

Workshop RPA

June 17-19, 2015

Abstract 2:

Time-delay estimation based on Cross Recurrence Plot and Joint Recurrence Plot for passive underwater acoustic source localization.

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Passive acoustic localization of underwater sources, like cetaceans, is generally based on a two steps approach. First step consists in a time-delay estimation (TDE), which aims at measuring the relative time difference of arrival (TDOA) of the signal on spatially separated sensors. Second step consists in determining the position of the source from a set of estimated TDOA related to the array geometry, by using a spatial inversion algorithm. In this presentation we only focus on the first step.

The most popular method for time-delay estimation in underwater acoustic is the cross-correlation. However, this method has some weaknesses when the signal of interest is mixed in high-level background noise and propagate in reverberant and dispersive environment that warp the waveform of the signals received at different sensors. In such conditions, the cross-correlation gives poor and unreliable estimates of the time-delay, particularly if a low percentage of samples look alike on the different sensors.

In this presentation, we propose to use Cross Recurrence Plot (CRP) and Joint Recurrence Plot (JRP) to estimate the time-delay. First, we identify samples that are recurrent on the different sensors, by calculating the CRP and the JRP between pairs of sensors. Then, we use recurrence quantification analysis (RQA) to estimate the time-delay. Several RQA metrics such as the longest diagonal line L_{max} , the longest curved trace, the diagonal-wise tau-recurrence rate, the recurrence rate and the joint probability of recurrence are considered for this purpose. The most reliable RQA metric for TDE is determined through performance analysis tests involving simulated signals with known time-delay. The influence of the embedding dimension m , of the delay τ and of the recurrence threshold on the performances of the TDE are also discussed. Finally, the proposed method is validated on real data recorded at sea by an hydrophone array and containing cetacean and fish vocalizations.