Wave breaking analysis using stereo video system

OceanFlux Workshop, Sep. 2013

Introduction:
Images of the ocean surface in the visible range of the electromagnetic spectrum provide quantitative information on a number of physical parameters. Recently, Mironov and Dulov (2008) used video records to analyze wave breaking. Their study provided statistics over a large range of breaking events. On the other hand, Benetazzo et al. (2008) proposed a method to reconstruct the elevation maps of the ocean waves from spatial-widenspread and non-intrusive stereo video system. Here we combine these two approaches to provide a full 4-D analysis of breaking.

High definition, high frequency stereo video acquisitions

Wind and Wave experiment conditions

Detection of breaking events
Detection of breaking events on images is done using method of Mironov and Dulov (2008) [3].

Sea surface reconstruction by stereo triangulation

Point matching improvements
Point matching processing used here is greatly inspired from work of Benetazzo (2006) [1]. Using cross-correlation, pairs of corresponding points are found, with sub-pixel matching algorithm proposed by Benetazzo et al. (2012) [2]. However, this method fails to detect properly the corresponding points around foam patches (upper figure). Method used here was improved to provide better matching (lower figure).

Analyse of Breaking Events
The four sequences of elevation maps are used to investigate distribution of breaking over wave scales and directions. First, breaking events are detected on images. Reprojected on 3D sea surface, breaking speed and direction are computed.

Projection on 3D surfaces

Breaking speed and direction distributions

Conclusion:
We improved the point matching point method of Benetazzo (2006) to reconstruct sea surface in presence of breaking waves. Reconstructed 3D sea surfaces were validated using wave gauges data. Nevertheless, we notice that small swell in first acquisition is badly reconstructed. Four sequences of elevation maps are then used to investigate distribution of breaking over wave scales and directions. These distributions are in line with previous observations by Mironov and Dulov (2008).

Perspective:
Evolution of the breaking wave shape will be investigated, in particular the critical slope of the incipient breaking waves. Wave dissipation due to breaking should also be estimated. Obtained sea surfaces will also be used to analyze directional shape of the wave-number spectrum.

References