

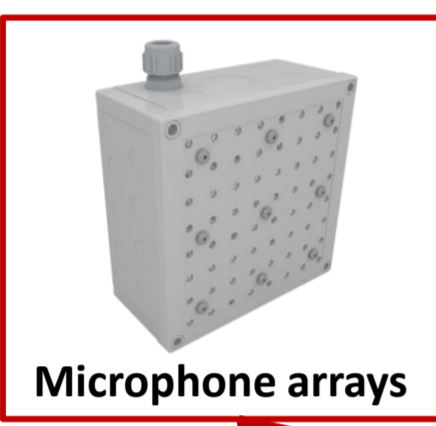


Robust Bayesian Beamforming for Sources at Different Distances with Applications in Urban Monitoring

Dude, where's my car? And how loud is it?

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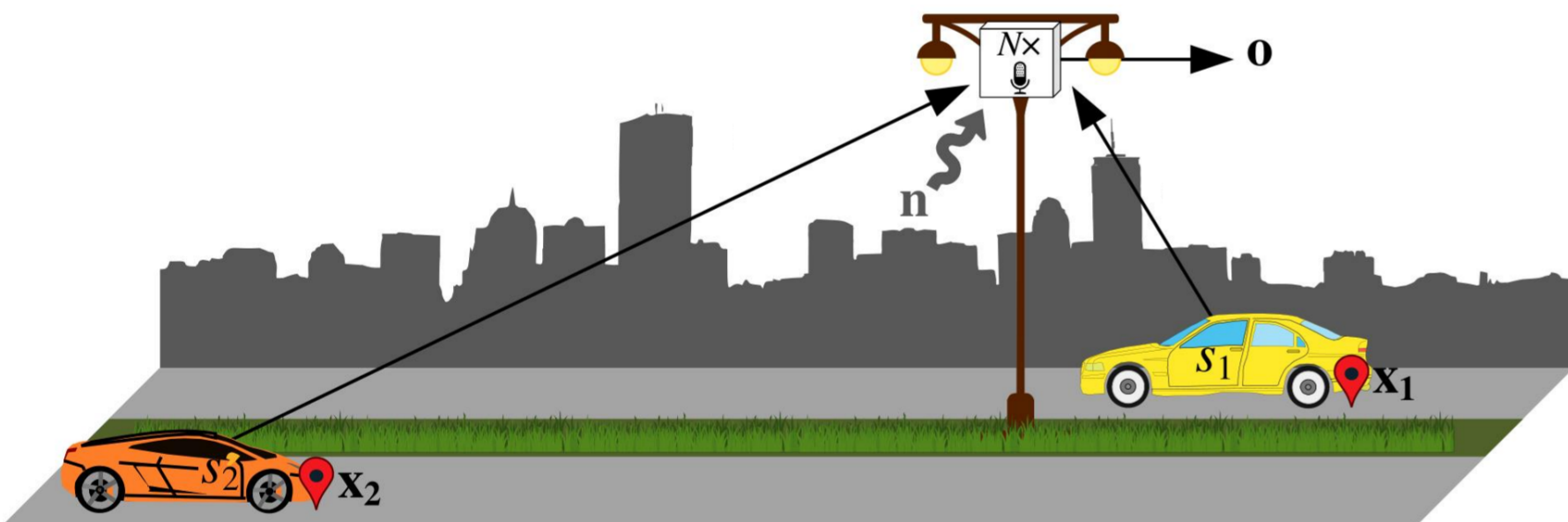
APPLICATION: URBAN MONITORING



Acoustic sensor networks can provide valuable actionable intelligence to authorities for managing safety in the urban environment. Examples of events: car alarms, breaking glass, gunshots, and violation of noise regulations.



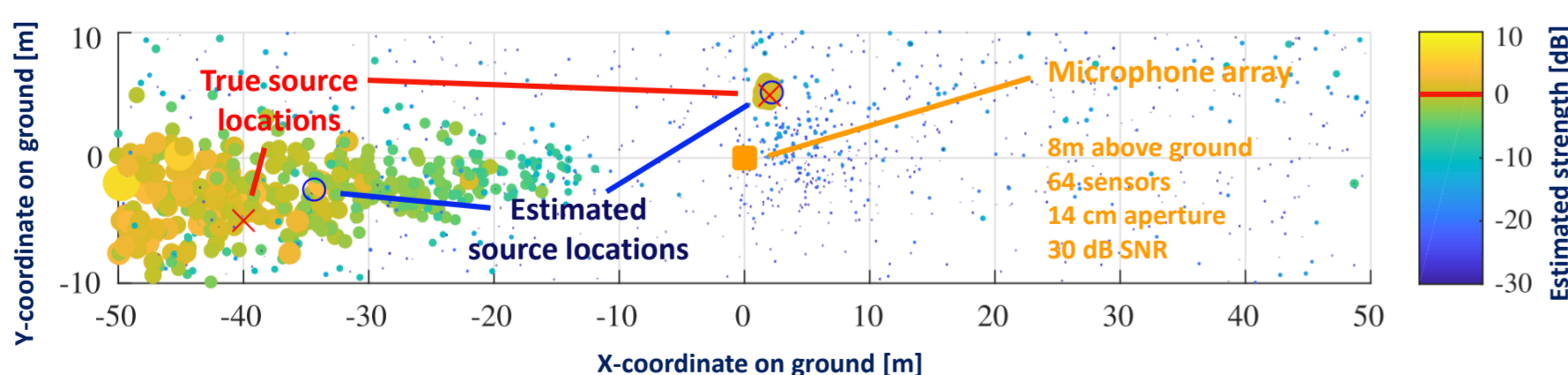
KEY COMPONENT: SPATIAL FILTER



Given a sensor observation (o), the spatial filter must estimate the unknown strength (s_m) and location (x_m) of the sources.

OUR CONTRIBUTION

A robust beamformer which can estimate an unknown number of sources at different distances and strengths:

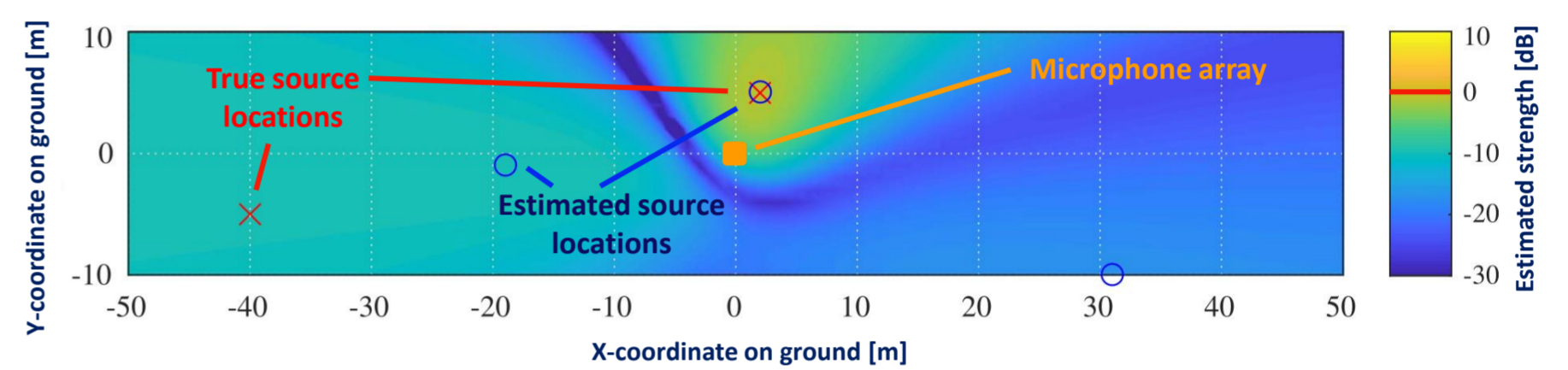


The dots mark samples from the (probabilistic) estimator. Estimated strengths and locations are close to the true values.

By perturbing the synthetic observations, we illustrate robustness.

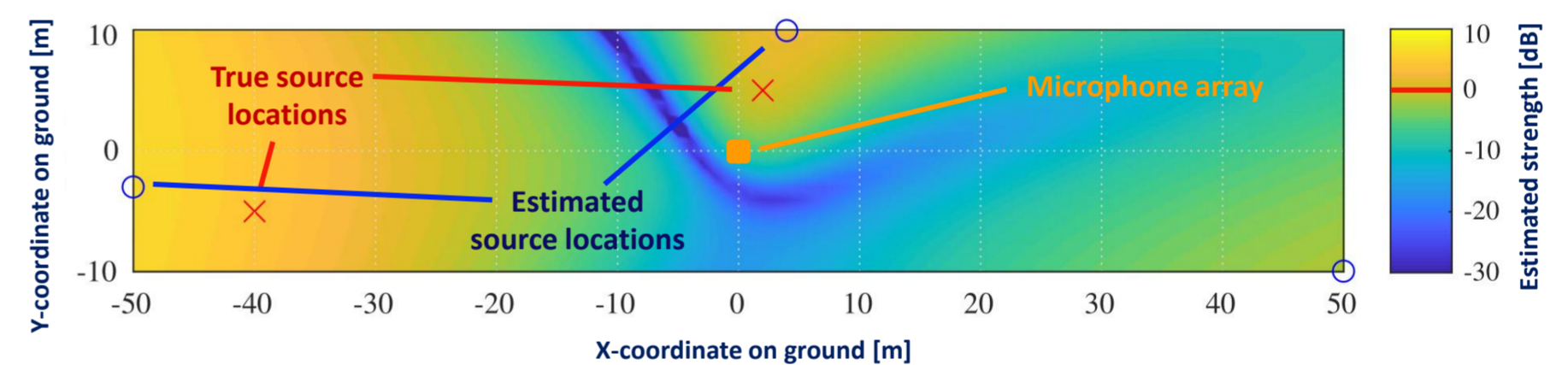
CLASSICAL METHODS: LIMITATIONS

Methods which do not account for propagation loss:



For two equal sources, the one near the array is estimated as louder. But for event detection, the absolute sound level matters!

Methods which do not account for interfering sources:



The strength loss is now compensated, but the estimated locations are way off. The estimators are not robust!

OUR METHOD: BAYESIAN INFERENCE

We construct a probabilistic generative model by considering source strength *and* location as random variables. The best estimator is then inferred using Bayes' rule.

This leads to an iterative algorithm with similarities to deconvolution beamforming. The (difficult) posterior distribution is approximated using Gibbs sampling. Its marginals are computed by combining importance sampling and inverse transform sampling using Chebyshev polynomial approximation.

FUTURE WORK

- Reduce computational cost.
- Exploit multiple (changing) snapshots over time.
- Validate performance with data from testing grounds.
- Extensive comparison with other literature results.