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DIGITAL IMAGE ANALYSIS TECHNOLOGIES FOR DECISION SUPPORT SYSTEMS IN AGRICULTURAL

Abstract. *The paper describes information technologies for efficient management of crop yields and decision-making support in agriculture as a whole. The analysis of automation technologies supporting decision-making in agriculture indicates the necessity of their improvement and integration of new functions for increasing the yield and quality of agricultural products, increasing the efficiency of operational management of sown areas. The paper formulates the research tasks arising from the review of geoinformation technologies and technologies for the analysis of digital images of sown areas.*

Keywords: geoinformation technologies; agriculture; decision-making support

Introduction

In recent decades, the use of digital images of geographical areas for the purposes of agriculture has become topical. The rapid development of this direction is facilitated by the development of wireless communication technologies, digital photography technologies, image display devices, operating systems and services for image storage and processing. These opportunities have become a prerequisite for the intensive development of geographic information systems and technologies.

The use of geoinformation systems is an important tool for managing sown areas, analyzing yields and forecasting future yields. By 2050, according to the Food and Agriculture Organization, the world's population may grow to 9.6 billion. This is a big burden on agriculture, because productivity in the coming years should increase significantly. Moreover, agriculture now uses most of the water supply, and arable land is not enough. That is why the urgency of the development of geoinformation technologies to support decision-making in the field of agriculture is beyond doubt. The first effective geoinformation system for agriculture is ESRI ArcGIS [1].

The European Union finances a number of projects related to agricultural informatization, in particular the Horizons 2020 program. Many European companies are actively involved in this area: eCow, Connected Cow, Anemon, etc. [2].

In [3], the hypothesis that crop yields can be determined by inhomogeneities in field images is described. Processing of digital image fields gives valuable information about the state of agricultural crops, allowing you to evaluate the health of plants and predict yields, terms, quantity and quality of products. The image of the crop area can be presented in the form of time series, which allows applying the appropriate methods for their prediction [4 – 9].

The management of crop yields is part of the managerial task of an agribusiness, which requires the use of new concepts for project and program management [10 – 15].

For the analysis of yields, it is necessary to take into account external factors of influence, in particular, the quality of air on the territory of cultivating crops [16].

One of the methods for analyzing digital images of agricultural fields is the representation of these images as time series. The work [17-19] describes methods and technologies for processing time series of digital images for decision-making in agriculture.

The purpose of the article

The research objective is:

1. To review the technologies of efficient crop yield management to support decision-making in agriculture.
2. To form, on the basis of technology review, research tasks that include the improvement of geoinformation technologies described, in particular in the development of methods for analyzing digital images of crop areas.

Presenting main materials

Geoinformation technologies for management of sown areas

The use of geoinformation technology for the purposes of agriculture may relate to:

- collection of soil quality information;
- collecting information on the necessity of fertilizing on designated agricultural areas;
- collection of information on plant diseases;
- collection of information on possible yields (eg, apple orchard image analysis during the flowering period of apple trees to estimate apple yields in the current season).

This information is necessary for effective management with a view to obtaining a larger yield,

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forecasting the price of a crop, the rapid elimination of plant diseases, etc.

Today, the popular concept is based on SSCM (site specific crop management). An important task for SSCM is to increase yields, that is, to ensure the quality and quantity of agricultural produce received. SSCM is realized on the basis of GPS technology, which determines the location of objects and the state of plants on agricultural plots through a satellite network. RTK (Real Time Kinematic) technology allows you to define objects in the area with great precision. After collecting information on the state of the soil technology SSCM allows you to manage the use of fertilizers, chemicals, herbicides, pesticides and other substances.

Application of this technology is relevant not only for Ukraine, but also for China, where in some regions, farmland yields several times a year. All this requires the rapid management of the process of maturation of crops. The technology that uses the GPS module allows you to process large areas in a short time and minimize human exposure.

Operational information on the state of the field (the presence of pests, plant disease, soil condition) makes it possible to form map of yield. These maps make it possible to assess the future benefits of growing crops, as there may be significant differences in yield within a single field. This affects both the state of the soil and the inclination of the surface of the field. Separately there can be formed and evaluated map of the soil, allowing you to evaluate the content of their sand, clay, peat. All this allows timely planning of plants for crops within the same field, as well as taking into account the required proportions of fertilizers, which are differently determined for soils of different types. It is clear that for the calculation not only information on the state of soils, but also the yield on these soils in previous periods, as well as information on the use of fertilizers in previous seasons is necessary.

To create a map of agricultural areas you can use drone, which is equipped with a specialized camera to create images of the map of the state of crops, taking into account the infrared reflection for the determination of the normalization difference vegetation index of NDVI. It was found that on the basis of such images, it is possible to estimate the state of plant health, the internal structure of the leaf, the content of chemicals, etc.

Earth remote sensing is also used for agriculture. The information that can be obtained from this technology is the geo-physical characteristics of the earth's surface. Also, remote sensing of the Earth allows you to get up-to-date information on the movement of underground and groundwater. Such information can be used for irrigation and, in general, to form a comprehensive assessment of the environment for sowing operations taking into account possible risks. However, remote sensing of the Earth is expensive technology, which depends on weather conditions, since the sensing takes place using aviation.

To reduce the cost of remote sensing the Earth can use small aircraft that do not depend on clouds, because they fly significantly below the cloud level and can quickly transmit information to the station for its prompt processing.

For example, Ursula Agricultural uses small aircraft to study sown areas. With the help of this study, areas of crops that require pesticides are determined.

According to the calculations of PrecisionHawk [20], the analysis and scanning of the area of agricultural crops requires a large amount of time and resources. In addition, often field surveys are sometimes erroneous. To avoid errors in the analysis, a long scan is required – about 11 hours per acre of crops. However, the use of advanced sensors and drones allows you to scan data from 500 to 1000 acres less than a day.

Using droni, agricultural specialists can:

1. Measure the health of plants.
2. To forecast productivity.
3. Optimize harvesting time and planting.
4. Identify signs of plant diseases before they are inevitable.
5. Estimate damage from rain, hail, wind or other adverse weather conditions.

Today, the task of automating the processing of digital image data of air monitoring data, that is, the creation of a geoinformation monitoring system that combines air monitoring with data processing and analysis methods to obtain the condition of sown areas and prompt decision-making on their management, is urgent. This requires a clear link to the geographic coordinates of the territory and the use of geographic information systems and technologies.

The development of geographic information systems and technologies involves improving the technology of taking pictures and processing images, the emergence of high quality maps, such as Google Maps, increasing the speed of data transmission, the development of a new direction – Internet things, which is directly applied in agriculture.

Important tasks in creating geoinformation systems are:

- creating new map maps and updating old maps;
- task of preservation and access to digital image maps;
- providing cross-platform system.
- Geographic information systems integrate with:
- systems of information gathering;
- data storage systems;
- data processing systems;
- data retrieval systems.

Geographic information systems can also be part of decision support systems. Such systems are an effective tool for optimizing and automating the work of an agricultural enterprise, which reduces risks and uncertainty, as well as increases profits. However, the development of analysis methods is a complex task.

One of the classifications of geoinfrastructure systems is as follows:

1. Geographic geographic information systems. Such systems consist of subsystems of image processing, modeling, analysis taking into account many factors. Such systems are used for planning, managing areas and

for common tasks for which geographic information systems need to be involved.

2. Specialized geographic information systems. A number of specific tasks are used in the field of land management, assessment and analysis of territories, territorial administration, the search for a rational route, the task of extraction of minerals, eco-monitoring, in the field of transport, etc.

3. Tourist geoinformation systems.

4. Cadastral geographic information systems. Such systems are used to account for land in forestry and water management.

5. Geoinformation systems for managing systems and processes. Such systems are designed to plan communication, traffic and operational management of other systems.

At the heart of geoinformation systems, methods are laid down, the main focus of which are:

1. Search, interpolation of data, search by subject, classification of data.

2. Location analysis.

3. Analysis of the territory.

4. The task of breaking and searching the nearest neighbor.

5. Spatial analysis.

6. Measurement.

The functions of geographic information systems, as a rule, depend on the type of system and are defined in the process of creation. The main functions are:

– collecting, presenting and storing digital information that displays spatial representation of objects;

– data conversion;

– averaging and data aggregation;

– data modeling;

– data analysis, including the use of additional sources of information;

– visualization of data in the form of maps, tables, graphs, diagrams.

Figure shows the main tasks of geoinformation systems in agriculture.

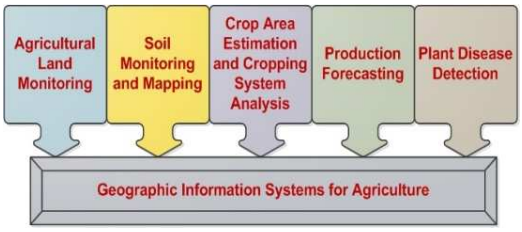

Figure – Basic tasks of geoinformation systems in agriculture

Agriculture becomes more intelligent with the availability of modern technologies such as precision equipment, Internet things (IoT), sensors and geo-positioning systems, unmanned aerial vehicles, robotics, etc.

The Internet concept of things in agriculture is becoming widespread because of the many benefits it offers. This allows farmers to collect timely geospatial information on requirements for soil plants, and to designate and apply plant-specific plant-based treatments to increase agricultural production and protect the environment. Precision farming is associated with high tech tools that are more precise, economical and user-friendly. Recently, Global Market Insights opened a market report, according to which by 2024, the world market of precision agriculture will reach 10 billion dollars.

Conclusions and perspectives of further research

Consequently, it can be concluded that agriculture now needs to use new information technologies, in particular GIS and GPS, to effectively manage sown areas. The disadvantages of such systems are high cost, the need for experts to analyze the field images. In addition, often such technologies do not allow to determine all the necessary characteristics of the fields, which is the disdain of a particular farm and specific crops grown.

Today, small aircraft or drones can produce high-quality digital photos. These images are inputs for specialized software systems or decision support systems that analyze images and give an opinion on the state of soils, crops, and the like.

The urgent task is to develop methods for analyzing such digital images for the establishment and forecasting of yield levels, the identification of areas of over-drying of the soil, the content of weeds, the incidence of plants, etc.

Integration of these methods into geoinformation systems will create a multifunctional decision support system in agriculture.

Thus, the perspective tasks of the study are:

1. Sound research of known methods for analyzing digital images.

2. Develop new and modify existing methods for analyzing digital images. The developed methods should take into account the needs of the agricultural enterprise and determine the maximum number of indices for the cultivation of crops with maximum efficiency.

3. Integrate the developed methods into the geographic information system, which geoinformation technologies automates the processes of making operational decisions in agriculture.

4. Verification of the developed system and methods of processing digital images in the work of real agro enterprises.

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ТЕХНОЛОГІЇ АНАЛІЗУ ЦИФРОВИХ ЗОБРАЖЕНЬ ДЛЯ СИСТЕМ ПІДТРИМКИ ПРИЙНЯТТЯ РІШЕНЬ У СІЛЬСЬКОМУ ГОСПОДАРСТВІ

Анотація. *Описано інформаційні технології ефективного управління врожайністю сільськогосподарських культур та підтримки прийняття рішень в сільському господарсьві загалом. Проведений аналіз технологій автоматизації підтримки прийняття рішень у сільському господарстві вказує на необхідності їх удосконалення та інтеграції нових функцій для збільшення врожайності та якості сільськогосподарської продукції, підвищення ефективності оперативного управління посівними площами. В роботі сформульовано задачі дослідження, які випливають з огляду геоінформаційних технологій та технологій аналізу цифрових зображень посівних площ.*

Ключові слова: геоінформаційні технології; сільське господарство; підтримка прийняття рішень

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