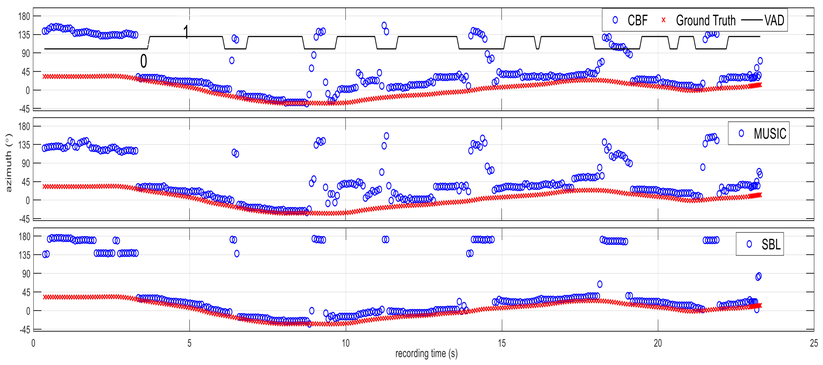
- It is a high-resolution direction-finding algorithm
- Capable of resolving closely-spaced signal sources
- It needs multiple snapshots for better resolution

Results

- Dataset – LOCATA dataset
- Task : Localization of static and moving speaker







References

[1] H. W. Löllmann et al."The LOCATA challenge data corpus for acoustic source localization and tracking." SAM. IEEE, 2018.
[2] R. Pandey, S. Nannuru and A. Siripuram, "Sparse Bayesian learning for acoustic source localization", ICASSP 2021 (Accepted)

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