论文与技术报告

多通带低群延迟误差FIR滤波器设计的迭代算法

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摘要：

常数低群延迟有限冲击响应（FIR）滤波器在通信等领域得到了广泛应用，尤其是要求无波形失真、信号延迟小的场合。而低群延迟的FIR滤波器，其相位响应只能做到近似线性相位，其群延迟只能做到近似常数。为了减小与期望常数群延迟之间的误差，最近提出的通过迭代更新相位误差上界函数来逐步减小群延迟误差的方法，只考虑了单通带滤波器的minimax设计。本文将把该方法推广至多通带FIR滤波器的minimax设计和约束最小二乘设计,先对各通带单独处理使每个通带的最大群延迟误差有效降低后，再考虑各通带之间平衡，对各子带的最大群延迟误差进行折中，进而使整个通带上的最大群延迟误差继续减小。对约束最小二乘设计还特别考虑了通过修改收敛参数来解决相位误差约束过紧时设计问题无解的问题。仿真实例表明，该方法能有效减小多通带滤波器的最大群延迟误差。

关键词： 多通带有限冲激响应滤波器　minimax设计　约束最小二乘设计　群延迟误差　相位误差

Iterative Procedures for the Designs of Multi-band FIR Filters with Reduced Group Delay Error

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Abstract:

The finite impulse response (FIR) filter with constant low group delay has been widely used in many application areas, especially in the systems which require the filtered signal to have no phase distortion and low group delay. The phase response of the filter with low group delay can only be approximately linear, and its group delay can only be approximately constant. A procedure was recently introduced to gradually reduce the error between the designed and the desired group delays by updating the phase-error upper-bound function iteratively. However, the procedure has only been used to design single-band minimax FIR filters. In this paper, the procedure is modified such that it can be applied in the minimax and constrained least squares designs of multi-band FIR filters. Firstly, each passband is dealt with separately to effectively reduce the group delay error in each passband. Then, a balance is introduced to tradeoff the group delay errors in different passbands, resulting in further reduction of the largest group delay error in the whole passband. To guarantee feasible solutions to the constrained least-squares design, an inner loop is also introduced to reduce the convergence parameter of the procedure. Design examples demonstrate the effectiveness of the modified procedure in reducing the maximum group delay error of the multi-band FIR filters.

Keywords: multi-band finite impulse response filter　minimax design　constrained least squares design　group delay error　phase error

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