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Morphological Filtering of SHM Datasets

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This article reports on our success in applying a mathematical morphology approach, normally used in image processing, to SHM data collected from the Red River North Perimeter Bridge in Winnipeg, Canada. This data is modeled as the sum of the true structural response, together with an undesirable temperature dependent strain and a strain offset. A single reference gauge was installed on the structure with the intent of tracking and removing the latter two effects. In practice, however, that approach failed to yield satisfactorily corrected datasets. Further attempts were made to use basic envelope detection or simply high pass filtering to remove the slowly varying components of the data. Both of these methods show some promise but did not perform sufficiently well to be of practical use.

In place of the previous approaches, a modified form of envelope detection was implemented that applies morphological operators to the recorded strain signal. In this study the operators opening and closing were used, which are based on the more fundamental operations of erosion and dilation. When processing SHM data, the opening and closing operations were applied in pairs: opening-closing, and closing-opening. Doing so removes the important strain event activity from the original signal leaving only the background response. It is then possible to subtract this background response from the original signal to produce a cleaned signal.

This approach can be applied equally well to signals with significant background trends and to signals with no discernible trend, without the risk of corrupting the key features of the data in either case. This means that the technique can be applied indiscriminately as a general pre-processing step to clean SHM measurements before further analysis is carried out. Having such a generally applicable method is important as it simplifies the data processing by avoiding the need to perform separate, case-based, procedures on the data streams.

Ключевые слова:

Содержание.
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