Cephalopod species identification using integrated analysis of machine learning and deep learning approaches

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ABSTRACT

Background. Despite the high commercial fisheries value and ecological importance as prey item for higher marine predators, very limited taxonomic work has been done on cephalopods in Malaysia. Due to the soft-bodied nature of cephalopods, the identification of cephalopod species based on the beak hard parts can be more reliable and useful than conventional body morphology. Since the traditional method for species classification was time-consuming, this study aimed to develop an automated identification model that can identify cephalopod species based on beak images.

Methods. A total of 174 samples of seven cephalopod species were collected from the west coast of Peninsular Malaysia. Both upper and lower beaks were extracted from the samples and the left lateral views of upper and lower beak images were acquired. Three types of traditional morphometric features were extracted namely grey histogram of oriented gradient (HOG), colour HOG, and morphological shape descriptor (MSD). In addition, deep features were extracted by using three pre-trained convolutional neural networks (CNN) models which are VGG19, InceptionV3, and Resnet50. Eight machine learning approaches were used in the classification step and compared for model performance.

Results. The results showed that the Artificial Neural Network (ANN) model achieved the best testing accuracy of 91.14%, using the deep features extracted from the VGG19 model from lower beak images. The results indicated that the deep features were more accurate than the traditional features in highlighting morphometric differences from the beak images of cephalopod species. In addition, the use of lower beaks of cephalopod species provided better results compared to the upper beaks, suggesting that the lower beaks possess more significant morphological differences between the studied cephalopod species. Future works should include more cephalopod species and sample size to enhance the identification accuracy and comprehensiveness of the developed model.

Subjects Computational Biology, Marine Biology, Data Mining and Machine Learning

Keywords Cephalopod, Machine learning, Deep learning, Species identification, Beaks, Deep features, Traditional morphometric features

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