AI in marine sciences: detection and classification of marine vessels with underwater acoustic data

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The development of coastal regions has constantly been threatened by increasing human activities. This has led to the establishment of Marine Protected Areas (MPAs), where human activities are regulated or banned. However, when these areas are not efficiently monitored, they attract illegal activities. The monitoring of these MPAs poses a significant challenge, as they are often impossible to monitor visually. This project proposes to establish an underwater acoustic monitoring system to detect vessels by their sound signature. This is achieved by using machine learning techniques proficient in object detection and classification, laying the groundwork for robust underwater acoustic monitoring systems.

Human activity at sea is mainly tracked through the AIS. AIS data is an anti-collision system used for real time identification and tracking of vessels at sea. It contains information about the position (e.g., longitude, latitude, and speed) at a certain time and voyage information (e.g., MMSI and Vessel type) of a vessel. While the primary purpose of this data is to prevent collisions, including historical coordinate information and vessel types provides an opportunity to create a ground truth dataset to detect and classify marine vessels by their sound signature.

Through the integration of AIS data and passive acoustic hydrophone recordings, obtained from two North Sea stations over a total duration surpassing 100 days (with approximately equal distribution across the two stations), a comprehensive database has been established. This database includes acoustic recordings and relevant information such as the distance to the nearest boat and its type. By using state-of-the-art machine learning methods, two convolutional neural networks (CNNs) are being created. Both networks are based on a pretrained audio model, notably from Yu *et al.* (2018), and apply the framework introduced by Á. López García *et al.* (2020). The first CNN predicts the absence or presence (i.e., binary) of a vessel within a certain range (e.g., presence within a range of 7km). The second CNN aims to predict the actual distance of present vessels and information about the vessel (vessel type).

Under the iMagine project (https://www.imagine-ai.eu), we aim to publish this database and classifiers within a user-friendly module. This tool allows domain scientists to process acoustic underwater recordings, identifying the presence, distance, and type of vessel. In this learning process, the final goal is that classifiers could be used as a reliable autonomous monitoring system in maritime environments.

References

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