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# ANALYSIS OF THE APPLICABILITY OF A COMPUTER VISION SYSTEM FOR ASSESSMENT OF THE QUALITY OF QUAIL EGGS

## Introduction

In the past years the Japanese quails were used as lab birds because of their easy breeding, early sexual maturity, short reproductive cycle and high egg productivity. The quails are known as a meat and egg source [10]. The eggs of different birds have the same nutritional composition and have the same potential to be used as a food source. On the other hand the information about the quality of the eggs and their use as a food source is essentially limited to chicken eggs [3]. The chicken eggs are very well-studied in regard to their quality, but data about the egg quality of other kinds of bird species is missing in the literature. For the consumer of importance are both the external traits, such as – egg cleanness, freshness, weight, and eggshell thickness, as well as the internal traits – quality of the yolk and egg white, egg components ration and chemical composition [13]. These characteristic are of importance for the industrialized quail farming.

The egg is a biological structure intended for reproduction. It protects and provides a complete diet for the developing embryo, and serves as the principal source of food for the first few days of the chick's life. The Japanese quails are tough birds, which are easy to take care for in a cage. They are resistant to a few diseases that are typical for other types of poultry. The quails lay eggs every 50 days. Under proper conditions these birds can lay up to 200 eggs per year. The life expectation of a quail is around 2.5 years. The quail eggs are white with brown spots; sometimes the eggshell is even tan or off-white coloured. Each bird lays eggs with a specific characteristic eggshell colour [14].

Eggs are classified as a natural food source. In the past years there has been an increased interest in the use of quails for meat and eggs along with other poultry products. Also there is an increased interest in the industrialized quail farming for meat and eggs. The industrialized farming of these birds leads to the question of the meat and egg quality. The external and internal traits of the eggs and their storage time are quality indicators. The eggs are used as a diet food since they are protein and nutrients source. The assessment of the egg quality depends on their weight, shell strength, ratio between the internal components, such as egg white, yolk, air cell and the possible variations between these traits. Some problems develop during egg storage such as weight loss and deterioration of the quality of whites and yolks. The passage of carbon dioxide and moisture through the eggshell leads to deterioration of the quality of the egg white and yolk and to loss of weight [2, 5].

The technical tools used for assessment of the egg quality are shown in [15]. The up-to-date technical tools use the identification of the following quality indicators:

- discovery of eggshell cracks;
- discovery of blood;
- discovery of leaking eggs.

This study aims at proposing a technical tool using a video sensor and software for assessment of the quail eggs quality using external indicators, because of the increased interest in the industrialized quail farming and egg consumption.

## Material and Methods

Hundred (100) eggs, laid by Japanese quail eggs, which were 15 weeks old, and kept in cages with 1 male and 2 female quails in a farm at the village of Bolyarovo, Yambol municipality, were used. The weight of the eggs was determined using the analytical electronic weight Boeco BBI-31 with an accuracy of 0,01 g. The width and length of the eggs was also recorded.

### *Computer Vision System*

For the purpose of the study a computer vision system, with the following components, was used (Fig. 1):

- Video camera – the camera is mounted on a flexible arm, which allows for changing the shooting height. The images are taken at a height of 20 cm.
- Lightning system – the lightning system allows for adjusting the light and removal of the noises. White-light LEDs, with a wavelength of 450 nm, were used.
- A PC with installed software for recognition and image processing using texture traits. The work algorithm of the proposed system is given in Table 1.

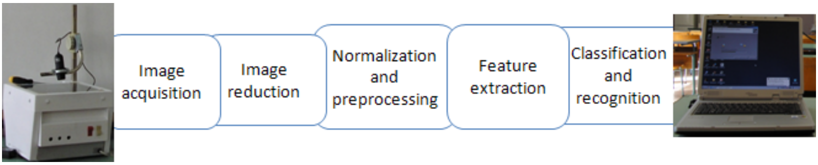



**Fig.1. Block-diagram of the computer vision system**

**Table 1. Algorithm for recognition using texture traits**

| Step | Work stage | Description |
|---|---|---|
| A | *Loading of the original image* | Location and segmentation of the object |
| B | *Removal of the changes in the contrast* | Determining the image gradient and segmentation threshold |
| C | *Creation of a binary mask* | Contains the basic elements of the sample |
| D | *Image filtering* | Using a disk type operators |
| E | *Setting up the threshold value* | Obtaining a binary mask using settings parameter and an edge operator application |
| F | *Filling the existing gaps in the closed outline* | Filling of small areas enclosed in the general outline using function and operators |
| G | *Removal of all elements connected to elements outline* | Setting the removal of diagonal links |
| H | *Improving the object outlook* | Using double smoothing |
| I | *Introducing the resulting outline to the original image* | Displaying of the outline over the original image using a specific colour |
| J | *Recognition of the eggshell traits* | – |
| K | *Calculating the egg parameters* | The parameters are calculated using the equations give in Table 1 |

## ***Software System for Image Recognition and Processing***

Software system for receiving, processing and analysis of images which is based on texture traits was developed.

The accuracy of recognition is regulated by the radius of the averaging filter of the “disk” type and settings parameter “Fudge Factor”. The “disk” type filter transmits a square matrix with a side equal to $d = 2 \times radius + 1$. The radius variation is 1, 2, 4, 6, 8 and 10. The settings parameter Fudge Factor is used for setting up the segmentation threshold and varies between 0,1 and 0,9.

The equations, provided in [1], were used for determining the physical parameters of the eggs – length, width, weight, eggshell thickness, egg shape index. The authors have used regression equations, with a regression coefficient of $R^2 = 0{,}32 \div 0{,}83$ for the different models with a significance level $P < 0{,}01$. The equations used for determining the physical parameters of the eggs are shown in Table 2 [1].

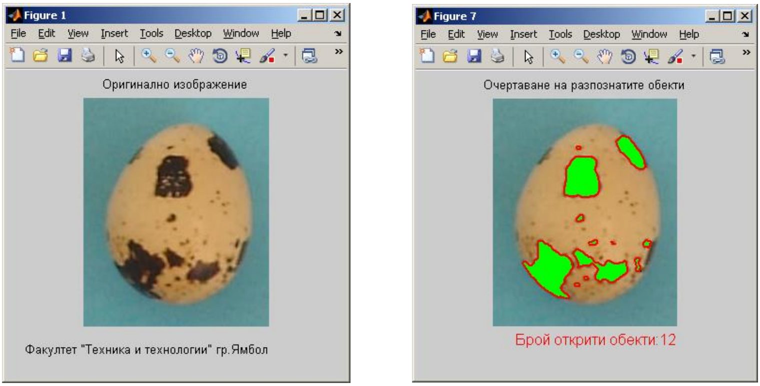
**Table 2. Equations used for determining the physical parameters of Japanese quail eggs**

| *Equation* | *Regression coefficient* | *Parameters* | *Source* |
|---|---|---|---|
| $Y=-1{,}658+0{,}828X_1+0{,}373X_2$ | $R^2=0{,}32$ | $Y$ is predicted egg weight,<br>$X_1$ – the egg width,<br>$X_2$ – the egg length | [4] |
| $Y=0{,}573+0{,}01532X_3+0{,}0238X_4$ | $R^2=0{,}51$ | $Y$ is predicted eggshell weight,<br>$X_3$ – egg length,<br>$X_4$ – egg weight | [7] |
| $Y=0{,}135+0{,}0031X_5$ | $R^2=0{,}54$ | $Y$ is predicted eggshell thickness,<br>$X_5$ – egg length | [6] |
| $Y=10{,}561-0.178X_6–0.045X_7+1{,}535X_8$ | $R^2=0{,}99$ | $Y$ is predicted eggshell surface area,<br>$X_6$ – egg width,<br>$X_7$ – egg length,<br>$X_8$ – egg weight | [6] |
| *Shape index = egg width / egg length* × 100 | | | |

## Results and Discussion

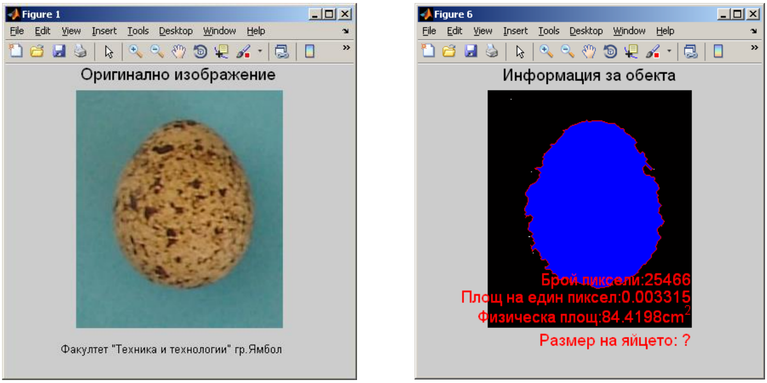
Figures 2 and 3 show the results of the software for image processing, whose function is to separate the egg from the background.

The original image of the egg is loaded in the Matlab work space. After that the object is located and segmented. The segmented object contrasts considerably with the background. The changes in the contrast can be removed with determining the gradient of the image. The gradient and the segmentation threshold are calculated and a binary mask containing the segmented egg is created. The *edge* and *Sobel operators* are used to calculate the threshold values. After that the "Fudge Factor" settings parameter is used for setting up the threshold value and once again the edge function is used to obtain the binary mask containing the segmented egg.




**a) Original image** **b) Image after processing**

**Fig. 2. Detection of eggshell traits (spots)**




**a) Original image** **b) Image after processing**

**Fig. 3. Determining the physical parameters of the eggs**

The binary mask of the gradient shows the lines with a strong image contrast. These lines do not sufficiently cover/follow the egg outline. If one compares the original image to the processed image, there will be noticeably differences between the lines covering the object in the gradient mask. These differences can be removed by using linear structural elements, which are created using the *strel function*.

The proposed algorithm for recognition and processing of the images of Japanese quail eggs, based on texture traits, is shown in Table 1.

Figure 2 shows the results of the application of the algorithm for recognition of eggshell traits (spots). Camouflage is conferred by background matching and disruption, which are both affected by microhabitat. Microhabitat selection that enhances camouflage has only been demonstrated in species with discrete phenotypic morphs. For most animals, phenotypic variation is continuous. In quail, variation in appearance is particularly obvious in the amount of dark maculation on the light-colored shell. When given a choice, birds consistently selected laying substrates that made visual detection of their egg outline most challenging [8].

The use of the computer vision system for determining the basic physical parameters of the eggs is shown in Fig.3. The efficiency of the developed algorithm was verified by comparing the values, detected by the system, and the values provided by an expert [9].

The obtained results were compared to the requirements, stated in the regulations concerning the quality of the eggs [11, 12].

## Conclusion

This article provides a description of a computer vision system, which can be used for determining the quality of Japanese quail eggs using texture traits.

An algorithm was developed for recognition of the eggshell coloring and determining of their physical parameters. The system discovers common defects in the production and storage of the eggs, defects that are given in national and European requirements and standards.

What follows is the development of improvements in the system's work process by modifying the procedures for defect detection with using different classifiers and improving the database for the defects in question.

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