Journal of Acoustical Engineering Society of Iran, Vol. 11, No. 2, 2024

# (Research Article)
# Identifying outlier data in the time series of the fluvial acoustic tomography system (FATS) for river flow measurement using modified singular spectrum analysis and Kernel density method

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Received: 2023/11/15, Accepted: 2024/03/17

## Abstract

Continuous monitoring of river discharge is crucial for environmental, social, and economic evaluations in water resources management. River acoustic tomography is a system that uses the acoustic tomography method to improve the accuracy of flow measurements and solve the problems of discharge measurement methods. However, the collected data may contain outlier data, which can change the output results and measurement error if not identified and removed. In this research, modified singular spectrum analysis and hybrid kernel density method along with five replacement methods were used to identify and remove outliers. The replacement methods include linear interpolation, an average of outlier data, an average of unexamined outlier data, the replacement of outlier data with the last valid data before the outlier data, and the average of one point on each side of the outlier data. Out of 12232 data, 1076 data (about 9%) and 676 data (about 6%) of the total data were identified as outlier data using the modified singular spectrum analysis and kernel density method, respectively. According to the analyses and investigations, the modified singular spectrum analysis has performed better than the kernel density method.

**Keywords:** Fluvial acoustic tomography, Outlier detection, Singular spectrum analysis, Kernel density, River discharge.

pp. 33-40 (In Persian)

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