Large-scale Sensor Network Localization using Cliques

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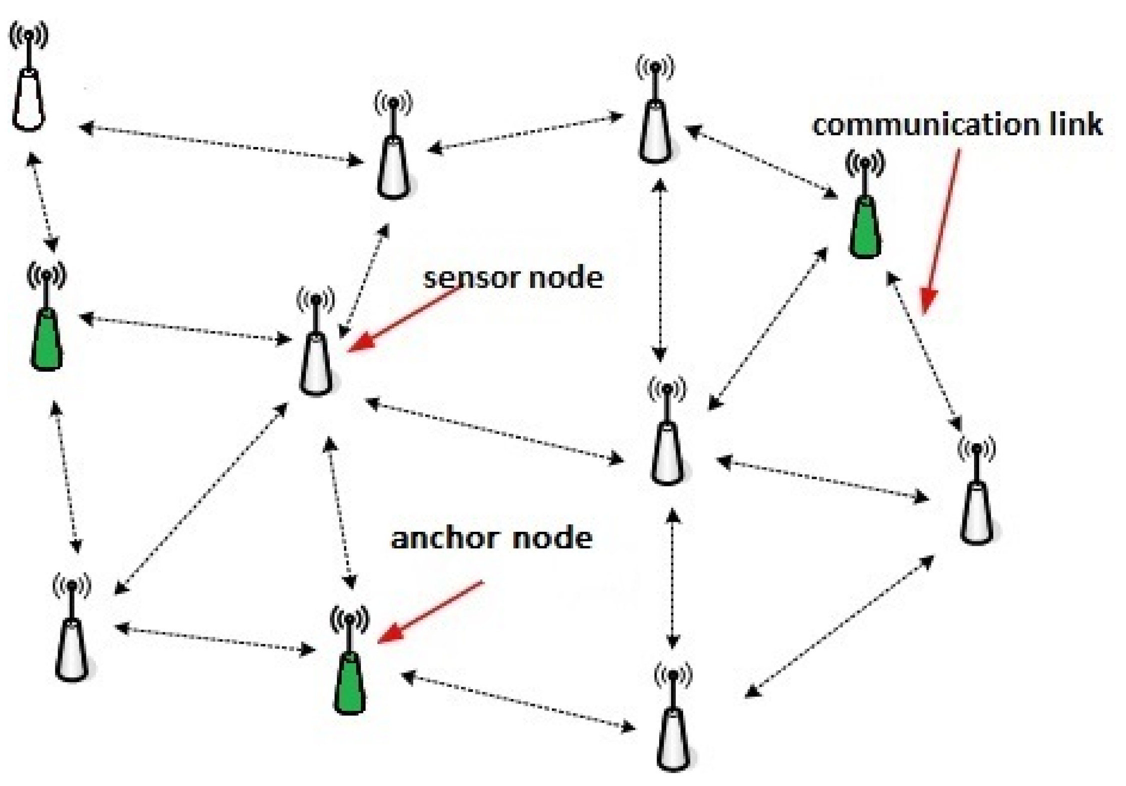
Objectives

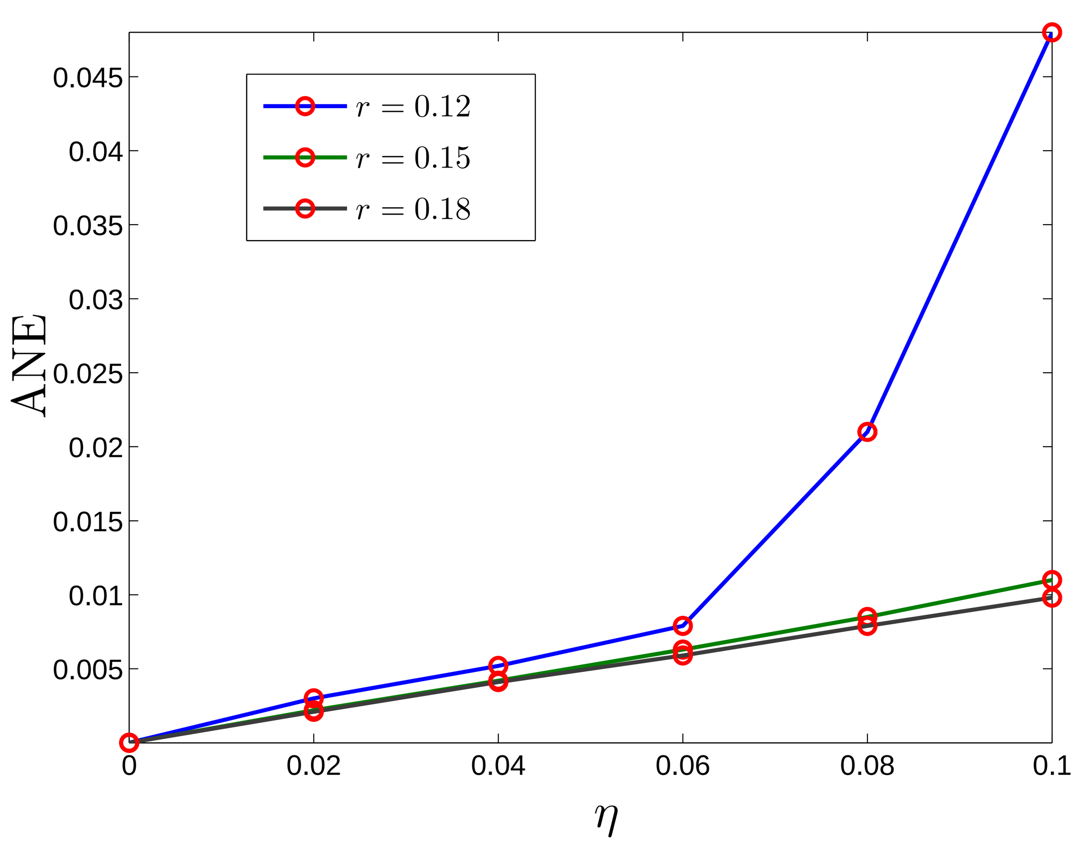
Estimate the sensor locations from the inter-sensor distances and locations of the anchors (sensors equipped with GPS).



Wireless sensor network.

Challenges in sensor network localization (SNL): accuracy, run-time, scalability.

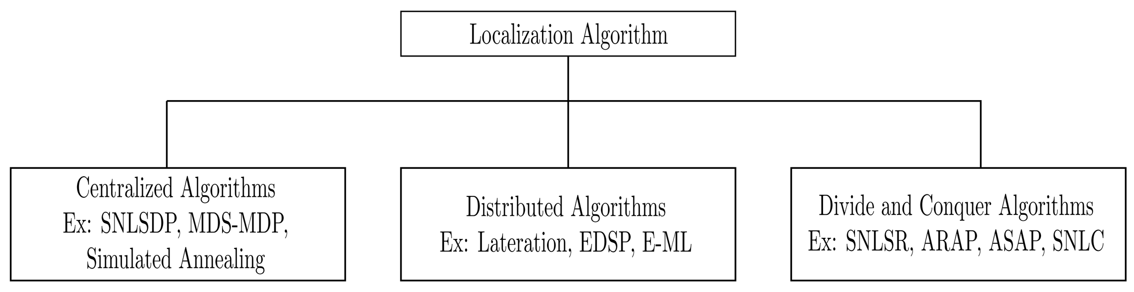
ANE vs. Noise Level



ANE versus noise level η for a random geometric graph (RGG) consisting of 500 sensors and 50 anchors. We consider the radio ranges $r = 0.12, 0.15$, and 0.18.

Introduction

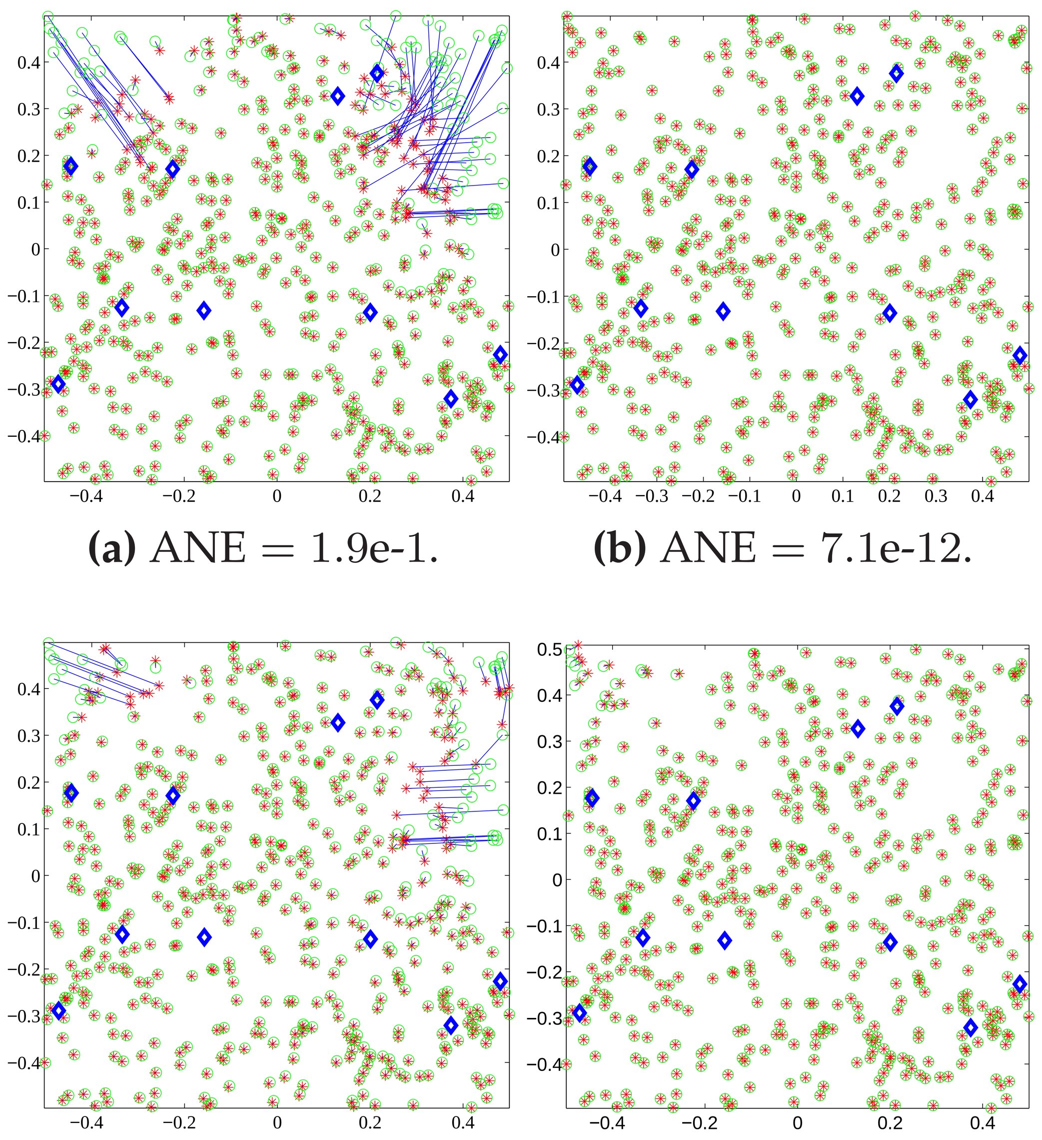
- SNL is a hard problem [Saxe, 1979].



Different SNL Algorithms.

- Clique is globally rigid.
- Clique can be localized using cMDS.
- Interior point solvers are not scalable.

Quasi $(d{+}1)$-Connectivity



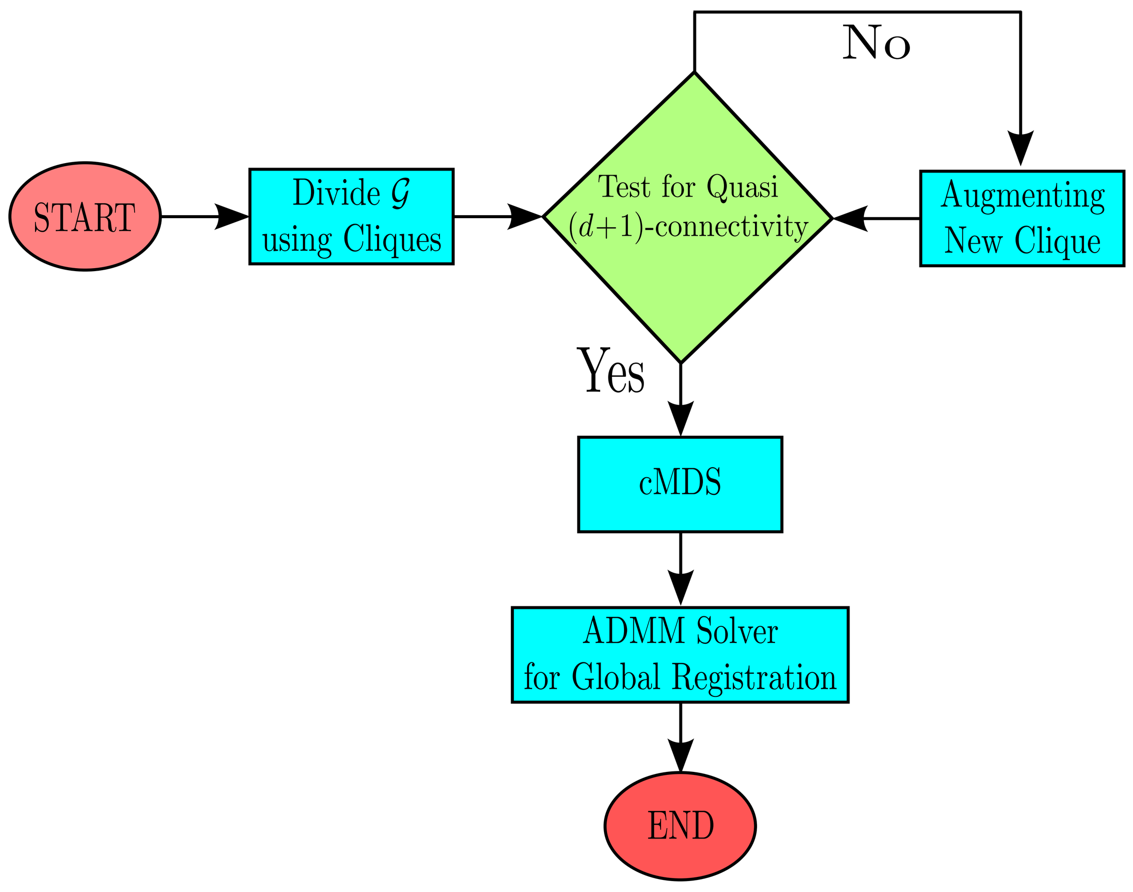
(a) ANE = 1.9e-1. **(b)** ANE = 7.1e-12.

(c) ANE = 8.6e-2. **(d)** ANE = 6.1e-3.

Illustration of the impact of quasi 3-connectivity on the registration accuracy. The parameters for the RGG are $N = 500$, $K = 10$, and $r = 0.17$. The top and bottom rows correspond to the noise levels $\eta = 0$ and $\eta = 0.01$.

Proposed Method

Divide-and-conquer based method.



Proposed agorithm for SNL.

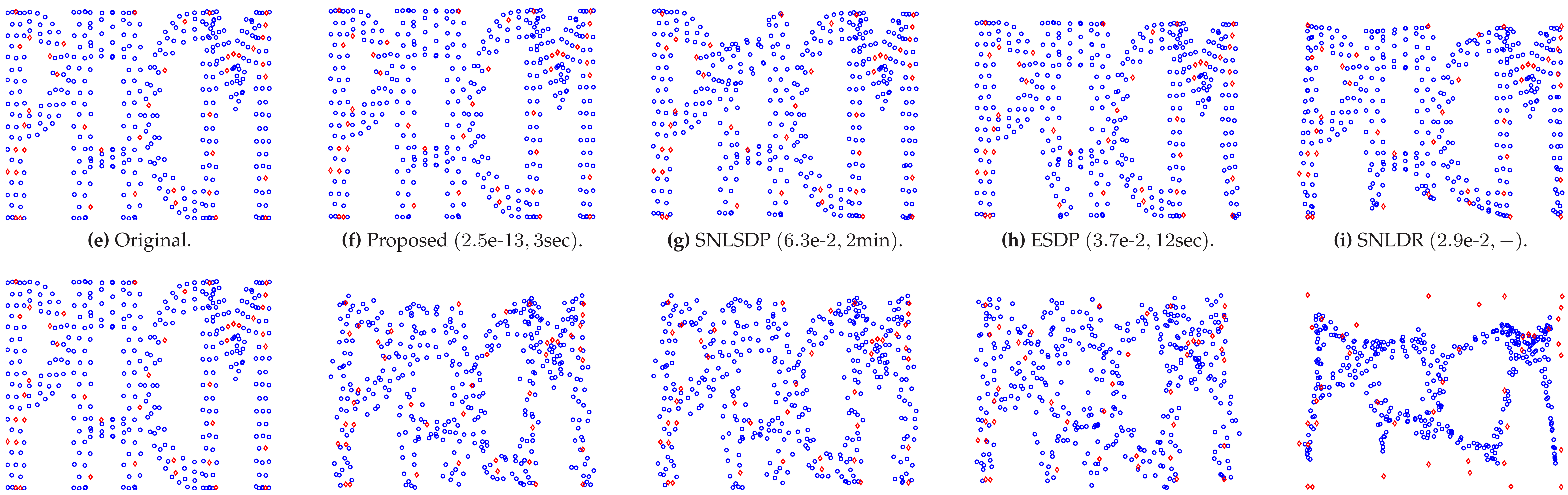
Conclusion

- Each clique is localized efficiently.
- Quasi $(d{+}1)$-connectivity helps to pose a better registration problem.
- Propose a scalable ADMM method to solve the global registration problem.

References

1. R. Sanyal and K. N. Chaudhury, "Scalable and accurate sensor network localization using cliques," *Proc. International Conference on Signal Processing and Communication*, pp. 1 – 5, 2016.
2. R. Sanyal, M. Jaiswal and K. N. Chaudhury, "On a Registration-Based Approach to Sensor Network Localization," *IEEE Trans. on Signal Processing* (under review).

Comparison of Localization Results for the PACM Logo



(e) Original. **(f)** Proposed (2.5e-13, 3sec). **(g)** SNLSDP (6.3e-2, 2min). **(h)** ESDP (3.7e-2, 12sec). **(i)** SNLDR (2.9e-2, –).

(j) Original. **(k)** Proposed (5.6e-2, 50sec). **(l)** SNLSDP (5e-2, 2min). **(m)** ESDP (1e-1, 14sec). **(n)** SNLDR (1.5e-1, –).

Comparison of localization results for the PACM logo. The parameters are $N = 382$, $K = 43$, and $r = 1.9$. Blue circles (○) denote original (column 1) and reconstructed (columns 2-5) sensor locations, and red diamonds (◇) denote anchor locations. The top and bottom rows correspond to the noise levels $\eta = 0$ and $\eta = 0.5$.