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# IMPROVING AGRICULTURAL PRODUCTIVITY USING MODERN DRONE TECHNOLOGIES WITH INTEGRATED LIDAR AND GIS

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Global agriculture is currently operating under severe pressure, as the population is growing, climate change is intensifying, and natural resource degradation is deepening, which directly increases the risks to the stability of food systems. The problem of water resources is becoming particularly acute, as the areas with water shortages for agricultural production are predicted to expand, and therefore there is a need for more water-saving technologies and intelligent irrigation management. Current climate changes are already manifesting themselves in the form of a decline in the yield of certain crops in a number of regions, and these trends may further intensify, so the agricultural sector needs adaptive approaches that quickly adapt to environmental changes [2]. Against this background, the technological state of the agricultural sector is best described by the transition to precision agriculture, where data-driven work and more targeted field management are becoming the basis [1]. Here, geoinformation technologies play an important role, because they collect spatial and technological data into unified databases and reduce information losses, and also allow for the coordination of technical, agronomic and economic indicators in a single information environment [3].

In this logic, new generation drones become a practical “bridge” between field condition measurement and management action, because they provide high-precision monitoring, high spatial resolution data collection and the possibility of more targeted interventions [2].

In general, according to S.M. Farhan, J. Yin, Z. Chen, M.S. Memon, the use of LiDAR significantly expands the functionality of autonomous and robotic systems, in particular in crop monitoring, disease and weed detection, yield assessment, mapping, navigation and automated harvesting, and the combination of data from aerospace and ground platforms increases the accuracy of spatial analysis and supports site-specific management of agroecosystems [1]. At the same time, the authors draw attention to the need to systematize approaches and critically analyze results to avoid interpretation errors and ensure the stability of decisions [1]. That is, conceptually, LiDAR combines high spatial accuracy, work with three-dimensional models, dependence on data collection parameters and orientation on practical support of management processes in the agricultural sector.

*Table 1*

**Main conceptual features of LiDAR technology in agriculture**

| Conceptual feature | Content and practical significance |
|---|---|
| Three-dimensional laser scanning | enables the creation of highly accurate 3D models of terrain, vegetation cover, and soil characteristics to support decision-making |
| Plant height assessment | makes it possible to quantitatively determine crop development, though accuracy depends on plant structure and laser signal penetration |
| Biomass assessment | relies on the analysis of spatial distribution of points in 3D space, requiring proper model configuration and flight parameters |
| Sensitivity to data collection parameters | flight altitude, speed, and coverage density affect the number of scanning points and the quality of results |
| Integration with autonomous systems | supports monitoring, navigation, mapping, yield assessment, and automation of agricultural operations |
| Focus on site-specific management | allows a shift toward site-specific management of agroecosystems and resource optimization |

*Based on sources: [1, 4]*

If we compare GIS with LiDAR, the difference lies primarily in the functional role of each technology. As noted by S.M. Farhan, J. Yin, Z. Chen, M.S. Memon, LiDAR acts as a source of high-precision primary spatial information in the form of three-dimensional models of relief and vegetation cover [1], while D. Minaiev, Y. Radelytskyy in their study show that GIS performs the function of a system for accumulating, structuring and analytical processing of this data within a single information environment of the farm [5]. That is, if LiDAR is more responsible for measuring and detailing space, then GIS is more responsible for the logic of data management, their interpretation and practical use in planning and controlling agricultural operations [1, 3].

*Table 2*

**Main conceptual features of GIS technology in agriculture**

| Conceptual feature | Content and practical significance |
|---|---|
| Integration of spatial and technological data | combines different types of information into unified databases for comprehensive analysis of agricultural production |
| Support for decision-making | ensures planning, control, and optimization of agrotechnological operations |
| Spatial referencing of agro-operations | uses GPS for precise positioning and the creation of digital field maps |
| Analysis of spatial variability | identifies zones of differences in soil properties, crop conditions, and productivity |
| Integration with remote sensing and LiDAR | utilizes laser scanning data and satellite imagery to improve analysis accuracy |
| Formation of a unified information environment | aligns technical, agronomic, and economic indicators within the farm |

*Based on sources: [3, 6, 1]*

Increasing the productivity of the agricultural sector using new-generation drones is primarily due to the ability to quickly obtain objective, spatially bound and detailed information about the condition of crops and the production environment, as well as to promptly convert this information into practical management decisions. The key factors for increasing productivity are regular monitoring of crops, accurate assessment of plant height and biomass, timely detection of spatial heterogeneity of the field, targeted application of resources, optimization of spraying and plant protection, as well as increasing the efficiency and flexibility of managing agro-technological processes. These factors allow reducing resource overspending, reducing technological risks and stabilizing yields. The use of LiDAR technology provides highly accurate three-dimensional measurement of relief and vegetation cover, which allows obtaining quantitative indicators of crop development and moving from visual assessments to substantiated data, and therefore increasing the accuracy of agronomic decisions. At the same time, GIS forms a single information environment within which data from drones, navigation systems and other sources are integrated, spatial analysis is provided, coordination of technological operations and planning support is provided. The combination of LiDAR and GIS allows you to combine measurement accuracy with management logic, that is, to transform detailed spatial data into practical scenarios of actions in the field, which creates the basis for more effective, economically feasible and sustainable decisions in the agricultural sector.

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