Chapter 8
Pattern Analysis in Marine Data Classification and Recognition: A Plea for Ontologies

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ABSTRACT

With the advent of upcoming new patterns to handle (e.g., big data and semantic annotation), to encourage research to detect and identify objects, the development of the internet of things in the ocean requires the interconnection of all equipment (sensors) to observe the oceans. By serving as a common conceptualization among these tools, marine ontologies can lead to lower costs and better flexibility in marine data recognition and classification. To that end, marine pattern analysis literature (1991-2021) is used to create a sample network of records, comprising visual and textual features that can be annotated from video and image sequences, with the underwater parameters as the target of interest. The sample is split into ontological and machine learning (ML) datasets to build a prediction of the importance of data visualization techniques. The predicted suitability is strong with data classification that belongs to the machine learning dataset. However, the initial results from the study are encouraging, because ontologies' tools are proposed as automatic reasoning mechanisms.

INTRODUCTION

An improved ontological representation of marine data as a paradigm for pattern analysis software development requires more work on combining different modes of inference (OWL, ML), the design of algorithms for data classification (DC), and visual data recognition (DR) for signal and image analysis (Malde et al., 2020). This poses the problem of how marine databases should be represented. An ontology of a domain is an "explicit formal specification of the terms in the domain and relations among them" (Gruber, 1993). An ontology fully describes the subject area as a dictionary, in a way it is the ideal tool when we focus on the generation of contextual descriptions for images (in 3D shape retrieval

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for example (Ferreira et al., 2010). Most pattern analysis algorithms in oceanography are to be used for object detection and recognition research, motivated by this challenge it can be proved that an ontology could be a relevant approach to the problem of marine data recognition and classification.

The marine data received from wireless sensor networks are heterogeneous. For instance, the existing marine acoustic data cannot meet the amount of data required for training models (Zurowietz & Nattkemper, 2020). Positioning and orientation systems, and other sensor technology, are based on multi-beam echo sounder acceptance and quality assurance. An automated system produces multiple overlapping range images that were the first for correctly registered mapping of the ocean floor (Kamgar-Parsi et al., 2011).

The purpose of this chapter is to identify relevant pattern analysis research in marine data classification and recognition and to review its intersection with the state-of-the art in marine ontologies. It focuses on the 3D modeling and analysis domain; computer vision and interactions are described for machine learning (ML) and marine ontologies.

BACKGROUND

Application of ontologies in ocean data grows out of an Artificial Intelligence (AI) engagement with marine data metrics of interoperability and reuse. Ontologies serve as such a tool and method to assess the added value robotic technology brings to the marine environment (autonomous underwater vehicles (AUVs) or (ocean floor observation systems) OFOSs). From a pattern recognition point of view, ontologies for describing sensors and sensor networks work in the context of Sensor Web applications. Knowledge representation in the Internet of Things (IoT) presents a general architecture of Sensor Web applications. And that is why it provides huge numbers of interconnected data across an extended variety of various ocean regions, which classifications depend on the specific context and resources of LinkedData (Fang, 2021).

By using ontological representation, the best technical progress, undertaken by a community to unambiguously set definitions and interconnect concepts in various fields, is captured. The use of ontologies for representing database entities has proven to be advantageous in the field of Pattern Analysis and Machine Intelligence (PAMI) (see Table 1).

The concept of marine ontologies may be the solution in developing systems and workflows that would meet the various possible marine data requirements and from them derive up to standard products/maps without human assistance except at the user interface. As shown in Figure 1, research on ontology topics can be followed from different perspectives. The index is the percentage of the publications in the ontology sub-areas of research. It covers the semantic web, web services and so forth. Especially, the semantic web, data integration, and web service have attracted the attention of many researchers in recent years while the research on the topics of data source, relation extraction and, heterogeneous data seems less consistent. One element is the major cause of these problems, as far as a common ontology for marine data is necessary to enable the exchange and integration of data. Terminology is used to describe similar that data can vary between marine specialties or world ocean regions, which can complicate data searches and data integration.

The outputs selection was initially based on the idea that machine learning (ML) enhanced by ontology can compare pattern analysis performances using marine data (Lowell & Calder, 2021). But on ontologies-specific statistics are few, and it is difficult to say what actualities are a significant part of the terms in an ontology (Schlegel et al., 2016).