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FUZZY ADAPTIVE FILTER FOR STATE ESTIMATION OF SOUND ENVIRONMENT SYSTEM AND ITS APPLICATION TO PSYCHOLOGICAL EVALUATION

Hisako Masuike[1] and Akira Ikuta[2]

[1]Department of Circulation Information
Hiroshima National College of Maritime Technology
Toyota-gun, Hiroshima, 725-0231, Japan
masuike@hiroshima-cmt.ac.jp

[2]Department of Management and Information Systems
Prefectural University of Hiroshima
Minami-ku, Hiroshima, 734-8558, Japan
ikuta@pu-hiroshima.ac.jp

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Abstract. *The internal physical mechanism of actual sound environment system is often difficult to recognize analytically from the bottom-up viewpoint, and it contains unknown structural characteristics. Furthermore, the observations in the sound environment often contain fuzziness due to several causes. In this paper, a method for estimating the specific signal for sound environment system with unknown structure and fuzzy observation is proposed by introducing a fuzzy theory and a system model of the conditional probability type. The effectiveness of the proposed theoretical method is confirmed by applying it to the actual problem of psychological evaluation for the sound environment.*
Keywords: Fuzzy observation, Sound environment system, Adaptive state estimation, Loudness

1. **Introduction.** The internal physical mechanism of actual sound environment system having a complicated relation to various factors is often difficult to recognize analytically, and it contains unknown structure. Furthermore, the stochastic process observed in the actual phenomenon exhibits complex fluctuation pattern and there are potentially various nonlinear correlations in addition to the linear correlation between input and output time series [1,2].

On the other hand, it is necessary to pay our attention on the fact that the observation data in the sound environment system often contain fuzziness due to several causes, for example, the permissible error of the accuracy in measurements, the quantized error in the digitization of observation data, and the existence of confidence limitation in measuring instruments. Furthermore, it has been reported in psychological acoustics that the human psychological evaluation for loudness can be distinguished up to 7 scores: 1. Very calm, 2. Calm, 3. Mostly calm, 4. Little noisy, 5. Noisy, 6. Fairly noisy, 7. Very noisy [3]. In our previous study, based on the quantized observation on the loudness scores, a method for estimating the specific signal for the sound environment system with unknown structural characteristic has been proposed [1,2]. However, each score is affected by the human subjectivity and the borders between two neighboring scores are vague. In this situation, in order to evaluate more precisely the objective sound environment system, it is necessary to introduce a fuzzy theory to estimate the waveform fluctuation of the specific signal based on the observed data with fuzziness.