Transfer Learning for Distance Classification of Marine Vessels Using Underwater Sound

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This study investigates the use of underwater acoustics to classify the distances of marine vessels in ecologically sensitive areas, including Marine Protected Areas (MPAs) and offshore wind farms. By employing a convolutional neural network (CNN) model, we classified vessel proximity based on passive acoustic recordings collected from the Belgian part of the North Sea. The dataset consists of over 116 days of acoustic recordings, integrated with Automatic Identification System (AIS) data, offering a comprehensive representation of varying seasonal and environmental conditions. To enhance model performance, we applied transfer learning to the BioLingual CLAP model, comparing two approaches, fine-tuning the network and using it as a feature extractor, to classify vessel distances into 1 km bins up to 10 km, with an additional category for distances beyond 10 km. This approach produced robust results, achieving accurate predictions with a root-mean-square error of 1.587 km. Our model demonstrates significant potential for passive acoustic monitoring, particularly for identifying vessels in MPAs, including those that do not broadcast AIS signals (dark vessels). This research contributes to the EU-funded AXOLOTL project (exploring model adaptions for Cyprus) and contributes to the Marine SoundLib. The associated training dataset and code are publicly available ensuring accessibility for further development and reproducibility. Ultimately, this research seeks to advance monitoring capabilities and support enforcement actions aimed at safeguarding marine ecosystems.