is faster, with a complexity of $\mathcal{O}(nb^2M)$ per timestep, if there are n robots and b beacons. We suspect our superior accuracy is in part due to our explicit modeling of sensor errors, rather than just using observed distances.

In some experiments, due to the hop-based distance approximation and rejection of samples based on maximum transmission range, SMCL+R did not converge as it was impossible to draw acceptable samples. As the approach assumes a unit-disk connectivity model [15], this was exacerbated by probabilistic connectivity and inter-distance measurement models. For example, with a probabilistic connectivity model P_o, if a robot is within the maximum transmission range from a beacon, but is two hops away, the correct samples for the robot will always be rejected. Thus, the experiment in Fig. 6 used a unit-disk model for both approaches. By modeling probabilistic connectivity and inter-distance measurements, our approach is more robust as it does not experience to these problems.

IX. CONCLUSION AND FUTURE WORK

We present a new algorithm for collaborative robotic self-localization and tracking using NBP. We compare the NBP dynamic tracking algorithm with SMCL+R, a sequential Monte Carlo algorithm [1]. Whereas NBP currently requires more computation, it converges in more cases and provides estimates that are 3 to 4 times more accurate. We are now working to reduce the computation time of the NBP algorithm.

The graphical modeling framework underlying our approach is very rich and we anticipate several extensions and generalizations. We hope to explore how orientation estimates can improve localization accuracy by modifying the proposal distribution of Eq. (16). Similarly, knowledge of environment geometry could be used to prune trajectory estimates that pass through obstacles. We are also working on "active" tracking where multi-modal estimates of robot position can be resolved by directing robots to move in directions that will reduce uncertainty.

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