*phase of 5-7 and 10-12 corn leaves. The greatest value of the height of the plants (231,4-303,9 cm) was in variants where two-time of foliar nutrition by microfertilizer "Ekolist Monozink" was used in the phase of 5-7 and 10-12 corn leaves. Growth of plant height, in comparison with control, is 5.4-16.2 cm.*

***Keywords: corn, hybrid, plant height, microfertilizer, bacterial drug, nutrition, maturation group, growth regulator***

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## EXPERIENCE IN USING MATHCAD TO ANALYZE DATA FROM UAVS FOR REMOTE SENSING OF CROPS

**N. A. PASICHNYK,** Candidate of Agricultural Science, Associate Professor of the Agricultural chemistry and Plant Production Quality Chair
**O. O. OPRYSHKO,** Candidate of Technical Science, Associate Professor of the Automation and Robotic Systems Chair
**D. S. KOMARCHUK,** Candidate of Technical Science, Associate Professor of the Automation and Robotic Systems Chair
**V. O. MIROSHNYK,** Candidate of Technical Science, Associate Professor of the Automation and Robotic Systems Chair
***National University of Life and Environmental Sciences of Ukraine***
*E-mail:* N.Pasichnyk@nubip.edu.ua; ozon.kiev@gmail.com

***Abstract.*** *Illuminated results of experimental shooting of plantings of plants using UAV, with further calculation of graphic data in the software environment MathCAD .The analysis of the use of different channels of shooting, also the decision about the filtering of received images from third-party objects, especially the ground, is presented.  Such results are obtained: mathematical software MathCAD can be used effectively for the analysis of graphic data obtained during monitoring of UAV plantations. When organizing an image from third parties, especially the soil, it is expedient to use the data on all measuring channels at the same time. The green channel is sufficiently informative to recognize areas that do not correspond to plants.*

***Keywords: remote monitoring, UAV, unmanned aerial vehicles, vegetation cover, spectral shooting, MathCAD software, filtering of images***

**Introduction.** Compared to satellite solutions, the use of unmanned aerial vehicles (further UAVs) for remote monitoring of plantings fundamentally provides new opportunities, since it allows to shoot efficiently, regardless of clouds, with high resolution. Due to the low cost of the equipment, such solutions are available even for small farms or private enterprises, but specialized software for processing data today is a significant problem that limits the widespread adoption of these technologies. Therefore, the investigation of the possibility of using the standard mathematical software for solving problems sensing data processing tasks obtained from UAVs is relevant, which was the purpose of the work.

**Analysis of recent researches and publications.** Currently, different software is used for processing spectral data and calculation of stress indexes [1, 96-97]: ENVI 4.0 software was used to processing satellite data, besides which ERDAS, ER Mapper, PCI (EASI / PACE), TNTmips, and others are also on the market. In [2, 407-410] was used Matlab software to processing data from UAV. In [3, 28-31] the image analysis was performed with Gnu-R, using the package ‘‘pixmap” to processing data from digital camera. In [4, 31-33] the image analysis was performed by own software LD which calculated the average value for the pixels. In [5, 28-32] was designed Multi-modal data acquisition (MMDAQ) software to interface with the NDVI sensor, the digital camera, the range finder.

SlantView, which was specialized developed for UAV, provides the ability to filter data, while simultaneously several filters can be used for separation soil apart. SlantView software was developed for Slantrange, which uses 4 channels, but is not adapted for RGB shooting photographs, although the optical range is also informative for determining the state of plants [6, 62-64].

**Materials and methods of research.** As experimental data for the research, used photos of wheat crops were grown during the vegetative stage entering the tube, received on May 19, 2017, at the experimental station of the department of agrochemistry and quality of plant products of the NULES of Ukraine [7, 266-267] (Fig. 1).

**Fig. 1. Photo of the experimental field of wheat of the winter, where the plots: *G* - ground road, *0* - the plot without fertilizers (control), *1* - the recommended fertilizer rate is introduced**

In addition to the experimental sections of the stationary field (see Fig. 1), the shaded area of the soil at the margins of the field (not shown in Fig. 1) was additionally considered, as it is possible to fix the photos of areas that are in the shade from the plants. For analysis, the relevant sites have been cut and stored individually by Microsoft Office tools. For the creation of spectral stress indexes in the first stage, the parameters of the filters were determined, that is, the values of the spectra corresponding to the soil and the shaded soil. At the second stage, was calculated the average value for each channel after filtration.

**Results.** Data was computed using the MathCAD software (version 14.0.0.163). Such software is quite widespread in Ukraine and provides a trial period of use, that is, it is accessible to customers. The text of the program for calculating the red component for the first section is shown in figure 2.

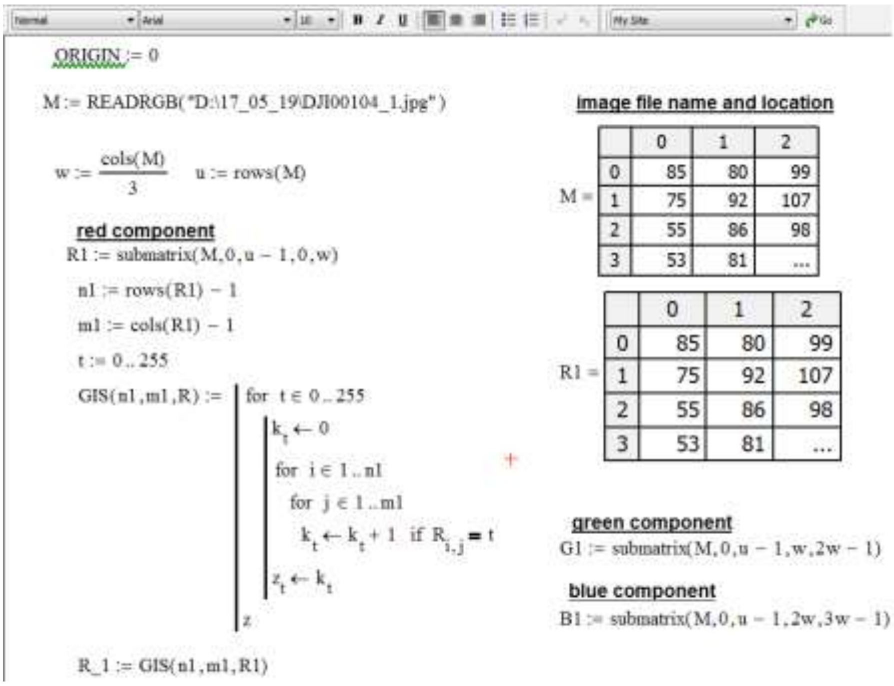


**Fig. 2. Program for calculating the distribution of color constituents for a RGB image file**

With the READRGB command ("filename"), the matkad creates a matrix, the number of rows that corresponds to the number of pixels of the image on vertically, and the number of columns is three times larger than the number of columns horizontally. The first third of the columns corresponds to the intensity of the red component, the second to the green, and the third to the blue. The integrity of color components in RGB format is measured by integers and varies in the range 0 ... 255. The presented program converts a submatrix corresponding to a certain color of an image into a table, the first column of which corresponds to the intensity of the color component, and the second to the number of pixels with the corresponding intensity of the color in the image. The results are presented in figure 3. For the rest of the colors and areas of the calculation is done in a similar way.

As can be seen from the data presented, the intensity of the color components for the soil corresponds to a range of 150 ... 175, and for the soil in the shade - 10 ... 20. The program for calculating the intensity of the channel by the mean value is shown in figure 4.

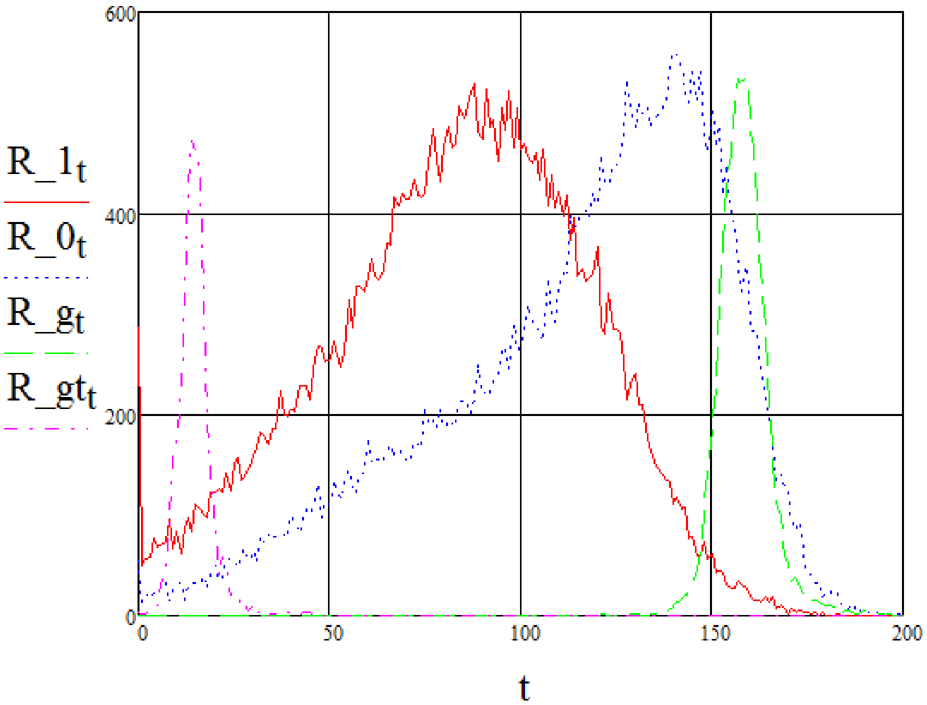


**Fig. 3. Distribution of the pixel brightness of the image for areas of the image**

Rgt := 20  Ggt := 25  Bgt := 30  values of R, G and B components of the soil in the shadow

Rg := 150  Gg := 140  Bg := 150  lower limit of the values of R, G and B component of the soil (ground road with a sidewalk)

Rgl := 175  Ggl := 160  Bgl := 175  upper limit of the values of R, G and B component of the soil (ground road with a sidewalk)

R1 := submatrix(M, 1, u, 1, w)  calculation of the red component

```
R(M) := | s ← 0
        | n ← 0
        | for a ∈ 1..u
        |   for b ∈ 1..w
        |     if [(Rgt ≤ M_{a,b} ≤ Rg) ∨ (M_{a,b} ≤ Rgl)] ∧ [(Ggt ≤ M_{a,b+w} ≤ Gg) ∨ (M_{a,b+w} ≤ Ggl)] ∧ [(Bgt ≤ M_{a,b+2·w} ≤ Bg) ∨ (M_{a,b+2·w} ≤ Bgl)]
        |       | s ← s + M_{a,b}
        |       | n ← n + 1
        | q_1 ← s/n
        | q_2 ← n/z
        | q
```

**Fig. 4. Program to calculate the value of the data channel filtered**

Since each pixel of the image has three components of the color, in the proposed filtration scheme, if one of the component parts of the color was recognized as non-responsive to the plant, then it was not calculated. Based on the results obtained, the intensity of RGB for the fields with the introduction of the recommended norm of mineral fertilizers (1) and without fertilizer (0) was {78: 109: 84} and {103: 120: 106} respectively. When filtering solely from the data of their own channel, the following results were obtained: {83: 109:

88} and {114: 120: 117} respectively. So, soil filtration can be most effectively implemented through the green channel. Such a range of changes in the values of color constituents, due to different state of mineral nutrition, is quite sufficient for use in creating spectral indices for UAVs.

**Discussion.** Mathematical software MathCAD can be used effectively for the analysis of graphic data obtained during monitoring of UAV plantations.

When organizing an image from third parties, especially the soil, it is expedient to use the data on all measuring channels at the same time.

The green channel is sufficiently informative to recognize areas that do not correspond to plants.

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# ДОСВІД ВИКОРИСТАННЯ ЗАСОБІВ MATHCAD ДЛЯ АНАЛІЗУ ДАНИХ ВІД БПЛА ЩОДО ДИСТАНЦІЙНОГО ЗОНДУВАННЯ ПОСІВІВ

**Н. А. Пасічник, О. О. Опришко, Д. С. Комарчук, В. О. Мірошник**

***Анотація.*** *Дослідження щодо можливості використання стандартного математичного програмного забезпечення для вирішення задач обробки даних дистанційного зондування, проведеного за допомогою БПЛА, є актуальними. Метою роботи було обчислення у програмному середовищі MathCAD графічних даних, отриманих у експериментальній зйомці рослинних насаджень за допомогою БПЛА. Представлені аналіз використання різних каналів зйомки, а також рішення щодо фільтрації отриманих зображень від сторонніх об'єктів, перш за все, ґрунту. Отримані такі результати: математичне програмне забезпечення MathCAD можна ефективно використовувати для аналізу графічних даних, отриманих під час моніторингу посівів за допомогою БПЛА. За організації фільтрації зображення від сторонніх елементів, перш за все, ґрунту, доцільно використовувати дані за всіма вимірювальними каналами одночасно. Зелений канал є достатньо інформативним для розпізнавання ділянок, що не відповідають рослинам. Отримані результати можуть бути використані за аналізу даних дистанційного моніторингу рослинних насаджень, а також у розробці спеціалізованого програмного забезпечення для таких досліджень.*

***Ключові слова: дистанційний моніторинг, БПЛА, безпілотні літальні апарати, рослинний покрив, спектральна зйомка, програмне забезпечення MathCAD, фільтрація зображення***

# ОПЫТ ИСПОЛЬЗОВАНИЯ СРЕДСТВ MATHCAD ДЛЯ АНАЛИЗА ДАННЫХ ОТ БПЛА ПО ДИСТАНЦИОННОМУ ЗОНДИРОВАНИЮ ПОСЕВОВ

**Н. А. Пасичник, А. А. Опрышко, Д. С. Комарчук, В. А. Мирошнык**

***Аннотация.*** *Исследования возможности использования стандартного математического программного обеспечения для решения задач обработки данных дистанционного зондирования, проведенного с помощью БПЛА, актуальны. Целью работы был расчет в программной среде MathCAD графических данных, полученных в экспериментальной съемке растительных насаждений с помощью БПЛА. Представленные анализ использования различных каналов съемки, а также решение о фильтрации полученных изображений от посторонних объектов, прежде всего почвы. Получены следующие результаты: математическое программное обеспечение MathCAD можно эффективно использовать для анализа графических данных, полученных в ходе мониторинга посевов с помощью БПЛА. При организации фильтрации изображения от посторонних элементов, прежде всего почвы, целесообразно использовать данные по всем измерительными каналами одновременно. Зеленый канал достаточно информативен для распознавания участков, не соответствующих растениям. Полученные результаты могут быть использованы при анализе данных дистанционного мониторинга растительных насаждений, а также в разработке специализированного программного обеспечения для таких исследований.*

***Ключевые слова: дистанционный мониторинг, БПЛА, беспилотные летательные аппараты, растительный покров, спектральная съемка, программное обеспечение MathCAD, фильтрация изображения***