Iterative Constrained Weighted Least Squares Source Localization using TDOA and FDOA Measurements

Abstract:

This paper investigates the constrained weighted least squares (CWLS) source localization problem by using time difference of arrival (TDOA) and frequency difference of arrival (FDOA) measurements. The problem can be formulated as a quadratic programming with two indefinite quadratic equality constraints, which is non-convex and NP-hard. Moreover, the weighting matrix is coupled with the unknown source position and velocity. We propose an iterative CWLS method that can efficiently solve this problem. It iteratively performs a linearization procedure on the quadratic equality constraints to obtain an approximate programming with linear constraints, which can be analytically solved, and the weighting matrix is updated in each iteration. Theoretical analysis reveals that the proposed method, if converges, can lead to the global optimal solution of the formulated problem which reaches the CRLB accuracy under mild assumptions on the measurement noises. The Monte Carlo simulation results indicate that the percentage of convergence within 20 iterations is more than 96%, and the localization accuracy is significantly improved over the previous methods with less computation time requirement. Moreover, it is found from simulations that the iterative CWLS method retains acceptable performance even under the ill-conditioned situation when the sensor geometry is not desirable.