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Automated identification of copepods using digital image processing and artificial neural network

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Abstract

Background: Copepods are planktonic organisms that play a major role in the marine food chain. Studying the community structure and abundance of copepods in relation to the environment is essential to evaluate their contribution to mangrove trophodynamics and coastal fisheries. The routine identification of copepods can be very technical, requiring taxonomic expertise, experience and much effort which can be very time-consuming. Hence, there is an urgent need to introduce novel methods and approaches to automate identification and classification of copepod specimens. This study aims to apply digital image processing and machine learning methods to build an automated identification and classification technique.

Results: We developed an automated technique to extract morphological features of copepods' specimen from captured images using digital image processing techniques. An Artificial Neural Network (ANN) was used to classify the copepod specimens from species *Acartia spinicauda, Bestiolina similis, Oithona aruensis, Oithona dissimilis, Oithona simplex, Parvocalanus crassirostris, Tortanus barbatus* and *Tortanus forcipatus* based on the extracted features. 60% of the dataset was used for a two-layer feed-forward network training and the remaining 40% was used as testing dataset for system evaluation. Our approach demonstrated an overall classification accuracy of 93.13% (100% for *A. spinicauda, B. similis* and *O. aruensis*, 95% for *T. barbatus*, 90% for *O. dissimilis* and *P. crassirostris*, 85% for *O. similis* and *T. forcipatus*).

Conclusions: The methods presented in this study enable fast classification of copepods to the species level. Future studies should include more classes in the model, improving the selection of features, and reducing the time to capture the copepod images.

Background

Copepods are the largest and most diversified group of crustaceans [1]. They are ubiquitous and the most abundant aquatic metazoans. Ecologically, copepods act as the most important link between phytoplankton and higher trophic levels in aquatic food webs. Copepods are sensitive to environmental disturbance and they can be the bioindicator for the changes in water quality [2]. Community shifts of copepods also provide sensitive indicator of climate change on marine biotopes [3]. Thus, copepods are one of the most studied microorganisms in marine food webs and fisheries studies. The size of adult copepods ranged from 200 μm to 2 mm in size, while their numbers can range up to 60,000 individuals per m^3 of water [4]. Positive identification of these organisms and completion of the work are thus hampered by their small size (mostly <0.20 mm in total length) and sheer numbers.

The identification of copepod species requires information of their morphology. Body shape is useful to characterise the genera, but may not be useful to differentiate closely related species. At the species and finer level, the characters of specific appendages such as the fifth legs are required [5]. Body shape and characteristics may however be useful to predict species in specific locations or habitats

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