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Research Article

# ON THE DEVELOPMENT OF A SYSTEM FOR DIGITAL REMOTE MONITORING OF AGRICULTURAL LAND

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**Gulyaev Rinat Amirovich**
Paxta Ilmiy-Innovasiya Markazi LLC 100100, Tashkent, Uzbekistan

**Sultonov Azamat Akramovich**
Paxta Ilmiy-Innovasiya Markazi LLC 100100, Tashkent, Uzbekistan

**Yunusov Ravil Fuatovich**
Paxta Ilmiy-Innovasiya Markazi LLC 100100, Tashkent, Uzbekistan

**Rafikov Damir Rafailovich**
Paxta Ilmiy-Innovasiya Markazi LLC 100100, Tashkent, Uzbekistan

## ABSTRACT

The purpose of this study is the development and implementation of a remote sensing system for the formation of primary accounting data based on the digitalization of the agricultural sector, automation of accounting processes, reducing the influence of the human factor, which allows for operational monitoring of the state of sown areas, planning agrotechnical measures, control of equipment working in the fields. There are on average 400-600 circuits per remote sensing operator. The proposed modern approach to the organization of agricultural production is aimed at reducing losses and costs, improving the quality and competitiveness of agricultural products and products from it in the national and international markets.

## KEYWORDS

Earth remote sensing systems, digitalization of the agricultural sector, operational monitoring, sown areas.

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## INTRODUCTION

In recent decades, the development of computer, space and information technologies has led to qualitative changes in the field of remote sensing of the Earth (ERS) using airborne and space vehicles.

Currently, the use of Earth remote sensing (ERS) data finds application in a variety of industries: from the search for minerals to Agriculture [1].

The most important function of remote sensing is image analysis. This analysis is performed using computer tools that provide rich functionality and display results in various forms, allowing the researcher to more accurately interpret the materials submitted for the study.

That is why the emergence of a new generation of imaging systems and the images obtained with their help with ultra-high spatial resolution make it possible to study natural and artificial objects both on land and on the surface of water bodies, as well as to study atmospheric phenomena.

In particular, the World Meteorological Organization cites data according to which 82% of all data used for weather forecasting were obtained using spacecraft [2].

Now space monitoring belongs to one of the most successfully and dynamically developing innovative industries. With its help, a wide range of tasks is solved not only in the military and intelligence spheres, but also in environmental protection services, in the aftermath of emergencies, as well as in various sectors of the national economy - in agriculture, forestry and water management, oil and gas, exploration and development of minerals, in transport, communications, telecommunications, etc.

For a long time, agriculture was not an attractive business for investors due to a long production cycle, exposure to natural risks and large yield losses during cultivation, harvesting and storage, the inability to automate biological processes, and the lack of progress in increasing productivity and innovation. The use of IT in agriculture has been limited to the use of computers and software mainly for financial management and tracking commercial transactions. Not so long ago, farmers began to use digital technologies to monitor crops, livestock and various elements of the agricultural process [3].

To improve the quality of management using remote sensing data, the most promising and currently active direction is the development and implementation of digital monitoring based on geographic information systems (GIS).

The digitalization of agribusiness makes it possible to obtain the most complete information to optimize the use of resources and reduce the cost of production. Systems for receiving and processing information include sensors, equipment for communication, storage and aggregation of information, various analytical units for optimizing process control [4].

The unanimous opinion of specialists and analysts on the benefits and effectiveness of digitalization was reflected in the adoption by the Cabinet of Ministers of the Republic of Uzbekistan of December 17, 2020 "On measures to develop a digitalization system in the agro-industrial complex and agriculture of the Republic of Uzbekistan" No. 794.

The following are identified as priority areas for digitalization of the agricultural sector:

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- Introduction of departmental and interdepartmental information systems for the efficient use of agricultural land, water resources and control over the state of crops;
- Transfer of services provided by organizations of the agro-industrial complex (AIC), including state ones, into electronic form;
- Implementation on the basis of public-private partnership (PPP) of targeted projects for the introduction of modern information and communication technologies (ICT) in agriculture;
- Introduction of online technologies for monitoring the use of water resources in reservoirs and irrigation systems;
- Improvement of the water resources management system, formation of a database for accounting for water use and water consumption;
- Assistance to enterprises in the implementation of start-ups to launch a business and commercialize the results of innovative projects.

In this regard, one of the important areas of digitalization is becoming more widespread - precision or coordinate farming and related unique digital monitoring systems.

The implementation of traditional ground route agronomic surveys of agricultural land allows you to obtain reliable and timely data in the conditions of small farms. However, this approach is unacceptable in relation to large agricultural holdings, agroclusters, for which such observations, due to the vastness of their territories, will be irregular, both in time and in spatial coverage. In this regard, it is advisable for large agricultural enterprises to introduce and develop modern remote methods, which are an important element of effective information support.

"Bukhoro Agrocluster" LLC, carrying out the cultivation of raw cotton on an area of 47 thousand hectares and wheat - on 22.5 thousand hectares of farmland in the Bukhara region, with the assistance of Paxta Ilmiy-Innovasiya Markazi LLC within the framework of the state grant of the Ministry of Innovative Development of the Republic of Uzbekistan to Istan, started developing and implementing a system for remote monitoring of agricultural production in these territories.

The purpose of this study is to develop and implement a new digital remote monitoring system for generating primary accounting data based on the digitalization of the agricultural sector, automation of accounting processes, which together will reflect agricultural activities in such aspects as an inventory of agricultural land with the creation of a map of fields and crop rotations, agrochemical (AHO) survey and monitoring of the green mass index (NDVI), agro-ecological survey (Scouting), analysis of weather conditions (Meteo) , precision farming with differential application of seed, mineral fertilizers, plant protection products ( PPP ), etc., and also monitoring the movement of equipment, planning and auditing the fact of agrotechnical measures with the formation of analytical data .

The scientific significance of the results of the ongoing research lies in the development of a single web platform that will allow, on the basis of information coming from remote sensing modules, stationary and mobile devices, to form historical databases for each contour on the readings of weather stations, annual crop rotations , NDVI indices and plant development, the condition of the soil and its fertilization with nutrients, the movement of equipment and material resources, the planned and actually completed field work. The specified platform will also be equipped with a module, for the first time in practice, capable of

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generating statistical data in the context of administrative-territorial divisions (ATD: region, district, settlement), agricultural enterprises and farms [5].

**Field map**

To depict significant parts of the earth's surface on a plane, special projections are used, which make it possible to transfer points of the earth's surface to a plane according to mathematical laws, then the position of the points becomes possible to determine in the simplest system of flat rectangular coordinates x , y. Such projections are commonly referred to as map projections [6].

In the CIS countries, including Uzbekistan, a conformal projection of an ellipsoid on the Gauss-Kruger plane (named after Gauss, who proposed this projection, and Kruger, who developed formulas for its application in geodesy) was adopted.

The earth's ellipsoid is divided by meridians into six- and three-degree zones. The middle meridian of the zone is called the axial meridian. The coordinate axes for each zone are the rectilinear middle meridian - the abscissa axis and the rectilinear equator - the ordinate axis. All other meridians are curvilinear and symmetrical with respect to the middle meridian and the equator. The zones are numbered from the Greenwich meridian to the east. The longitude of the axial meridian of the first zone is 3° (because it is in the middle of the zone, and this zone is counted from the Greenwich meridian). The zone number N and the longitude of the axial meridian L° are related by the equality:

$L° = 6° N - 3°$

To build topographic maps of Uzbekistan, a multi-band image of the earth's ellipsoid is used, when zones with a length of 6 ° are transferred to the plane.

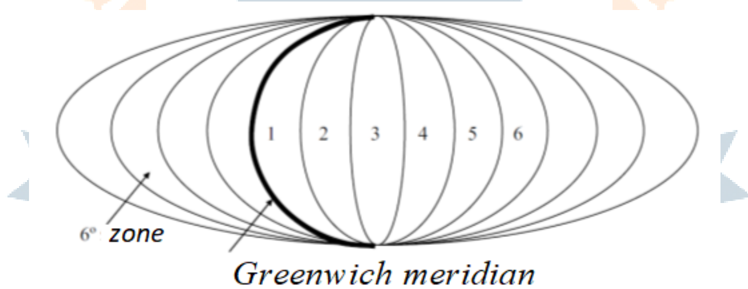


**Fig 1. Scheme of a multi-stripe image of the earth ellipse.**

Each zone is built on a separate tangent transverse cylinder so that the axis of contact passes along the middle meridian of the zone PP', called the axial meridian. Each zone has its own axial meridian.

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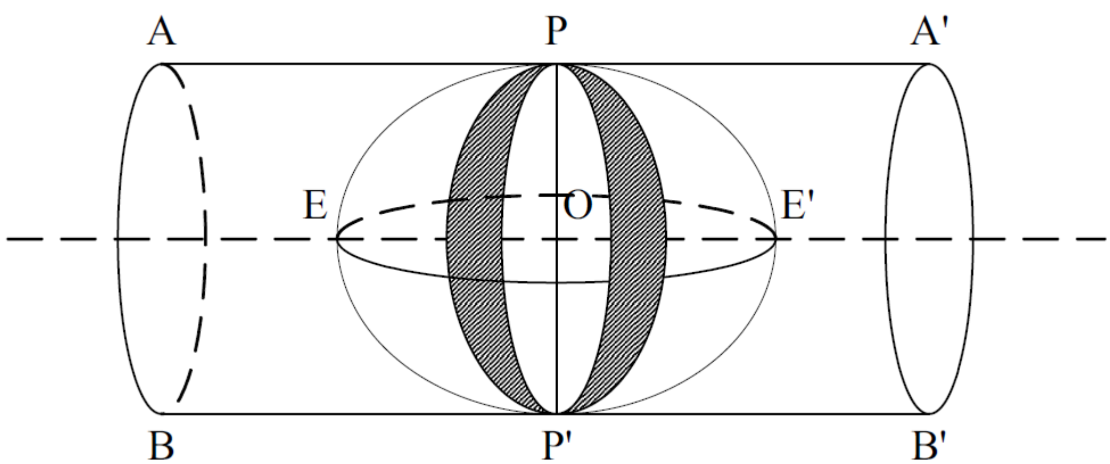


Fig. 2. Scheme of expanding the surface of an ellipsoid using a cylinder

When the cylinder is deployed in a plane, the axial meridian is depicted without distortion by the straight line PP' and it is taken as the xx axis . The equator EE' is also depicted as a straight line, perpendicular to the axial meridian. It corresponds to the y -axis . The origin of coordinates in each zone is the point O - the intersection of the axial meridian and the equator.

So, the position of any point is determined by rectangular coordinates x and y.

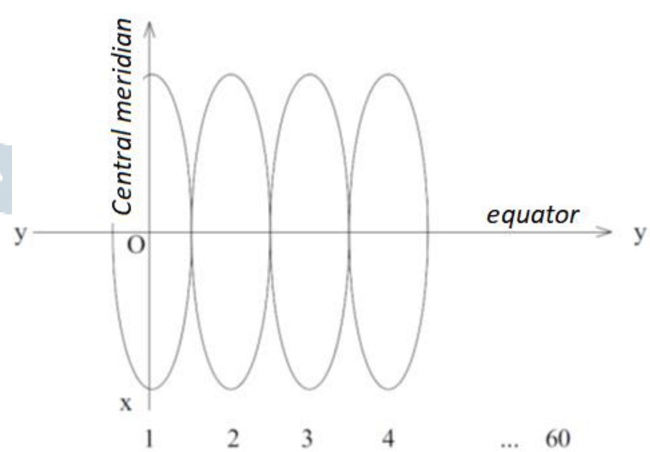


Fig. 3. The result of the deployment of the cylinder on the plane

To perform work throughout the USSR since 1946 (Decree of the Council of Ministers of the USSR dated April 7, 1946 No. 760), the geodetic coordinate system SK-42 ( Pulkovo 1942 ) was used, based on the Krasovsky ellipsoid with the length of the major (equatorial) semiaxis a = 6378245 m and compression f = 1:298.3. This reference ellipsoid is named after the Soviet astronomer-surveyor Feodosy Nikolaevich Krasovsky. The center of this ellipsoid is shifted with respect to the center of mass of the Earth by about 100

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meters to maximally correspond to the Earth's surface on the European territory of the USSR . Prime meridian - Greenwich prime meridian.

At present (including in the GPS system) the WGS84 ellipsoid (World Geodetic System 1984) is widely used with the semi-major axis length a = 6378137 m, compression f = 1:298.257223563 and eccentricity e = 0.081819191. The center of this ellipsoid coincides with the Earth's center of mass.

The prime meridian is the reference meridian (IERS Reference Meridian (International Reference Meridian)), passing 5.31″ east of the Greenwich meridian. It is from this meridian that the longitude in the GPS system (English GPS longitude) is counted [7-8].

Vectorization, formation and archiving of a database of spatial objects is practically carried out in the Pulkovo 1942 coordinate system. State security and, accordingly, are restricted for general access.

The formation of field maps and their placement in the My Fields application of the developed web platform is carried out by constructing geometric projections of agricultural contours in the WGS84 international coordinate system, which is also used to project satellite images , build coordinates and polygons of stationary and mobile objects, transport telematics used by the web - a platform from other available open sources of information (global and state geoportals, satellite monitoring systems, etc.).

In the generated maps, real spatial objects can be represented by a group of elementary objects, which, having, in turn, a unique identifier, can be considered as an individual object.

There are different options for linking spatial and attributive data about an individual spatial object, which are called the principles of interaction between a GIS and a database. However, for all three options, the scheme for linking spatial and attributive information is the same - through ID identifiers.

**A raster data model** is a digital representation of features as a collection of raster cells (pixels) with feature class values assigned to them. Raster representation implies positioning of objects with indication of their position in the corresponding rectangular matrix in a uniform way for all types of spatial objects (points, lines, polygons and surfaces).

**A vector model** is a representation of data of point, line and area (polygonal, contour) types of objects, has analogies in cartography, where objects with a point, line and area character of spatial localization are distinguished. Vector models are historically associated with vector-type map digitizing devices (vector input devices) with manual tracing, which generate a stream of pairs of plan coordinates when the cursor (travel head) moves over the digitizer tablet while tracking objects of the original placed on it.

It should be noted that vector representations of spatial objects occupy much less space in computer memory than raster representations.

**Digital model** geofields are a way of digitally describing spatial objects that are continuous in three-dimensional space. The digital model of the geofield implies. That for each point within the geofield definition area, it is possible to uniquely determine the value of the geofield at this point.

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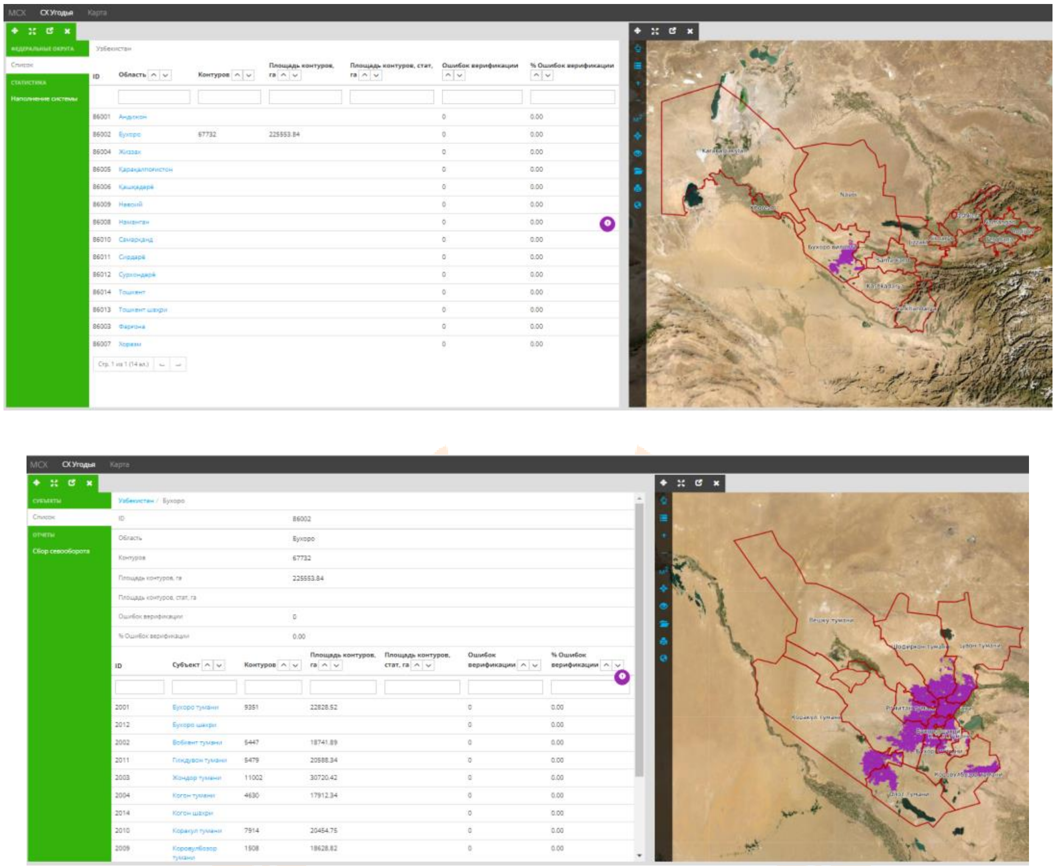

Fig 4. Map of boundaries of administrative-territorial divisions

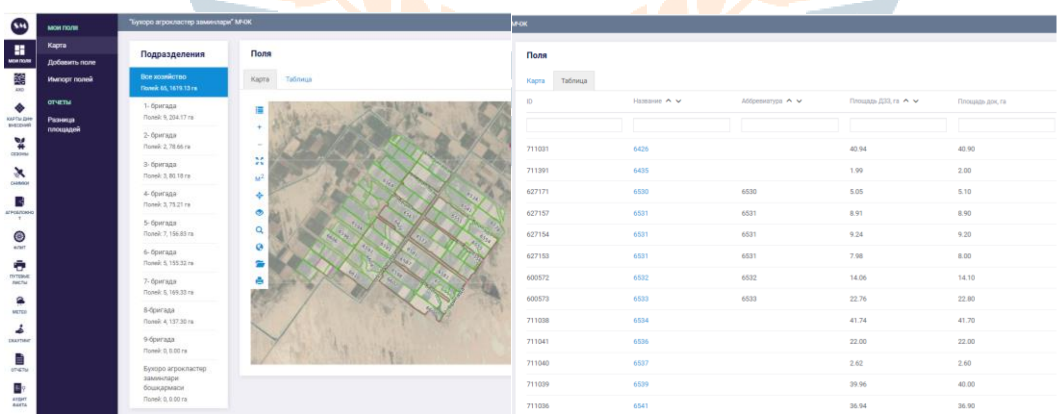

Fig. 5. Map of the boundaries of agricultural enterprises and contours

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For each farm and contours, certification was carried out, indicating the name and details of the farm, the name and cadastral number of the contours, the area of the contours according to cadastral documents and the actual area of production plots, the purpose of the fields, soil survey data and other paraphernalia.

The proposed modern approach to the organization of agricultural production is aimed at reducing losses and costs, improving the quality and competitiveness of agricultural products and products produced from it in the national and international markets.

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