Public Abstract
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Determining the position of object has been a very important and fundamental research topic in GPS, radar, sonar, and especially in mobile communications and sensor networks over the past few years. It is often accomplished by using a number of sensors that measure the radiated signal from the object, here we consider the distance based measurements, including time of arrival and time difference of arrival at different sensors. Some existing methods square the distance measurements and solve resultant cost function using available optimization technique but with suboptimal accuracy. To improve accuracy, we add proper range weighting into original cost function, and find it achieves optimal performance while maintaining the computational advantage of existing method. And we extensively investigate the effects of range weighting on the localization performance under different sensor number, measurement noise correlation, and geometry of sensors and object. We also conduct similar range weighting under time difference of arrival measurements. In addition, the weighting technique is extended to the scenario where the sensor positions are not exactly known and only coarse sensor positions information is available.

For some applications, e.g., robotics, spacecraft, and gaming, orientation information in addition to position is also needed. Here we consider joint position and orientation estimation using the distance or direction measurements between the fixed sensors on the object and the anchors at fixed locations. When using distance measurements, the existing method omits some terms in the equation, which may cause serious degradation. We develop two-step procedure to improve the accuracy, the first step obtains the coarse solution that is better than existing computationally efficient method, and the second step refines obtained solution. If the rigid body is moving, we adopt additional Doppler measurements, which is frequency shift due to the motion, to obtain its velocities information. Beyond abovementioned distance related measurements, we can also use direction measurements of landmarks. We solve the 3-dimensional scenario that is seldom considered before, without requiring prior knowledge on object’s position or orientation. Furthermore, we extend it to the scenario where there is more than one direction finding sensor on-board, which either increases the robustness and accuracy since some landmarks may be unobservable due to blockage, or decreases the minimum requirement on number of landmarks.