MSc-thesis assignment

Wavelets

Figure 1 Example of obtaining ware field information near trunk of a breakwater

The FBI uses wavelet techniques for image compression of digital fingerprints to save storage space. In geophysics wavelets are being used to analyse seismic signals for detecting e.g. earthquakes and oil layers. In finance the wavelet is used to analyse stock markets due to their dynamic and non-linear nature. These are just a few examples to highlight the applicability of the wavelet techniques.

The same techniques are potentially very interesting for Deltares as coastal engineers have to deal with complex time dependent physical processes as for example illustrated in the figures included.

To improve the understanding of these physical processes associated with waves, wave structure interaction, stability of structures or the influence on morphology various measurements

Figure 2 Example of measuring wave field

techniques like time sampling, lasers scanning, photography are employed to capture instant information on wave conditions, forces, currents, erosion and accretion for further detailed analysis.
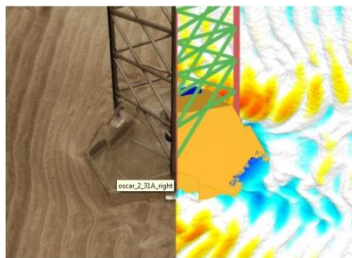

Figure 3 Example Stereophotography

This assignment is related to the part of detailed analysis of time series containing the time evolution of wave heights, forces, etc. Currently, the analysis is performed through Fourier analysis combined with filtering techniques to remove e.g. noise. However, the Fourier analysis has its limitations.

The purpose of this assignment is to look into the added value of applying existing wavelets and the related techniques compared to Fourier type of analysis.

The question is: can we improve our analysis by employing wavelet instead of Fourier technique? To answer this question, the following tasks have been defined for this assignment.
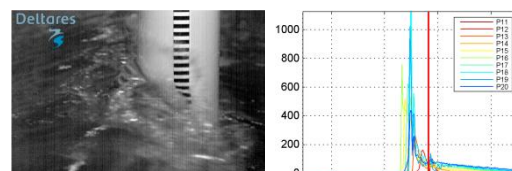

Figure 4 Example wave impact on a pile and measured pressure

Tasks

1. Provide a summary/overview on how wavelets are being used in other fields of expertise, including background information on the mathematical aspects of wavelets.
2. Verify the added value of wavelets by comparing results obtained through wavelet techniques with Fourier analysis by using different type of measured of time series (e.g. pressure due to wave impact, wave height, etc.) which representative for Deltares. Important aspects related to this task are:
    a. Use wavelets to detect and filter different components (e.g. noise) from the signal by using for example thresholding methods.
    b. Use wavelets to detect, if possible, the influence of wave basin characteristics on measured signals.

      c.   Use wavelets to detect non-stationary properties in a signal, which is not possible by using standard Fourier analysis.

3. Research the sensitivity of wavelet specific parameters, e.g. type of wavelet, on the output of a wavelet analysis, including using statistical techniques to be able to interpret results.
4. Make wavelet analysis accessible in projects through scripts on top of an existing wavelet toolbox (yet to be selected). One important aspect for this task is the presentation of results.

Requirements

➢ Programming skills in either Matlab and/or Python.

This assignment is your chance to start a new era in coastal engineering with respect to time series analysis and also create added value to your own skills as wavelets are used in various fields of expertise. The only difference is jargon as the mathematics stays the same! If you are interested, please contact me.

Indication start date: After August 2016

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