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Automatize landmarks setting on Species morphometry using Deep Neural Networks

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ABSTRACT

Morphometry landmarks are known as one of the approaches to analyze the characteristics of organisms. Finding landmarks setting can give to biologists a comprehensive description of the organism. In this study, we propose a convolutional neural network (CNN) to predict the landmarks on biological's species. The network is designed as a combination of the "elementary blocks". After training with a set of manually landmarks dataset, it has been used to predict the morphometric landmarks on biological images automatically. The network has been checked by applying two scenarios: training from scratch and fine-tuning. The predicted landmarks have been evaluated by comparing with the coordinates of manual landmarks which have been provided by the biologists. The network model is implemented by Python on Lasagne framework.

1 Introduction

Morphometry analysis refers to measure the topography of an object, for example, its shape and its size. Biologists work with several parameters from organisms such as lengths, widths, masses, angles,... to analyze the interactions between environment and organisms development. Besides the traditional information, landmarks (or points of interest in the image) are known as one of the characteristics to analyze the shape. Instead of collecting all information, the shape is determined by a finite set of points, called landmarks. Landmarks store important information about the shape of the object, *for example*, the corners of the human mouth are a kind of landmarks. Mostly, the landmarks are along the outline of the object but in some special cases, it could be defined inside the anatomical part, *i.e* the landmarks on Drosophila wings are the intersection of veins on fly wings, but the landmarks on pronotum can be located at the shape edge or inside the pronotum. In our study, the morphometric landmarks are specific points defined by biologists. They are used in many biological studyings. Currently, the landmarks are set manually by the entomologist, the operation are time-consuming and difficult to reproduce when the operators change. Therefore, a method that gives automatic location of landmarks could have a lot of interest.

In this study, we have used a dataset including the images of collecting from 293 beetles in Brittany lands. All the images are presented in RGB color with two dimensions. For each beetle, the biologists took images of five parts: *left and right mandibles*, *head*, *body*, *and pronotum* (Fig.1). For each part, a set of manual landmarks has been positioned by an entomologist.

In the concept of automatically landmarks setting, image processing is usually the first choice to apply. This is a process that we apply a set of algorithms (in image processing) to extract and to analyse the object of interest. In which, segmentation is most often the first and the most important step. This task remains a bottleneck to compute features of an image. In some cases, the object of interest is easy to extract and can be analyzed with the help of a lot of very well-known image analysis procedures. Like previous study [**?**], we have analyzed two parts beetle mandibles (Fig.1a and Fig.1b). These parts are pretty easy to segment (enough good quality for our goals). In that work, we have applied a set of algorithms based on the combination of principal component analysis [**?**] and SIFT descriptor [**?**]. Unfortunately, this method is irrelevant with the case of the images that are not precise or diffi-

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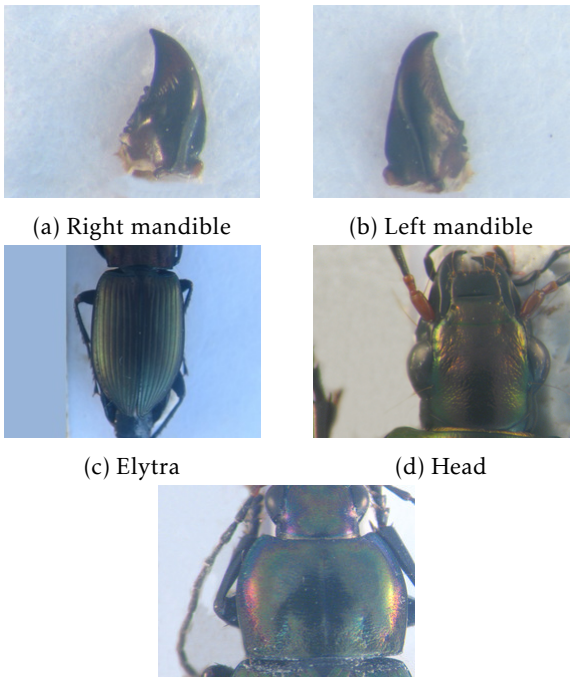
cult to segment, *i.e.* pronotum images. So, the remain question of how to predict the landmarks on the images like the pronotum images? This is the reason why we have turned to a way of analyzing images without need for a segmentation step. So, the next step has been to work with the prontoum images (Fig.1e). For each pronotum image, a set of 8 manual landmarks have been set by the biologists (Fig.**??**). They are considered as the ground truth to evaluate the predicted landmarks by our method.



(a) Right mandible (b) Left mandible

(c) Elytra (d) Head

(e) Pronotum/thorax

Figure 1: The anatomical parts of beetle

To achieve the landmarks prediction, this work introduces a method for this automatic detection of the landmarks on pronotum images. The main idea consists on design and train of a CNN [**?**] with a set of manual landmarks. In the first stage, the network has been trained from scratch on the dataset of pronotum images from the first model. In the second step, the training has been modified to improve the quality of prediction by including the fine-tuning[**?**] step. The network has been implemented by using Python on Lasagne library [**?**].

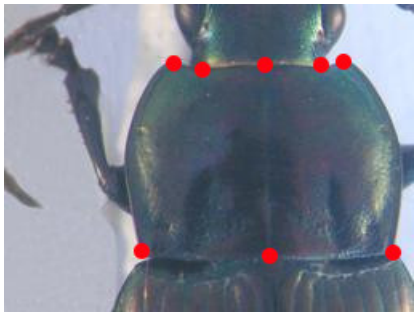


Figure 2: A pronotum image with its eight manual landmarks

The rests of the article is organized as follows. In the next sections, we first give a briefly overview of the related works on automatically landmarking. We then shortly present an overview about CNN. After that, in Section X1, we describe the architecture of the proposed network and its parameters also. The dataset augmentation processes are presented in Section X2. In Section X2, we give the first results of the model, then we present the step of fine-tuning to improve the result. Finally, we conclude the article with a discussion of future works in Section X3.

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3.3 Figures

Figure 3: ASTESJ logo

Figure 4: ASTESJ logo

3.4 Tables

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Table 1: Summary of datasets used

3.5 Units

3.5.1 Some Common Mistakes

1. The word “data” is plural, not singular.

2. The subscript for the permeability of vacuum μ_0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.

3. A graph within a graph is an “inset”, not an “insert”. The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).

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References

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