Automatic morphology: Application on biological images

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ABSTRACT

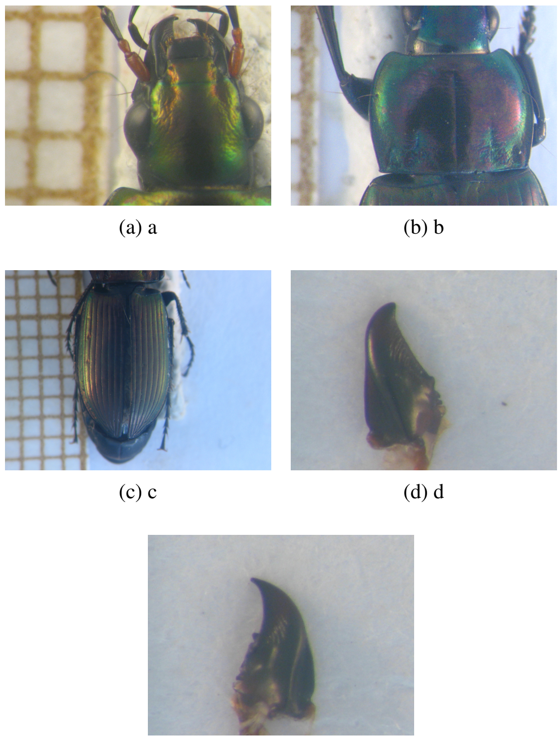
Morphology is a important characteristics of the biological analysing. Knowing the morphology of an object do not only help us generate the information of the object or re-construct the object but we also classify the objects. Indicating the morphology in biological image is a large field and having many methods from manual methods to semi-automatic or automatically. In the content of this article, we proposed a method to automatic determine the characteristics to define the morphology in biological, specify on beetle. Through segmentation and registration, our method is used to determine the landmarks on the images. The experiment is done with two datasets. The result is evaluated by the coordinates of automatic landmarks and the centroid size of all estimated landmarks.

Keywords

Automatic morphology, landmarks identification, image registration.

1 INTRODUCTION

In biology, morphology analysis is widely used to keep the changing information of the organism or detecting the difference information between the organisms. From the result of morphology analysis, we can conclude the evolution of an organism family, or we may classify the organisms. Especially in agriculture, morphology is one of best ways to learn about the variations of the insect on crops. The morphology methods may be divided into the groups by the features which are used by the methods such as shape, structure, color, pattern or size of the object. In the aim to study the potential links between these variations and agricultual ecosystems, a set of 291 beetles has been collected with all the information about the sex, place where they are found and agricultural practices in each field were recorded. For each beetle, the morphometric landmarks has been defined on each part (each insect includes five parts (see figure 2)) of the insect by the biologies. Morphometric landmarks are points that can be defined in all speciemns and located precisely. Landmarks are widely used in many biological studies and they are currently included into the classification procedures.



(a) a (b) b (c) c (d) d (e) e

Figure 1: The parts of beetle: (a) head, (b) pronotum, (c) body, (d,e) left and right mandible

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In this paper, we focus on a method that can automatic idenfication of landmarks on 2D images of beetle, specify the mandibles of beetle. The method mainly includes three stages: firstly, we extract the feature of the object in the image; secondly, the automatic landmarks are indentified by image registration and generalizing

Hough transform; finally, a refinement of the estimated landmarks is done by cross-correlation.

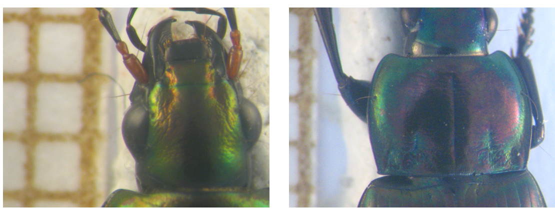
In section 2, the steps of our methods will be discussed. All experiments and evaluation are described in section 3. Finally, we have some conclusion and discussion in the section 4.

2 METHOD

For each image, a set of manual landmarks have been set by biologists corresponding to the morphological points of interest (18 landmarks for each right mandible and 16 landmarks for each left mandible). The automatic procedure to determine the landmarks is based on the segmentation of the image. The presence between two images are indicated by generalizing Hough transform, along with theirs translation and rotation are determine by applying registration. The last step is using cross-correlation to verify the location of estimated landmarks.

2.1 Image segmentation

In the methods of image processing, feature extraction is always a important stage. Besides, depending on the nature of the method, the methods are applied before (pre-processing) or after (post-process) extracting the features. In our method, the original Canny alogrithm[1] is ideal for detect the curves on the image. The ratio between lower threshold and upper threshold which are used in Canny algorithm is 1:3 (lower threshold approximated to 1 times *threshold value* and upper threshold set to 3 times threshold value). This value is evaluated by the experiments. The *threshold value* has been determined by analyzing the image histogram. During appling the Canny alogrithm to detect the curves of object, the gradient direction of each pixel which belongs to the curves is kept for the next step of the method.



(a) Segmentation result after applying Canny algorithm

(b) Segmentation result after applying Canny algorithm and post-process

Figure 2: The segmentation results of the image

In this study, the aim of segmentation stage is determined the outer border of the object which can be used to reconstruct the shape of the object as well as provide the best data for next step. The curves from Canny algorithm will be post-processed to remove the unnecessary curves i.e hole inside the border.

2.2 Generalizing Hough transform

The generalizing Hought transform (GHT)[2] is a key of this study. With two input images, GHT is used to recognize the similar between two images and estimate the landmarks of an image based on the landmarks of other image. The GHT includes two phase learning and recognition process. In the learning phase of GHT, model image is used to construct R-table. This is table that contains the polar value of each point in model's curves. A polar coordinate system is initialized in the model image by fixing a reference point and using it as orgin. The R-table records the polar coordinate values of all boundary points. The rows of R-table are indexed by the gradient directons of the points on the curves. It means that with a gradient direction can be exists many polar coordinate values. During the recognition phase, a 2D accumulator is used, called Hough Space Voting (HSV). The axes of HSV express the information of polar coordinate system. For each curve points on scene image, we try to find a record in R-table that corresponding with the gradient direction of each scene point. The voting will be carried out at all location in HSV that found in R-table. At the end of voting process, if the scene image is identical to the model image, then the cell where have the highest number of votes corresponds to the reference point of the model in the scene image. Besides, the peak value would be equal to the number of curve points of the scene image when the model and scene image match perfectly.

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6 ACKNOWLEDGMENTS

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7 REFERENCES

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