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Adaptive Digital Filters for Active Noise Control in Ducts

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The traditional approach to attenuate undesired noise uses passive techniques based on absorption or reflection. These mechanisms are utilized in passive silencers. However, passive silencers are ineffective at low frequencies, large, and costly. Therefore, the active noise control (ANC) technology is a promising alternative to reduce the size, weight, and volume of silencers. In an ANC system, the unwanted noise produced by a primary source is canceled acoustically by one or more secondary sound sources emitting an anti-noise wave. In practice, the response characteristics of the primary and secondary path are time-varying due to changes in temperature and mean flow velocity of the medium. Hence, an algorithm is desirable which calculates an anti-noise signal adaptively based on a measured reference and error signal.

This thesis deals with active noise control in ducts. Algorithms for adaptive digital filters are presented and evaluated which feature an online secondary path modeling to consider the time-varying behavior of the secondary path. ANC systems with online secondary path modeling often make use of the *least-mean-square* algorithm. In a nonstationary environment, an *extended recursive least-squares* algorithm is more promising in terms of tracking. This algorithm can be regarded as a special form of the Kalman filter. The tracking performance depends on the tuning of several parameters affecting directly the covariance matrices. Thus, a covariance management is presented which simplifies the tuning of the adaptation parameters and improves the tracking performance.

Computer simulations of an active muffler in an automotive exhaust system show the performance of the proposed method compared to results obtained by well-established algorithms. The sound pressure characteristics, i. e. the noise, and the exhaust gas temperature were measured in a real automotive exhaust system, whereas the mean flow velocity of the exhaust gas was estimated.

The acoustic modeling of duct systems is discussed in the first part of this thesis, whereas the second part deals with algorithms for the active noise control of small and broadband noise. The first part makes also a contribution to the modeling of acoustic waveguides by the propagation parameter, which has not been presented in this form before.

Compared to the results of an ANC system using existing algorithms, the derived approach based on a covariance management leads to the highest attenuation of small and broadband noise.