Ontology-Based Modelling of Ocean Satellite Images*

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Abstract. In this paper we will define an ontology about the semantic content of ocean satellite images in which we are able to represent types of *ocean structures*, *spatial* and *morphological* concepts, and knowledge about *measures* of temperature, chrolophyll concentration, among others. Such ontology will provide the basis of a classification system based on the low-level features of images. We have tested our approach using the *Protegé* semantic web tool.

1 Introduction

The need to access information in large volumes of image data, e.g. big images, large image archives, distributed image repositories, etc, has motivated the research in the field of *Image Retrieval (IR)* [DJLW08, LZLM07]. Images can be described by means of the name, date, author, color, resolution, etc. However, images can be also described by means of the so-called *"semantic content"*. In this context, the so-called *Content-based Image Retrieval (CBIR)* technology [Han08, DJLW08, WL08] is focused on the definition of mechanisms for analysing, detecting and extracting the *high-level* semantic content of images from *low-level* features, the representation of the semantic content, and the retrieval of images. Some tools of CBIR: VisualSEEK [SC97], SIMPLIcity [WLW01] and ALIPR [LW08], among others, have been already developed.

On the other hand, the CBIR community is interested in the combination of IR with the *Semantic Web (SW)* [BLHL+01] in order to have a framework for semantic content modelling. The SW aims to provide mechanisms for representation and exchange of knowledge through the net. Two formalisms, named *RDF (Resource Description Format)* [LS04] and *OWL (Web Ontology Language)* [GHM+08] have been proposed for the SW. This later is an extension of the former, and they provide languages for describing semantic information about a *domain* of interest. Semantic information is considered as an *ontology* (and *meta-data*) about the domain. An ontology expresses the elements of the domain: *classes*, *properties* and *individuals*, and the intended meaning of the elements: *hierarchical relationships*, *restrictions*, combinations of concepts, etc.

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In this context, some authors have proposed the introduction of ontologies in images (and multimedia) annotation and retrieval. This is the case, for instance, of the proposed [TPC04, IT04, NST+06, ATSH09] ontology based modelling of *MPEG-7* [CSP01]. Basically, the proposed ontology based models aim to adapt the *XML*-based *MPEG-7* specification to a more general framework based on *RDF* and *OWL*, looking for a semantic framework for multimedia features. Such ontology-based semantic framework is more suitable for combination of *multiple resources* of multimedia elements in which low and high level features can be semantically described, allowing to use the *reasoning* capabilities of ontology based models. An interested line of research in this context is the study on how ontologies can be used for modelling *concrete domains*. This is the case of [GC05] for music meta-data, the *M-OntoMat-Annotizer* domain specific tool [BPS+05], and the *Rules-By-Example* [LH10] approach used in the fuel cell domain.

On the other hand, the research field of *Computer Vision (CV)* has studied how to analyse and detect the content of images by applying *pattern recognition* techniques (see [May99, EM09, MME05, MEM07]) based on *decision trees*, *expert rules* and *neural networks*, among others (see [PGMC05, PCG07] for some examples). One of the domains in which such techniques have been successfully applied is *satellite images* of the land and the ocean. Basically, such techniques are based on the *pre-processing* of images and *segmentation*, and in applying *machine learning* methods in which an *expert* participates. Such *training* methods are able to obtain *image classifiers* that can detect, for instance in the case of ocean images, *ocean structures* like *upwellings*, *eddies* and *wakes* from low-level features of images. Such low-level features of images are related to the *spatial* and *morphological* relationships: *shape*, *size*, *land distance*, among others, and *measures* about *temperature* and *chlorophyll temperature*, among others.

In this paper we will define an ontology about the semantic content of ocean satellite images in which we are able to represent types of *ocean structures*, *spatial* and *morphological* concepts, and knowledge about *measures* of temperature, chrolophyll concentration, among others. Such ontology will provide the basis of a classification system based on the low-level features of images. We have tested our approach using the *Protegé* [GMF+03] semantic web tool.

2 Ontology Based Modelling of Ocean Satellite Images

Our work can be summarized as follows:

– We have a repository of *images* about a certain area of the ocean. For each image we have the date, the latitude and the longitude.
– We can have several types of images: images about *temperature* and about *chlorophyll concentration*, among others, usually of the same area and date. The type of image depends of the type of band used.
– Each image is *pre-processed* and *segmented* for obtaining a set of *regions* for each image. Each region is described by means of a set of low-level features including: *perimeter*, *area*, *volume*, *grey scale*, *barycenter*, *inertia moments*,

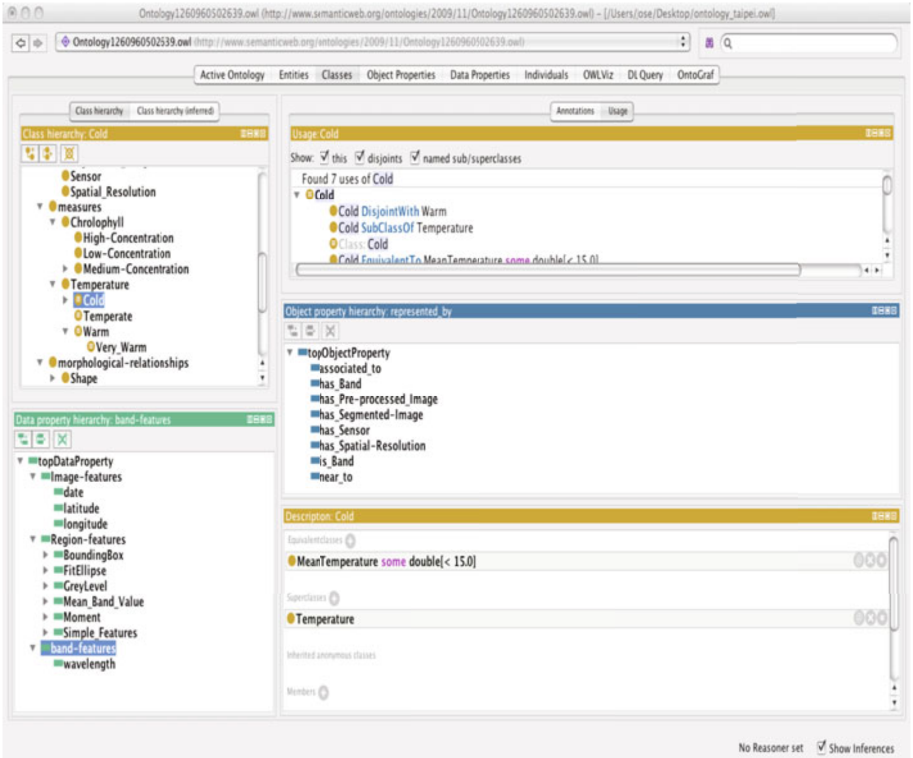

Fig. 1. Snapshot of the Tool

among others. Depending of the type of the image, we can have data about temperature, chlorophyll, etc.

- The processing of images depends on the *type of satellite*, the *type of sensor*, the *band* and the *spatial resolution*. In particular, a given satellite (for instance, *NOAA*, *AQUA*) can be equipped with sensors (for instance, *AVHRR*, *MODIS*) and each sensor can cover several bands (for instance, *thermic infrared*, *visible*), each one with an spatial resolution (for instance, *1 km*, *250 m*).
- Now, we would like to model the parameters for classifying satellite images by means of an ontology. With this aim, we have used the *Protegé* tool in which data about images, processed images and regions associated to processed images, and the type of images (temperature, chlorophyll concentration, etc) are introduced. The classifiers have to be organised in terms of the type of image for which is suitable, including satellite, band, sensor, etc.
- In summary, the ontology should be able to represent:
  - The types of images we handle and the information about images: satellites, sensors, bands and spatial resolutions.
  - Processed images, regions detected from processed images and low-level features.

- Kinds of ocean structures and their relationships.
- Parameters required for classifying images.

3 Using the Protegé Tool

In summary, the *Protegé* tool provides support (Figure 1 shows an snapshot of the tool) for the following tasks:

– Definition of a suitable ontology of semantic concepts and relationships between them, about the content of images. Such concepts can be hierarchically defined.
– Detection of inconsistences about the semantic concepts.
– Definition of a suitable ontology for spatial and morphological concepts and measures. Such concepts and measures can be hierarchically defined.
– Detection of inconsistences about spatial and morphological concepts and measures.
– Defining parameters and elements of a classifying system for ocean satellite images.

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