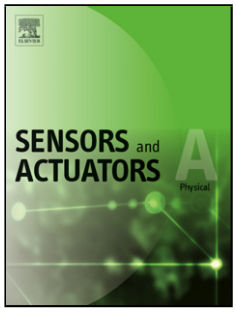

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Hybrid methods for MEMS gyro signal noise reduction with fast convergence rate and small steady-state error

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Highlights:

- Hybrid methods for signal noise reduction is proposed under different conditions.
- Determine IMF modes by consecutive MSE and probability density functions.
- Determine different motion state by AMA even at complex motion state.
- Select proper denoisng method accordingly.

In this paper, a hybrid method is proposed for noise reduction in MEMS gyro signal. To ensure rapid response rate and small steady-state error, and by simultaneously considering the motion state complexity of noisy signal especially under dynamic state, denoising scheme is well-designed, which can be divided into three steps: distinguishing different IMFs modes, determining current motion state, and selecting proper denoising method. Two carefully selected indexes divide the IMFs into three parts, noisy IMFs, mixed IMFs and information IMFs, with the mixed IMFs needed further processing. Sample variances based on AMA are used to determine current motion state. Accordingly, soft interval thresholding, soft thresholding, or forward-backward linear prediction is selected to reduce noise components contained in the mixed IMFs. Denoised mixed IMFs and information IMFs constitute final denoised signal. Practical MEMS gyro signal under different motion conditions are employed to validate the effectiveness of the proposed method. Hilbert spectral analysis and Allan variance further verify the proposed method from qualitative and quantitative point of view. Besides, computational time complexity is also analyzed.

Keywords: empirical mode decomposition, signal denoising, motion state detection, switching based method, soft interval thresholding

1. Introduction