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Active Tracking using the Invariance Extended Kalman Filter (IEKF)

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The pressure received from a moving source in a shallow water channel has a frequency dependent structure that is imposed by the propagation characteristics of the channel. While an exact description of this structure requires fine knowledge of the channel properties (including bottom composition), an approximate relationship which utilizes the so-called waveguide invariant can be used to describe the intensity variations as a function of frequency versus range. This relationship has been extensively explored and utilized for application to passive sonar systems. Recent work has demonstrated that a similar structure, called the active invariance, may be present in active sonar.
In this paper the active invariance relationship is incorporated into an extended Kalman filter (EKF) to create a new tracking formulation called the Invariance EKF (IEKF). The IEKF differs from the conventional formulation by incorporating the time -dependent frequency content into both the state space representation and the update equations, where the relationship between target position and frequency is given by the active invariance expression. Performance of the IEKF relative to conventional approaches is explored with normal mode simulations and bistatic data collected in the Maltese channel.
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