Application of Mobile Devices in Distance Learning

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Abstract

The possibilities for using mobile devices, such as tablets and mobile phones, for the analysis of the condition of food products, are a prerequisite for the development of methods, technical means and methodologies for their use in educational activities. This article proposes methods and tools for obtaining, processing and analyzing data on the condition of eggs using mobile devices. Spectral characteristics of hen eggs, as well as of quail eggs were obtained. Examples of the results application of the present elaboration in distance learning of students are presented. In case the proposed methods and tools are used, the whole process of obtaining, processing and analyzing spectral characteristics can be monitored and shared with learners – it is enough just to have a mobile device with Internet access.

Keywords: M-Learning, Distance learning, Spectral characteristics, egg yolks, mobile devices

1 Introduction

The training, formal or informal, is realized using mobile devices. It is essential that educational technologies are focused and adapted to the needs of the present times (Govindasamy et al., 2019; Liu & Zhang, 2019). In the context of a complicated epidemiological situation in 2020, this form of learning has been imposed in a number of countries (Gómez-García et al., 2020; Liu, 2020). More and more pupils and students who take part in the distant form of learning use their mobile devices (Zlatev & Baycheva, 2018).

A growing interest in the application of mobile technologies is observed in the field of obtaining, processing and analyzing data in regard of the condition, composition and properties of food products. Using a "measuring" tool, which is always at hand, is of interest to mobile users (Zlatev & Baycheva, 2017). Through the mobile applications developed in recent years, an express analysis of the color, spectral characteristics, and product type recognition can be performed, using the video camera of the device as a data source (Gábor & Péter, 2015; Gómez-García et al., 2020).

The possibilities for using mobile devices, such as tablets and mobile phones, in the analysis of the condition of food products, require the development of methods, technical means and methodologies for their usage in educational activities, either in technically oriented specialties in the field of engineering or in the training of food technology, animal husbandry, plant growing, and ornithology specialists.

One of the products for which mobile applications for analysis have been developed is bird eggs. They are the subject of research and training of specialists in the field of food technology, poultry farming, and ornithology.

The application of mobile devices is among the other, already traditional, methods for obtaining basic eggs characteristics. During the training of specialists for analysing these products it is necessary to develop methodological models, software applications, use methods for data processing and analysis and their introduction into the curriculum in order to increase students'

interest in the subject area, their technical culture, literacy, knowledge and competence in terms of recognition, implementation, perception of information received, product recognition condition and building skills for independent work.

The purpose of this paper is to propose methods and tools for obtaining, processing and analyzing data on the eggs' condition, using mobile devices.

2 Exposition

In the present study, the object of research on the possible usage of mobile devices in the analysis of eggs and training in this area is the egg yolk.

The properties of egg's yolk are an element of the trading eggs' grading. The main indicators of the yolk are color and its index, related to its geometric dimensions (Lukanov et al., 2019).

Table 1 shows data from a study on the importance of egg yolk color in various fields of science and practice. Significance for consumers and that for food technology, poultry and ornithology is included.

Table 1. Importance of egg yolk color

From the point of view of	Importance	Source
Consumer	Preferences depend on the country in which the eggs are traded. The color of the yolk is a key indicator of its quality, according to consumers	(Alikhanov et al., 2017)
Food technologies	Nutrient content. Application as a raw material in food products	(Titova et al., 2015)
Poultry farming	Influence of bird nutrition on the external and internal characteristics of the yolk	(Lukanov et al., 2019)
Ornithology	Influence of the region and living conditions of birds on the yolk composition and properties	(Alikhanov et al., 2017)

The yolk color is determined by comparison with a standard. Different color scales have been created, with Roche and DCM being more commonly used (Titova et al., 2015).

Technical software that can be used in mobile devices such as a phone or tablet is divided into the following groups:

- ✓ Specialized. They use a model of the standards for the yolk color and the obtained values for the color are compared with it;
- ✓ With general purpose. Such are colorimeters that measure color in a specific color model.

Each of the two groups contains two subgroups:

- ✓ Software based. It uses the video camera of the mobile device as a source of color data input;
- ✓ Using an external color sensor. The sensor uses a wireless connection to the mobile device, for example via WiFi or Bluetooth.

The advantage of yolk color measurement systems that use an external sensor over those using a mobile device's camcorder is that the measurement becomes more accurate due to the lower degree of influence of ambient light and the measurement distance on the received data. The disadvantage is that a separate device is used outside the mobile phone.

The color of the yolk depends very much on the type of bird food. Using the color of the yolk to determine its composition and nutritional properties is not enough. For example, xanthophyll,

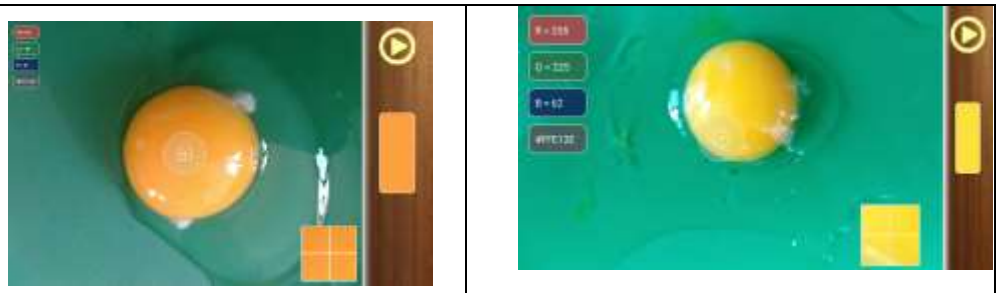
which makes the color more saturated, have no nutritional value. On the other hand, the carotenoids that impart a dark yellow color to the yolk act as provitamin A (Titova et al., 2015).

3 Material and methods

A total of 90 hens and 90 quail eggs from three producers were used for the purposes of the present study. 30 hen eggs and 30 quail eggs per producer. The eggs were purchased from the trade network of the town of Yambol, Bulgaria.

A video sensor of an LG mobile phone, model L70 (LG Electronics, Inc., Seoul, Korea) was used to obtain the yolk images. The video sensor is VB6955CM (STMicroelectronics International N.V.). Resolution 2600x1952 pixels. Pixel size 1.4 µm x 1.4 µm. It has a built-in autofocus mechanism.

Color digital images of hen eggs yolks and quail eggs yolks were obtained using the ColorMeter Free - color picker application (VisTech.Projects Inc.) for the Android operating system. Figure 1 shows an example of obtaining images of yolks. The yolks are placed on a field that contrasts with their color. The shooting distance is 10 cm.



a) hen eggs *b) quail eggs*

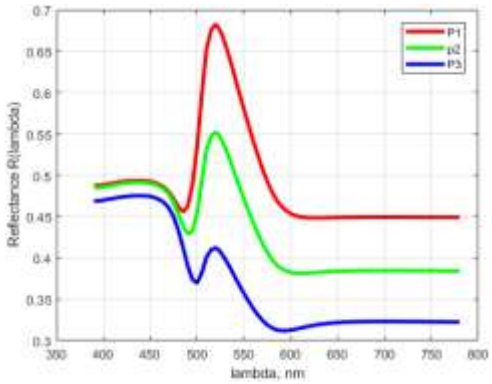
Figure 1. Examples of measuring the color and spectrum of yolks

The conversion of values from RGB to XYZ and LMS models in reflection spectra in the VIS region, in the range 380-780 nm is done by mathematical dependences and the conversion is possible in both directions of equality (Glassner, 1989). The matrices used to convert color components to spectrum are available in (Spectral and XYZ Color Functions) for the VIS range.

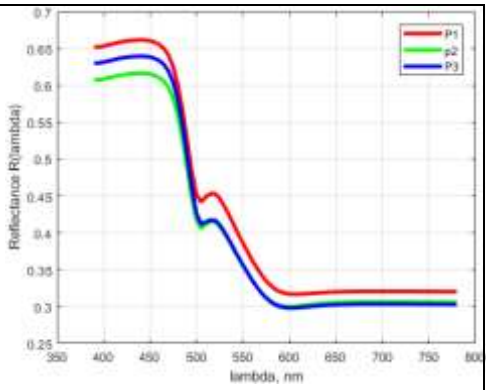
4 Results and discussion

The proposed methods and tools were used to obtain spectral characteristics of the products in this survey through the camera of a mobile phone. An example of the application of these online learning tools has been presented. The general purpose software product mentioned above is used, which uses the built-in camera of a mobile phone. Thus, the proposed method for obtaining spectral characteristics of egg yolks is available to a larger group of students (including outside the university laboratories) than when using specialized equipment and external telephone sensors.

As can be seen from Figure 2, the obtained spectral characteristics of the hen eggs yolks and quail eggs yolks show a visible difference between the different producers. In the case of hen eggs in the range 500-780 nm, and in the case of quail eggs in the range 380-480 nm when comparing the three producers, while in the range 500-780 nm the spectral characteristics of eggs from producer 1 are clearly distinguished, while those of the second and third producers overlap. The overlap is due to the similarity in the region of rearing and feeding of the birds, as well as the period for which they were kept before the measurement. This is also confirmed by the results reported in the available literature (Titova et al., 2015; Lukanov et al., 2019).



a) hen eggs



b) quail eggs

Figure 2. Presentation of egg yolks from different producers by their spectral characteristics

The whole process of obtaining and processing the spectral characteristics, carried out with the mobile device, as well as the work with the Matlab software system, can be observed by all students from the screen of their mobile phones. This is done with online video conference software.

Figure 3 shows video conference screens via Google Meet (Google Inc.). On this screen, the teacher shows the main errors that are made in the calculation and visualization of spectral characteristics obtained through the camera of the mobile device. The demonstration is in Matlab (The MathWorks Inc.) environment, but other software products, such as GNU Octave, can be used for this purpose.

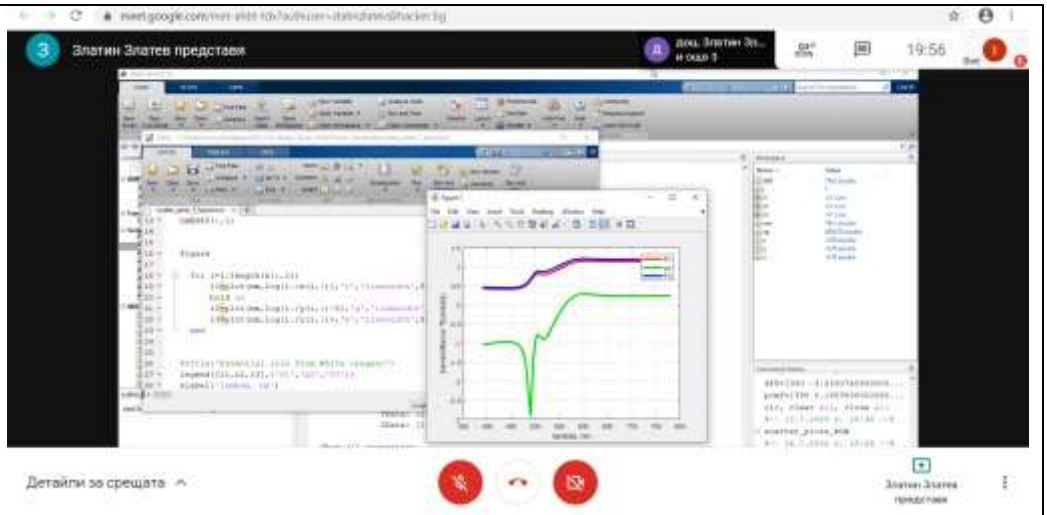


Figure 3. Online meeting using data obtained with a mobile device

After eliminating the measurement errors and removing the spectral characteristics, which have a significant deviation from the others for the respective manufacturer, students can move on to the next stage - processing and analysing these characteristics.

Figure 4 shows a block diagram of the process of learning for receiving, processing and analyzing data using a mobile phone. The objects visualized on the diagram are free to use by PIXABAY (https://pixabay.com).

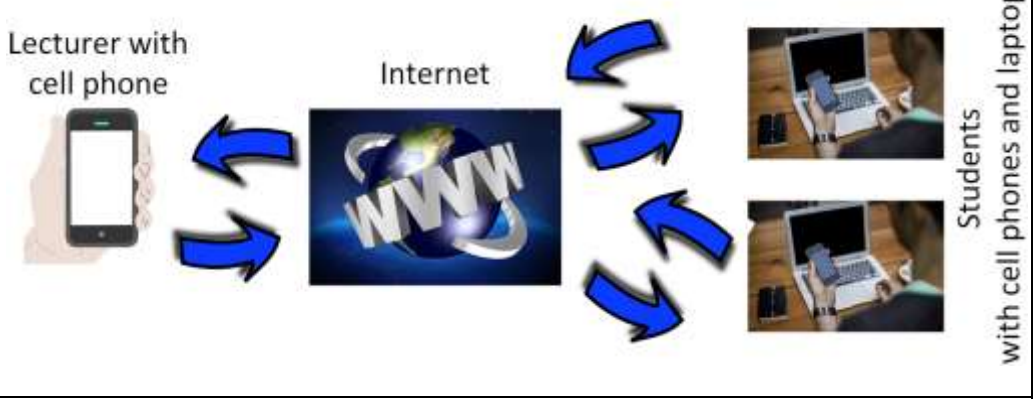


Figure 4. Block diagram of the learning process using a mobile phone

Taking photos of the analyzed object, in this case eggs can be done both by the teacher and after a short instruction to the students, with the help of the camera on their own mobile phones - of the object located near them. Object data, whether a list of values from an RGB color model or a color digital image, can be shared with other participants in the training, for example via email, or directly through Google Meet. The teacher demonstrates online how to process the measured data, using his/her personal computer or by providing a pre-recorded video. Students independently process the data on their personal computers. In case of questions or incorrect execution of the exercise, students can share their screens and discuss with the teacher the issues they have when processing the experimental data.

Supported by the proposed methods and tools, the whole process of obtaining and working with spectral characteristics can be observed and shared with the learners, with random placement and access to the Internet. On the other hand, the accessibility, comprehensibility and responsibility, when disseminating these mobile services, to each student as their user must be taken into account.

The proposed methods and tools can be used in the training of students in disciplines in the field of Artificial Intelligence, Machine Learning, Obtaining, processing and analysis of spectral characteristics and certainly, due to the use of well-known devices and technologies from their daily routines, will enhance their interest and desire to work.

Conclusion

Methods and tools for analyzing products of biological origin that are suitable for use in distance learning are proposed.

It has been proven that the camera of mobile devices can be used as a sensor to obtain spectral characteristics of products of biological origin and in particular the yolk of hen and quail eggs. The obtained measurement accuracy is sufficient for the application of the proposed methods in the training of students.

The comparative analysis showed that the results obtained with the camera of a mobile device are as close as possible to the spectrophotometers established in the research practice, having the

advantage that with its accessibility it can be applied in the educational activity in training for work with specialized laboratory equipment which is not publicly available.

The use of mobile devices (phones and tablets) can improve the quality of the learning process, but only when students are active participants and not passive observers of what they see on their screens. The presented methodology creates conditions for active participation of students. The use of tools and digital technologies from their everyday life makes the training interesting, attractive and motivates for active participation in the learning process.

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