

## Nonlinear FXLMS algorithm for active noise control systems with saturation nonlinearity

### ABSTRACT

In active noise control (ANC) applications, the saturation effect of the loudspeaker in the secondary path is considered as the most serious problem that could degrade performance of standard filtered-x least mean square (FXLMS) control algorithm. When the loudspeaker exhibits nonlinearities, the linear modeling approach fails to identify the secondary path accurately. In the literature, the nonlinear FXLMS (NLFXLMS) algorithm has been proposed to update the ANC controller with a block-oriented secondary path model. This model consists of nonlinear and linear filters whereby the nonlinear part which represents the saturation effect of the amplifier-loudspeaker system is modeled by a scaled error function (SEF). The NLFXLMS algorithm requires an exact copy of the linear and nonlinear models of the secondary path. However, NLFXLMS cannot be implemented in real time because the modeling of the SEF cannot be realized. In this paper, a new method to model the secondary path using the Hammerstein model structure and tangential hyperbolic function (THF) is proposed. The THF can represent the SEF to a certain degree of accuracy. Furthermore, the modeling of the THF can be realized using least mean square (LMS) algorithm and utilized in the NLFXLMS control scheme. Simulation results show that the performance of the THF-based NLFXLMS algorithm is comparable with the SEF-based NLFXLMS.

**Keyword:** Exact gradient FXLMS; Loudspeaker saturation; Nonlinear ANC; Scaled error function; Tangential hyperbolic function