ROBUST SEQUENCE-BASED LOCALIZATION IN ACOUSTIC SENSOR NETWORKS

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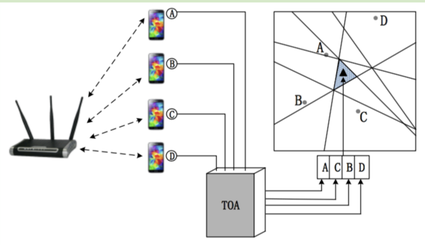
1.Introduction

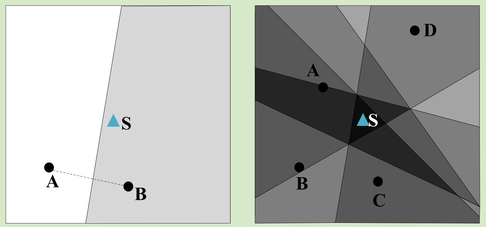
This paper designs a Half Plane Intersection method to Sequence-Based Localization. The localization space can be divided into distinct regions. The key idea behind HPI-SBL is to turn the localization problem into half-plane intersection by processing the node sequence.

2.System Overview

The following figure shows a layout of an acoustic sensor network with N sensor nodes and the acoustic source. We determine the source region by the arrival sequence of acoustic source to the sensors.



Next figure demonstrates the basic idea of the HPI-SBL. We can get the distance sequence $SA < SC < SB < SD$ from each node to the acoustic source S, which leads to three half-plane. The intersection of the half-plane is the final region of the acoustic source.



3.Design

We propose SBL, Probabilistic HPI-SBL and Weighted Probabilistic HPI-SBL methods to solve the problem.

3.1 SBL

Given node sequence $NodeSeq(\cdots i, j, k, \cdots)$ obtained by TOA. Then get the distance sequence $d_i < d_j < d_k$ from acoustic source to each node. Just considering the adjacent node, we can have the following $N(N-1)/2$ linear constraints: $d_i < d_j$, $d_i < d_k$ and $d_j < d_k$, etc, leading to half-planes H_{ij}, H_{ik} and H_{jk}, etc. $d_i < d_j$ means that the acoustic source lies in the left half-plane $d_i < d_j$ of the perpendicular bisector of $node_i$ and $node_j$. Half-planes intersection is the final region of the acoustic source.

3.2 Probabilistic HPI-SBL

To address the problem of sequence flip, Probabilistic HPI-SBL describe the probability of $d_i < d_j$ as:

$$p(d_i < d_j) > \alpha$$

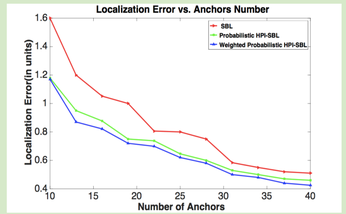
Probability of the acoustic source in the left side of the the half-plane $d_i < d_j$ is α, and the right side is $1-\alpha$. The half-planes intersection with the highest sum of probabilities is the final region.

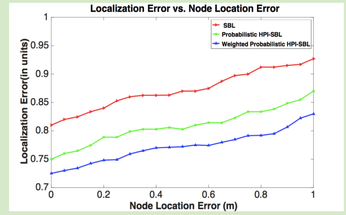
3.3 Weighted Probabilistic HPI-SBL

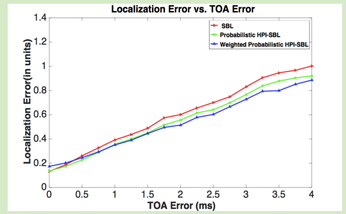
Weighted Probabilistic HPI-SBL distributes the half-planes to different probabilities. The edge constructed by i, j, if closer to the source, is more likely to occur flip, we give α_{ij} a smaller value. Otherwise, if further, we give α_{ij} a larger value. Then determine the real acoustic source region.

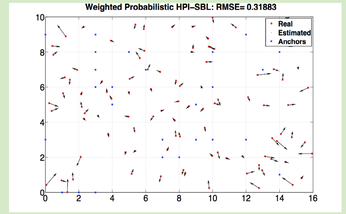
4.Evaluation

We developed a Monte Carlo simulator that implements our methods using MATLAB to verify our method and obtain an intuitive understanding of the localization performance under different conditions. We consider the parameters including the number of anchors, node location error, and TOA error. Then make testbed experiments to prove that our methods have a great performance. Result is shown in the followings.









5.Conclusion

This paper, we presented a simple and novel localization technique based on half-plane inter- section, HPI-SBL. The reference nodes sequence is computed by using TOA measurements of acoustic signals between the acoustic source and the reference nodes. The half-planes are constructed by processing the node sequence, then turn the localization problem into half-plane intersection problem.

6.References

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