



Review

Current and future trends in marine image annotation software



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ABSTRACT

Given the need to describe, analyze and index large quantities of marine imagery data for exploration and monitoring activities, a range of specialized image annotation tools have been developed worldwide. Image annotation – the process of transposing objects or events represented in a video or still image to the semantic level, may involve human interactions and computer-assisted solutions. Marine image annotation software (MIAS) have enabled over 500 publications to date. We review the functioning, application trends and developments, by comparing general and advanced features of 23 different tools utilized in underwater image analysis. MIAS requiring human input are basically a graphical user interface, with a video player or image browser that recognizes a specific time code or image code, allowing to log events in a time-stamped (and/or geo-referenced) manner. MIAS differ from similar software by the capability of integrating data associated to video collection, the most simple being the position coordinates of the video recording platform. MIAS have three main characteristics: annotating events in real time, posteriorly to annotation and interact with a database. These range from simple annotation interfaces, to full onboard data management systems, with a variety of toolboxes. Advanced packages allow to

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input and display data from multiple sensors or multiple annotators via intranet or internet. Posterior human-mediated annotation often include tools for data display and image analysis, e.g. length, area, image segmentation, point count; and in a few cases the possibility of browsing and editing previous dive logs or to analyze the annotations. The interaction with a database allows the automatic integration of annotations from different surveys, repeated annotation and collaborative annotation of shared datasets, browsing and querying of data. Progress in the field of automated annotation is mostly in post processing, for stable platforms or still images. Integration into available MIAS is currently limited to semi-automated processes of pixel recognition through computer-vision modules that compile expert-based knowledge. Important topics aiding the choice of a specific software are outlined, the ideal software is discussed and future trends are presented.

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1. Annotation of video and still images from the marine environment

Underwater photography has been used extensively to quantify the marine environment since the middle of the 20th century, and the amount of underwater digital media being captured has grown exponentially in the last decades (Vevers, 1951; Jaffe et al., 2001; Solan et al., 2003). In parallel, an increasing number of research and monitoring teams became interested in describing and analyzing large quantities of imagery data collected underwater. Recent examples of mass imagery collection for scientific purposes include the regular remotely-operated vehicle (ROV) operations in Monterey Bay (Schlising and Jacobsen Stout, 2006), the National Oceanic and Atmospheric Administration live under sea video feeds from the ship *Okeanos Explorer*, or the seabed video continuously streaming to the world-wide web from Canadian observatories (Leslie et al., 2010). Underwater imagery is used to log events related to technical operations, or to answer scientific questions within the disciplines of biology and geology. For example, still images and motion video have been used in ecology to count and track individuals in different habitats and at different spatial and

temporal scales (e.g. Benoit-Bird and Au, 2006; Huffard et al., 2016; Porteiro et al., 2013). The imagery type, platforms used and camera orientations can be varied to suit the scientific aims, and both discrete and continuous events may be recorded, including size and area measurements.

Annotation is a wide concept (from text documents to digital databases), and what is less ambiguous is the *process*, which we call annotation, of adding data to something that already exists. In the digital imaging community, annotation is often accomplished by superimposing the annotated data on an image. Image annotation also includes translating objects or events in an image to the semantic level, representing the actual content recorded in the image or video (e.g. describing an object or an animal behavior). Therefore, image annotations can be stored with the imagery, facilitating data management and the accessibility of information.

Scientists have endeavored to develop annotation tools for fast labelling and data retrieval since the early 1990s. This early work focused on analogue photographs and videotape, and later moved on to computer-supported investigation (Kipp, 2001). The emergence of technology to aid image annotation increased reliability,

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