Loudspeaker nonlinearity compensation with inverse tangent hyperbolic function-based predistorter for active noise control

Abstract

In active noise control (ANC), the performance of the filtered-x least mean squares (FXLMS) algorithm is degraded by the saturation of the loudspeaker in the secondary path. Predistortion is a linearization technique commonly used in signal processing applications to compensate for saturation nonlinearity. The design of the predistorter (PD) requires the use of direct measurement from the output of the nonlinear element. However, in ANC applications, direct measurement from the loudspeaker output is not available. Therefore, a conventional PD design approach cannot be directly applied. In this paper, a new PD-based compensation technique based on the inverse model of the loudspeaker nonlinearity is proposed. The PD is represented by an approximated memory-less inverse tangent hyperbolic function (ITHF). The approximated ITHF is scaled by a pre-identified parameter, which represents the loudspeaker nonlinearity strength. This parameter can be obtained by modelling the secondary path using a proposed block-oriented Hammerstein structure in which the nonlinear part is represented by a memory-less tangent hyperbolic function (THF). Simulation results show that using the proposed PD along with the FXLMS algorithm increase the noise reduction performance significantly.