论文与技术报告

基于数值积分卡尔曼-概率假设密度滤波的多说话人跟踪方法

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摘要：

针对多说话人跟踪的非线性系统模型，提出了一种基于数值积分卡尔曼-概率假设密度滤波的多说话人跟踪方法。该方法采用麦克风阵列的时间延迟估计作为观测数据，利用具有三次代数精度的球面-径向数值积分准则计算非线性系统贝叶斯滤波器中的多维积分，通过数值积分卡尔曼滤波和概率假设密度滤波对后验多说话人状态的一阶统计量进行估计，并通过递推更新得到说话人状态信息，实现非线性高斯系统的多说话人跟踪。该方法无需求解非线性系统函数的雅克比矩阵，且计算量较小。仿真实验分析了检测概率、虚警点数目、采样周期、信噪比以及混响时间变化时跟踪算法的性能。实验结果表明，该方法降低了系统模型非线性对滤波算法的影响，增强了跟踪算法的鲁棒性，提高了说话人状态和数目的估计精度。

关键词： 多说话人跟踪；概率假设密度滤波；卡尔曼滤波；非线性滤波

Cubature Kalman-Probability Hypothesis Density Filter for Multiple Speakers Tracking

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Abstract:

Aiming at nonlinear system model in multiple speakers tracking, a cubature Kalman-probability hypothesis density filter for multiple speakers tracking is proposed in this paper. Time difference of arrival for microphone array is taken as measurements, third-degree spherical-radial rule is utilized to compute the multidimensional integral in Bayesian filter of nonlinear system in proposed method, cubature Kalman filter and probability hypothesis density filter is applied to estimate first-order statistical moment of posterior multiple speakers states, and finally multiple speakers tracking of nonlinear Gaussian system is realized while the speakers' states are extracted by recursive updating. Compared with some filters in multiple speakers tracking, the proposed method has several advantages. Calculating Jacobian matrix of nonlinear system function, which is usually hard to be done, is no longer necessary in proposed filter and computational complexity also goes down. Simulation experiments have been taken to analyze the performance of proposed method when detection probability, false speakers' number, sampling period, speech-signal-to-noise ratio and reverberation time varies. Simulation results show that the proposed method reduces the impact on the performance of filtering algorithm from nonlinear system model, enhances the robustness of the algorithm, and improves estimation accuracy of multiple speakers' number and states.

Keywords: Multiple speakers tracking　Probability hypothesis density filter　Kalman filter　Nonlinear filter

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