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机动目标“当前”统计模型与自适应跟踪算法

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A "Current" Statistical Model and Adaptive Tracking Algorithm for Maneuvering Targets

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摘要 本文提出机动目标“当前”统计模型的概念并建议用修正的瑞利-马尔科夫过程描述目标随机加速机动的统计特性。文中指出了在机动目标运动模型中状态（机动加速度）估值与状态噪声之间的内在联系。在此基础上提出了具有机动加速度均值及方差自适应的卡尔曼滤波算法。对一维和三维的情形进行了计算机模拟。计算结果表明,在仅对目标位置进行观测的情况下,这类自适应估值算法无论对高度机动或无机动的目标均可给出较好的位置、速度及加速度估值。

关键词：

Abstract： This paper puts forward a "current model" concept of maneuvering targets.It means that when a target is maneuvering with a certain acceleration at present,the region of acceleration which can be taken in the next instant is limited,and is always around "current" acceleration.Therefore,it is unnecessary to take all of the acceleration value of targets into account during the establishing of statistical model of maneuvering acceleration.In view of the fact that "current" acceleration is variable,a kind of sliding maneuvering acceleration probability density function-modified Rayleigh density function whose mean-value is the current acceleration of target is proposed in this paper.By the use of the relationship between mean-value and variance of Rayleigh distribution,an adaptive algorithm of state noise variance can be accomplished.It is pointed out in this paper that when Kalman filter is used to estimate states of targets,there exists physical link between the state variable（acceleration）and the state noise since the maneuvering acceleration of targets is usully taken as the output of a system driven by white noise.Furthermore,the estimate of state variable（acceleration）is just the mean-value of the state noise multiplied by a coefficient.Taking advantage of this important property,an acceleration mean-value adaptive algorithm may be realized in tracking the maneuvering target.Based on the two points mentioned above,an acceleration meanvalue and variance adaptive Kalman filtering algorithm is presented in this paper.By the use of this algorithm,the estimation of states and the calculation of Kalman gains which used to be computed separately are put in an unified closed loop.Some anal-yses and computer simulation results in one and three dimensional cases are given in this paper.The simulation results show that under the condition that only target position data are available,the model and adaptive algorithm proposed in this paper can estimate the position,velocity and acceleration of target well,no matter whether the targets are highly maneuvering or not.Generally speaking,the relative value of the mean errors are less than 0.5% for range,1% for velocity and 2% for acceleration and the relative root-mean-square errors are less than 0.5%,5% and 5% respectively.