A Topological Approach for Motion Track Discrimination

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Abstract : Detecting small targets at range is difficult because there is not enough spatial information present in an image sub-region containing the target to use correlation-based methods to differentiate it from dynamic confusers present in the scene. Moreover, this lack of spatial information also disqualifies the use of most state-of-the-art deep learning image-based classifiers. Here, we use characteristics of target tracks extracted from video sequences as data from which to derive distinguishing topological features that help robustly differentiate targets of interest from confusers. In particular, we calculate persistent homology from time-delayed embeddings of dynamic statistics calculated from motion tracks extracted from a wide field-of-view video stream. In short, we use topological methods to extract features related to target motion dynamics that are useful for classification and disambiguation and show that small targets can be detected at range with high probability.

Keywords : motion tracks, persistence images, time-delay embedding, topological data analysis
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