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Developing a Computer Application for the Identification of Similar Butterfly Species Using MATLAB Image Processing

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Abstract:

Identification of insect pests to the species level is very important in the field of plant protection. The species name is a filing and retrieval system which enables us to store and/or retrieve all data for a species such as host plants, life cycle, damage, or pesticide resistance. However, identification of insects to the species level requires special knowledge and training. We aimed in this research to develop a computer application for the untrained person to identify digital images for three morphologically similar butterfly species. The first was the cabbage butterfly, *Pieris rapae leucosoma* Schawerda, a common pest of Cruciferae, while the other two (*Euchloe ausonia melisande* Fruhstorfer, *Pontia daplidice daplidice* Linnaeus) were generally considered non-pest species. Matlab 2017 software was used to build an implementation of the developed image processing technique. The insect digital image processing steps included resizing, orientation, filtering, extracting wing colors, and finally calculating the ratio of colors. Some images were used to train the computer to identify the images and the rest of images were used for identification by the computer. In addition, Graphical User Interface Application was developed to let any user

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(computer programmer or amateur) to upload process and identify an image. More than 99% correct identifications were obtained. The developed application may be a promising tool for insect image identification when more species are included and refinement of the technique is achieved.

Keywords:

Computer Identification, Insect Images, MATLAB

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Introduction

Butterflies may look very similar on the surface, but they are actually quite different. It is easy to confuse these amazing species. Butterflies come in amazing varieties of styles, colors and sizes. This paper will review the best ways to distinguish Jordanian butterflies for easy identification. By inserting a butterfly image on the computers, this image is scanned by MATLAB 2017 “a programming platform designed specifically for engineers and scientists”. The MATLAB language is a matrix-based language allowing the most natural expression of computational mathematics [4]. Then the appropriate filter is provided for the information (family name and characteristics to distinguish it for other species), and user will not need go back to the books for knowledge and information about the butterfly that he saw.

The main objective of this paper is to design and develop a system that helps to distinguish between various types of butterflies and identify the main characteristics that characterize each species. In addition, the system will help people in general to quickly identify the type of butterfly offered.

Many studies have been performed to identify insects using computer systems. For example, Butterfly Collection is an application that has 240 species of butterflies and moths in its database. Scroll through the photographs, learn species names, and see which species live near you [1].

Another one is Gardens with Wings which is a web site used to identify butterflies you may see in the garden or in the field by their shape, wingspan, opened and closed wing color, common name and family name, and then display information about them. 2008-2018. [2]

Also, British Butterflies identification web site is used to identify butterflies in Britain and display information about it based on collection

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characteristics: wing pattern, Primary Color, Secondary Color, Color Band.
2000-2018[3]

Research Justifications

The previously mentioned studies need to scroll through images stored in database and depend on the human recognition of the image. Also, they need to collect information on the insect depending on the observations of a human. A fully automated project is needed to be developed without any possibility of a human error.

This research aims to develop a computer application in Graphical User Interface (GUI) for the untrained person to identify digital images for three morphologically similar butterfly species, which can't be identified easily with human eyes (with sample photo for each):

1. Cabbage butterfly; *Pieris rapae leucosoma* Schawerda, a common pest of Cruciferae. Shortly (*Artogia rapae*) as shown in Figure 1.
2. *Euchloe ausonia melisande* Fruhstorfer. Shortly (*Euchloe ausonia*) as shown in Figure 2.
3. *Pontia daplidice daplidice* Linnaeus. As shown in Figure 3.

The last two species were generally considered non-pest species.



Figure 1. *Artogia rapae*



Figure 2. *Euchloe ausonia*



Figure 3. *Pontia daplidice* Linnaeus

Identification Algorithms Attempts

This research used three different methods trying to implement the appropriate algorithm for insects' identification:

- Using Shape Property: This method did not work in this research because the butterflies had similar shapes and the program could not distinguish between them. It was used to distinguish between a butterfly and a grasshopper [5].
- Detect Features: This method did not work also in this research because it is difficult to locate features for the understudy butterflies, as their shape, and color features are close [6].
- Histogram of RGB: This method was the worse in this research because the proportion of red, green and blue are similar in the three species of understudy butterflies [7].

Materials and Methods

A computer system was designed and programmed to distinguish between the butterflies based on the degree of dark gray and light gray extracted from the insects' images. The first step has been done in this system is to collect 15 samples of data for each species for the data training. Meanwhile, for the data testing, the program used 5 images for each species to be tested later on the system. Identification Algorithm stages can be summarized as:

1. The image will be resized to a fixed size [200 x 200] dimension in matrix form.
2. Calculate number of pixel of object: calculate RGB range channels: RedChannel, GreenChannel, and BlueChannel. Then, the number of Black Pixels (numBlackPixels) equals to the summation of all RGB Channels.
3. Compare the result with a specific range:

If $(173 < \text{numBlackPixels} < 600)$ condition is satisfied then the specimen is classified as *Artogiarapae*. Else, if $(3490 < \text{numBlackPixels} < 5200)$ condition is satisfied then the specimen is classified as *Euchloeausonia*. Or, if $(987 < \text{numBlackPixels} < 3489)$ is true the specimen is classified as *Pontiadaplidicedaplidice*. Finally, numBlackPixels is considered out of the above ranges , and the result is failed.

Implementation and Results

To walk through the system, user needs to perform the follow steps:

Step1: get into Application Home page, which is shown in Figure 4.

Step2: Upload Image of the butterfly by browsing the computer for Image file.

Step 3: View Result of testing the Uploaded Image. Figure 5 shows a sample Result Screen.

Step 4: Press on Close Button to end the application run.



Figure 4. Application Home page



Figure 5. Sample Result Screen

A total of 120 images of butterflies were collected for testing. These images were shot using a digital camera in blue background. 40 images were taken for each type. The obtained results were as shown in Table 1:

Table 1. Results of Testing Samples

Species	# of samples identified	Percentage %
Artogla rapae	32	80
Euchloe ausonia	30	75
Pontia daplidice daplidice	31	77.5
Average	Out of 40	77.5%

Conclusion

In the present study, three types of butterflies were tested using the MATLAB 2017 program. The proposed system distinguished between the butterflies by extracting the degree of color in the gray butterfly wing, and then calculate its ratio to the white color, thus determine the butterfly of the first species or second or third. Further studies should take place to increase the families under study. The strengths of this proposed system are that it is the first of its kind in terms of searching at the three understudy types of butterflies in Jordan. The proposed system solves the problem of non-discrimination between the types of butterflies with naked eye.

On the other hand, one of the weaknesses of the proposed system is that it is difficult for the program to recognize the butterfly if the background of image is not uniform or if the background of image is an image. Another weakness is that the specimen must be in foreground position, and it must not be broken or damaged by the pins, which leads to that some images are not recognized by the program. A sample with a broken wing is shown in Figure 6. Some images may not be included in the obtained range, due to the gray ratio of the butterflies' images which may be affected by the quality of image.



Figure 6. A sample butterfly with a broken wing

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