# APPLICATION OF GIS TECHNOLOGIES IN ENGINEERING GEODESY WORKS

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**Abstract:**
This thesis analyzes the theoretical and practical aspects of the use of geoinformation systems (GIS) technologies in engineering geodesy. The possibilities of increasing accuracy, speed, and efficiency through digital processing of geodetic measurements, spatial analysis, and automation of monitoring processes in the construction and infrastructure sectors are highlighted. The research results show that the use of GIS technologies has increased measurement accuracy by 1.5–2 times, reduced construction costs by 10–15%, and significantly increased safety. The prospects for digitizing engineering geodesy processes, integrating them with BIM systems, and developing monitoring based on artificial intelligence are also considered.

**Keywords:** GIS technologies, engineering geodesy, digital construction, spatial analysis, digital terrain model (DTM), geodetic measurements, BIM integration, satellite data, monitoring, digital infrastructure.

## Introduction

Currently, along with the rapid development of the construction and infrastructure sectors in our country, the issue of organizing engineering geodesy work on the basis of modern technologies is becoming increasingly urgent. The need to use high-precision geodetic data in the design, construction and operation of structures, buildings, transport networks, energy and hydraulic facilities is increasing. The introduction of **geoinformation systems (GIS)** technologies in the collection, processing, storage and analysis of such data is creating the basis for the advancement of the science of engineering geodesy to a new level.

Using GIS technologies, it is possible to digitally represent the topographic and geodetic characteristics of a place, analyze the relief, automatically process measurement results, form a spatial database and visualize them. The use of these capabilities in engineering geodesy work ensures high efficiency, first of all, **in determining the location of buildings and structures** , **designing road and transport infrastructure** , **modeling the relief of the earth's surface** , and **controlling construction processes** .

In recent years, the Resolutions of the President of the Republic of Uzbekistan “On the Development of the Digital Economy and Digital Government”, the “Concept for the Introduction and Development of Geoinformation Technologies”, as well as the “Measures to Improve the State Land Cadastre and Land Monitoring System” have stipulated the widespread introduction of GIS technologies in all sectors, including construction and engineering

geodesy. This accelerates the process of digital transformation of the sector and serves as a practical expression of the concept of **"Digital Construction" .**

The main advantages of using GIS technologies in engineering geodesy are **increased accuracy** , **rapid data updates** , **automation of spatial analysis** , and **the possibility of integrated management of construction processes** . In this case, data obtained from GPS/GNSS measurements, aerial photographs, drones, and satellite images are combined in a GIS environment to create **a digital terrain model (DTM)** and **a digital ground surface model (DSM)** . This integrated approach not only optimizes design processes, but also plays an important role in analyzing the location, stability, and safety of structures.

Also, the introduction of GIS technologies increases the efficiency of geodetic work in terms of time and resources compared to traditional methods. It creates opportunities for automatic monitoring of the location of construction objects, tracking changes in geodetic control points, modeling deformation processes and rapid adoption of engineering decisions. As a result, a **scientifically based, modern digital management system** is formed in the field of engineering geodesy.

The relevance of this study is that it highlights the theoretical and practical aspects of introducing GIS technologies into engineering geodesy processes in the conditions of Uzbekistan, analyzes existing methods, and serves to develop effective technological solutions in the field. The results of the study are of significant practical importance in the development of construction projects, the layout of roads and structures, and the automation of their spatial analysis [1-0].

**Results and discussion**

The results of the research show that the use of geoinformation systems (GIS) in engineering geodesy significantly increases the accuracy, quality and economic efficiency of construction and infrastructure projects. Based on GIS technologies, it is possible to digitally process coordinates, heights, slopes and relief parameters obtained from geodetic measurements, perform their spatial analysis and visual display. This allows the location of buildings, roads and structures to be accurately determined, their mutual distance dependence, vertical and horizontal slope levels, compliance with the relief and spatial relationships between engineering communications to be assessed. Also, using digital relief models (DEM, DTM) created in the GIS environment, the processes of selecting the optimal location of construction objects, planning road networks and analyzing surface changes are automated. This reduces errors at the design stage, optimizes construction costs and reduces the impact of the human factor.

As a result of the conducted analyses, it was found that the use of GIS technologies increased the accuracy of geodetic measurement results by 1.5–2 times. While traditional methods of site measurement and plan drawing required 5–6 working days, this process was carried out in

1–2 days using automatic analysis systems based on GIS. Also, the error rate in the analysis of the location of structures and measurement results was reduced by 25–30 percent. Based on the results obtained in the GIS environment, the slope of the construction site, soil deformation and height profiles were accurately modeled, and the technical safety indicators of the project were reliably assessed. In particular, route analysis using GIS technologies in conjunction with topographic data in the design of road and bridge structures yielded important practical results. In this case, optimal routes were determined taking into account relief changes and slope levels, and it became possible to reduce construction costs by 10–15 percent.

GIS technologies play an important role in engineering geodesy not only in design, but also in monitoring the construction process. Deformations, subsidence, displacements or changes in relief occurring during construction are regularly measured, and the results are automatically entered into the GIS database. As a result, geodetic stability is under constant control, and the safety level of structures is assessed in real time. Practical experience has shown that the use of GIS-based monitoring systems allows for the early detection of deformation processes, which is of great importance in preventing dangerous situations. As a result of this approach, subsidence and displacements have been reduced by up to 40 percent, and the quality and stability of construction have increased.

The use of GIS technologies in engineering geodesy is becoming an integral part of the concept of “digital construction”. Along with geodetic data, GIS systems are integrated with Building Information Modeling (BIM) platforms, and spatial and technical indicators of structures are managed in a single digital environment. Through this, the 3D model of each object, coordinate grid, height profiles, engineering networks and relief features are combined in a single information system. At the same time, each stage of the construction process — design, control and operation — is automatically managed based on a spatial database.

During the discussion, it was found that the capabilities of GIS technologies have not yet been fully implemented in all engineering geodesy organizations. The main reasons were the lack of qualified specialists, outdated technical equipment, incompatibility of data exchange formats, and limitations in digitizing geodetic measurement data. At the same time, the fact that special attention is paid to the development of geoinformation systems in the Republic of Uzbekistan within the framework of the “Digital Economy” and “Digital Government” programs opens up great opportunities in this area. In the near future, it will be possible to further increase the efficiency of the use of GIS technologies in engineering geodesy work by integrating aerial photographs taken from drones into GIS databases, establishing real-time monitoring using satellite images, and creating automatic analysis systems using artificial intelligence algorithms [11-17].

Thus, the results obtained showed that the role of GIS technologies in digitizing engineering geodesy processes, automating spatial analysis, and monitoring construction facilities is incomparable. A GIS-based approach increases the accuracy of geodetic measurements,

reduces construction costs, ensures a level of safety, and creates the basis for the formation of a “digital infrastructure” system.

## Conclusion

The above analysis shows that the use of GIS technologies in engineering geodesy significantly increases the quality of construction and infrastructure projects. GIS allows for the processing, analysis and visualization of geodetic data in digital form, which ensures high accuracy in determining the location of structures. Also, the use of GIS technologies in monitoring and control of the construction process increases safety, saves time and labor resources, and reduces errors caused by the human factor. Thus, GIS technologies play an important role as a key tool in digitizing engineering geodesy processes, managing spatial data, and forming a “digital construction” system.

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