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An algorithm for determination of the morphological characteristics of honey bees

Zlatin ZLATEV* and Veselina NEDEVA

Trakia university, Faculty of Technics and Technologies, 38 Graf Ignatiev str., 8602, Yambol, Bulgaria,
*correspondence: zlatin.zlatev@trakia-uni.bg

Abstract

At the current level of science and technology is used semi-automatic measurement of body parts of the bees, yielding images taken with a reference object via a camera or a scanner and then perform measurement by software using a pointing device. There are attempts to fully automated process of measuring the morphological characteristics of bees, at this stage there are conversions for Measuring wings, but this process for other parts are still made by manual way. The informative colour features for the separation of tergite and probotics from background in the image are selected by distance functions and correspondence analysis. Distances are determined between the values of the colour components of the object and background. From statistical analysis is found that appropriate for the separation of an object from background are S and V colour components of the HSV colour model. Algorithms and program in Matlab environment for separating tergite and proboscis from the background of the image and definition of their main sizes are developed. From the analysis of the results is found that the major influence on the accuracy of the measurement is the angle at the disposal of the bee body part in the image.

Keywords: colour components honey bee, measurement algorithm, morphometric characteristics

Introduction

The analysis of known research related to the measurement of morphological characteristics of bees shows that appropriate methods for this purpose are the following (El-Aw et al., 2012; Silvaa et al., 2015):

- Classical – by a stereo microscope and a magnifying glass;
- Computer – by software products for general-purpose and specialized.

Development and research into the measurement of morphological characteristics of bees include improvement of existing or creation of new methods for manual, automated and automatic measurement. The main characteristics, which are directed to these studies relate to measurement of parameters of the wings.

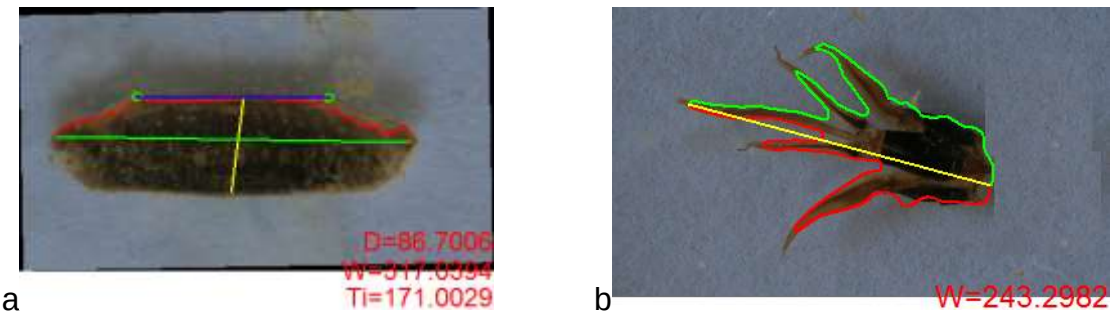
The aim of this paper is to explore the possibilities to automate the process of measuring the morphological characteristics in honey bees and to propose an algorithm and program to implement it.

Material and methods

The sample consists of front right wing, rear right wing, right hind leg, third and fourth tergites, sternit and proboscis. Samples were prepared in the laboratory of the section „Beekeeping“ at the Trakia University – Stara Zagora, Bulgaria. Same as used from (Lazarov, 2016). The method used in the study is the separation of the object from background by colour components. As a criterion for selection of colour features are the distances between colour components. The distances used are Mahalanobis, Euclidean, Cityblock, Chebichev distance and Fisher discriminant ratio, briefly described in (Penchev et al., 2016). The resulting distances are processed by method of correspondences analysis (CA) (Kazlacheva at al., 2014) of the software Statistica. Determined are the informative colour features by certain methodology (Georgieva et al., 2015).

Results and discussion

The proposed algorithm and its implementation are based on express, contactless measurement of elements from the body of bees through techniques of image processing. Emphatically it should be stressed that its establishment is not intended to replace or substitute authorized and approved in practice methods for measurement of these dimensions. Table 1 shows the resulting distances (for RGB and HSV colour models) to separate the object from the background using colour features of six colour models – RGB, HSV, Lab, LCH, XYZ, CMYK. The algorithm for measuring the main dimensions of tergite is described in Table 2. The original RGB image is transformed into HSV colour model. Experimentally it has been found that for the separation of tergite from the background in the image is suitable V (HSV) colour component.



a b

[a]Measurement of the tergite; [b]Measurement of the proboscis

Figure 1. Results of the algorithm for automatic measurement of honeybee body parts

Table 1. Distances between color components for object and background

D[a]	Mahalanobis		Euclidean		CityBlock		Minkowski		Chebichev		FDR	
A[b]/ CC[c]	T-B[d]	P-B[e]	T-B	P-B	T-B	P-B	T-B	P-B	T-B	P-B	T-B	P-B
R	1.8	1.8	34	43.6	42.8	53.7	34	43.6	31	40.4	2.1	2.6
G	1.8	1.8	34.4	37.8	42.9	47.4	34.4	37.8	31.5	34.4	4.3	6.6
B	1.8	1.7	38.9	38.4	48.4	47.1	38.9	38.4	35.8	35.7	4.5	7.9
H	1.7	1.7	0.4	0.3	0.5	0.4	0.4	0.3	0.4	0.3	0.5	1
S	1.8	1.8	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.8	1.5
V	1.8	1.8	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	2.6	3.2

[a]D-distance; [b]A-area; [c]CC-colour component; [d]T-B-tergite-background; [e]P-B-proboscis-background

Table 2. An algorithm for measurement of dimensions of tergite

Stage	Description
A	Loading of the original image
B	Levelling the object in the image
C	Conversion in HSV colour model and extraction of V component
D	Conversion of the image in black and white
E	Filtering of the image
F	Removing of noises
G	Obtaining of the object dimensions
H	Finding of the contour of the object
I	Finding of the long axis of the contour
J	Finding of short axis of the contour
K	Determining the distance between excrescences
L	Visualization of the results

The angle of the object in the image is changed ±10% relative to the horizontal axis. The results of this analysis show that for the tergite, with an error of up to 5%, the algorithm operates at an angle of rotation of the object with respect to the horizontal axis from -2^{o} to + 1^{o}. It is found that the measurement of the main dimensions in tergite and proboscis of honey bees is accurate to within 5% in deviation ±1.5^{o} of the longest axis from the object to the horizontal axis of the image.

Conclusion

The colour features by which body parts of bees – tergite and proboscis may be separated from the background of the image are measured and analysed. Through distance functions are defined colour components suitable for separation of object and background. From statistical analysis is found that appropriate for the separation of object from background are S and V colour components from HSV colour model.

The algorithms that use V complement from HSV model existing as measured other parts of the body except the bee's wing. From the performance analysis of the developed algorithms is found that the major influence on the accuracy of measurement has an angle of disposition of the portion of the body of the bee in the image. The main dimensions in tergite and proboscis of honey bees is accurate to within 5% deviation ±1.5^{o} the longest axis from the object to the horizontal axis of the image.

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