The Deep Sea Spy system: building a marine images annotation database from participative science

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Introduction

Most of the current knowledge of deep-sea environments is based on punctual, at best yearly, oceanographic cruises. Since 2006, deep-sea ecosystems are continuously being monitored using video cameras deployed on deep-sea platforms. The acquisition of high-frequency video data from deep-sea observatories like EMSO-Azores (www.emso-fr.org/fr/EMSO-Azores) or Ocean networks Canada/NEPTUNE Canada (NorthEast Pacific Time-series Underwater NEtwork) provide for the first time information on species behaviour, feeding habits, growth, possibly reproduction and organisms' response to changes in environmental conditions. Cameras deployed on those observatories acquire hourly video data representing thousands of hours and Tera Bytes of footage that require 10 times more hours of viewing to extract useful information. Since their first deployment in 2006, more than 5 Tb of video data from both the Atlantic and the Pacific oceans were acquired that cannot possibly be analyzed by a few researchers. Only with the help of citizen scientists will be able to process the huge archive of imagery.

The annotation system

The main objective of the project was to build a web-based application for manual imagery processing that will help gather information of interest for scientists as well as raise awareness among the general public about deep-sea ecosystems.

In order to meet this goal the specific technical objectives were to:

- Develop an online image annotation program that will allow participants to simultaneously perform defined tasks on the extracted images.
- Organise the output information in a searchable database consistent with existing Ifremer and EMSO databases following ENVRI + standards.

Ifremer, in association with the company Noveltis (Labège, France), developed the web-based application linked with its structured database. This system was named « Deep Sea Spy » (www.deepseaspy.ifremer.fr).

Figure 1: The Deep Sea Spy game annotation interface

The software is built as a game with dedicated missions. The goal of each mission is to annotate a series of images extracted from archived video sequences acquired with deep-sea observatories. The data obtained is related to the image (e.g. origin, date and position of acquisition, camera type), to the participant (e.g. age, country) and to the annotation (e.g. date, taxon, position/measurement/area in pixels). All this information is stored and exported in a central Oracle database compatible with international common vocabularies.

The query system

In order to achieve the final objective that is to answer scientific questions thanks to the data extracted from images researchers need a tool allowing data mining in the entire dataset collected through the annotation application. The « Deep Sea Spy Request » web interface was then developed to fulfil their requirements in terms of data selection by game mission, observatory, species and temporal criteria. This last parameter is particularly complex but crucial for dynamic studies that are based on observatories video acquisition. After query users can export annotation data results in a table suitable for further analyses. Ultimately the application will allow to perform quality checks such as outlier detection.

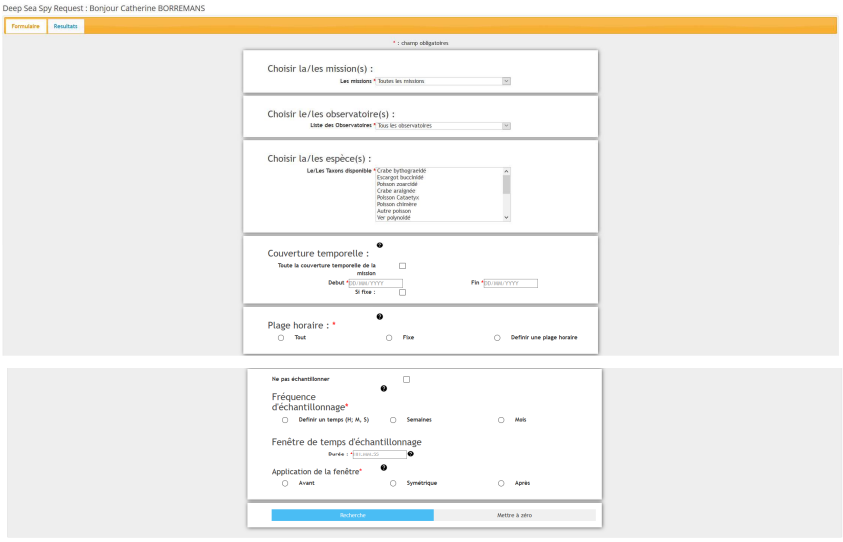

Figure 2: The Deep Sea Spy Request interface

Perspectives

In addition to the challenge of processing such a big citizen dataset another approach will be to implement deep learning algorithms: annotations will help train computer programs for the automatic detection of animal species in the image (Kuminski et al. 2014). It is noteworthy that this would only be possible thanks to standardization of images data in one common database schema.

Reference

Kuminski E, George J, Wallin J, Shamir L. 2014. Combining Human and Machine Learning for Morphological Analysis of Galaxy Images. Publ Astron Soc Pacific [Internet]. [cited 2015 Dec 15]; 126:959–967. Available from: http://www.jstor.org/stable/info/10.1086/678977