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INTEGRATION OF MODERN GNSS AND LIDAR TECHNOLOGIES IN GEODETIC MEASUREMENTS

Berdimuratova Mexribanim Allamuratovna

Lecturer of Department of Geodesy, cartography and natural resources,

Karakalpak State University named after Berdakh

Nukus, Uzbekistan, E-mail: mexribanim08@gmail.com

Abstract

This thesis analyzes the integration of modern geodetic measurement technologies — GNSS (Global Navigation Satellite Systems) and LIDAR (Light Detection and Ranging). The study explores the possibilities of determining terrain relief, creating three-dimensional models, and automating cadastral and cartographic works using these technologies. The processing of GNSS and LIDAR data through GIS (Geographic Information Systems) applications has shown a significant improvement in accuracy, efficiency, and reliability. The results of the study have practical importance in geodesy, cadastral management, and engineering fields.

Keywords

Geodesy, GNSS, LIDAR, GIS, digital cartography, spatial data, cadastre, coordinate system, measurement technologies.

At present, as a result of the rapid development of science and technology, the field of geodesy is also undergoing fundamental transformations. **Geodesy** is the science that studies the shape, dimensions, surface configuration of the Earth, and related spatial objects, and with the use of modern technologies it has reached a new stage in terms of accuracy, speed, and efficiency. Traditional measurement methods are increasingly being replaced by digital and automated systems.

1. Global Navigation Satellite Systems (GNSS)

GNSS technologies, particularly **GPS, GLONASS, Galileo, and BeiDou**, are among the most important tools in geodetic measurements. Using these systems, it is possible to determine positional coordinates with millimeter-level accuracy, monitor the movement of objects, and measure deformations of engineering structures. GNSS receivers have become an integral part of modern geodetic operations.

Figure 1. GNSS RTK Receiver

2. Electronic Tacheometers and Total Stations

Modern electronic tacheometers measure distances and angles using laser beams. Total stations automatically process these measurements and store the results in digital form. This approach reduces human error, increases accuracy, and saves time.

Figure 2. Electronic Total Station and GNSS Antenna

3. Aerial Photography and Remote Sensing (RS)

Remote sensing technologies are implemented using drones, satellites, and aircraft**.** Drones enable the rapid creation of topographic plans, 3D models, and orthophotos. This technology is widely applied in construction, agriculture, environmental monitoring, and cadastral works**.**

Figure 3. Drone with LiDAR Sensor

4. LiDAR Technology

LiDAR (Light Detection and Ranging) technology uses laser pulses to measure terrain with high accuracy. This method enables the creation of high-precision 3D models of the area. LiDAR plays a significant role in geodesy for applications such as road and bridge construction, forest management, and water resource monitoring**.**

Figure 4. Trimble R750 GNSS Receiver

5. Digital Mapping and GIS Systems

In geodesy, digital mapping and Geographic Information Systems (GIS) are closely interconnected. GIS technologies allow for the analysis of geodetic data, creation of interactive maps, and management of cadastral information. These systems play a crucial role in state land management, infrastructure planning, and environmental monitoring**.**

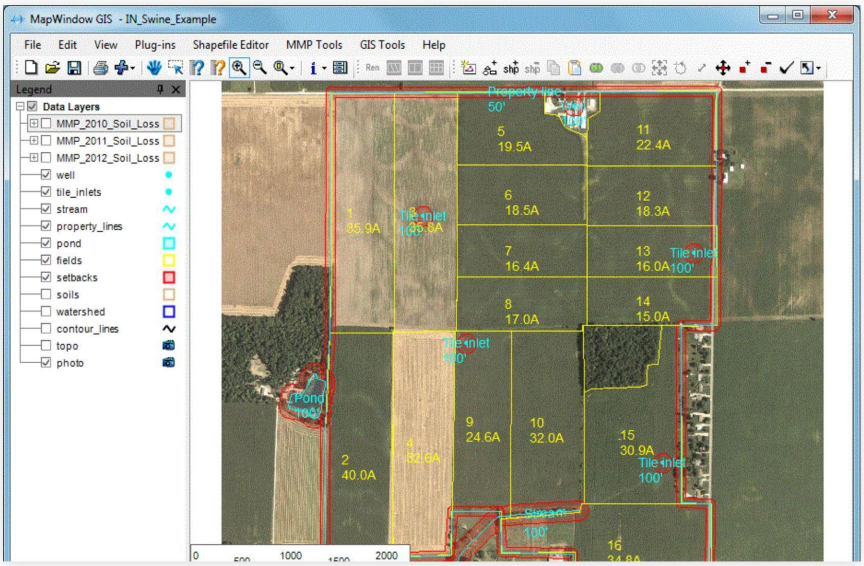

Figure 5. GIS System Interface

Conclusion: Modern geodetic technologies simplify human labor and significantly improve the accuracy and speed of measurement operations. The integration of GNSS, LiDAR, drones, electronic tacheometers, and GIS systems enables the automation of data collection, processing, and analysis in geodesy. Therefore, geodetic specialists need to master modern technologies and efficiently utilize digital information systems. This, in turn, directly contributes to the development of cadastre, construction, and regional planning in our country.

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