



Methods of Using Modern Geodesic Instruments in Monitoring the Deformation of Historical Monuments

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Abstract: This article analyzes the possibilities of using modern technologies to detect and monitor deformation processes of historical monuments. Proposals are made for monitoring and preserving the condition of monuments using geodetic, GNSS, lidar and drone technologies.

Keywords: Globalization process, historical and cultural monuments, anthropogenic impact, armed conflicts, natural disasters, vandalism, 3D technology, reconstruction, Digital archaeology.

ENTRANCE Historical monuments are an important part of cultural heritage, and the problems of their preservation and restoration are urgent. Deformation of monuments under the influence of natural and anthropogenic factors threatens their long-term preservation. This article proposes research methods based on modern technologies for identifying and analyzing structural changes in historical monuments.

Historical monuments are the cultural heritage of every nation, invaluable treasures testifying to the history of the past. They are not only architectural and artistic monuments, but also have historical, social and religious significance. However, over time, deformations are observed in these monuments under the influence of various natural and human factors. This creates the need for their proper preservation and restoration. Today, modern geodetic technologies serve as an important tool in determining deformations in monuments.

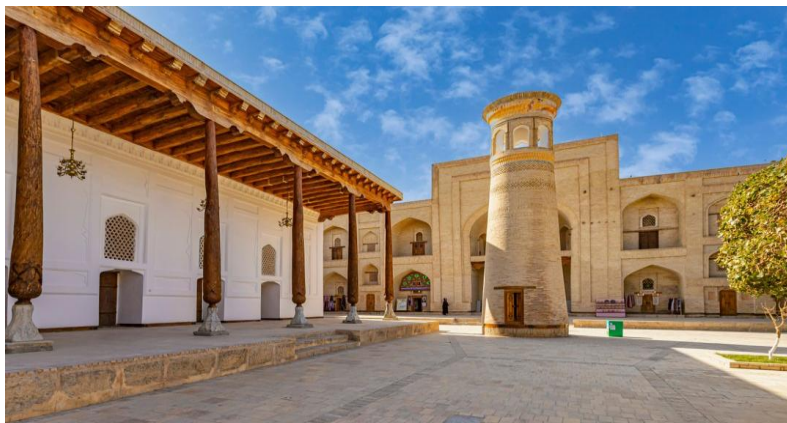
1. Identifying the causes of deformation: The following factors can cause deformation of historical monuments:

- Climate change and natural disasters;
- Gravitational and seismic effects;
- Humidity and soil changes;
- Anthropogenic impacts (transport vibrations, industrial impacts, etc.);
- Improper restoration and operating conditions.

The concept and causes of deformation: Deformation refers to changes in the shape and position of objects. In historical monuments, these conditions occur due to the following reasons: natural disasters (earthquakes, rain, wind), landslides, misuse, the passage of time,

and the negative impact of the environment. All of these undermine the structural stability of the monument.

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2. Studying deformation using modern technologies: Currently, the following technologies are used to detect and monitor the deformation of historical monuments:

- Obtaining high-precision coordinates using GNSS (Global Navigation Satellite System) technologies;
- Creating a three-dimensional model using Lidar (Light Detection and Ranging) technology;
- Using drones to regularly photograph monuments from above and monitor changes;
- Analysis of the degree of deformation of structures using 3D scanning technologies;
- Inspection of underground structures and their strength using georadar technologies.

Modern geodetic instruments: Monitoring of monuments has become much easier thanks to innovative solutions in geodetic science. The following instruments are widely used:

- Total Station (electronic survey station) – performs high-precision measurements;
- GNSS (Global Navigation Satellite Systems) – determines the coordinates of objects with global accuracy;
- 3D laser scanning – creates a full-size digital model of objects;
- Photogrammetry and drones - allow for quick and safe measurements.

O'LGHASH ASBOBLARI TASNIFLANISHI

Parametr turiga qarab

Termometrlar va pirometrlar

Manometrlar, vakuummetrlar

Sarf o'lchagichlar va hisoblagichlar

Sath o'lchagichlar

Gazoanalizatorlar

Konsentratomerlar

Zichlik o'lchagichlar



Geodetic instruments:



3. Research stages

1. Selection of the research object and assessment of the risk of deformation;
2. Determining the current status of monuments using GNSS and lidar;
3. Inputting the obtained data into GIS and 3D modeling programs;
4. Dynamic observation and analysis of deformation processes;
5. Based on the results obtained, develop strengthening and restoration methods.

Applied research and monitoring methods

Monitoring is carried out in stages: baseline measurements, periodic re-measurements, data comparison and analysis. Any shifts in the monument are detected through a 3D model. For example, monitoring of monuments such as the Registan complex, the Kalon Tower, and the Ichan Fortress has shown that structural shifts occur every year, albeit in small amounts.

4. Expected results

The monitoring results serve as a key factor in the restoration of monuments. Early detection of deformations allows for prevention of risks and the implementation of protective measures. They also create a valuable database for scientific research.

- Accurate and systematic monitoring of the deformation of monuments;
- Develop measures to predict and prevent changes in advance;
- Increasing the efficiency of restoration and reinforcement works;
- Provide scientifically based recommendations for the long-term preservation of historical monuments.

DISCUSSION

Humanity has a duty to preserve and pass on to future generations the monuments that are disappearing due to natural and human actions. Today, world scientists propose the use of advanced technologies (digital preservation and restoration) as a solution to the problem. With the help of advanced technology, it is possible to preserve historical monuments, especially those that are under threat of extinction, in 3D format. In the 80s and 90s of the 20th century, scientific research was conducted in developed countries, and since the 2000s in Russia, on the issue of using three-dimensional modeling in historical research. 3D (three-dimensional) modeling is the creation of a three-dimensional project based on an architectural plan or the artifact itself, its drawing, image, etc. [8,9,10,11.].

From June 14, 2021, a new project on digitizing historical monuments and monuments in 3D format has begun in our country as part of the "New Uzbekistan. New Perspective" program. This project will be implemented mainly in Samarkand. The Gori Amir Mausoleum, the Bibi Khanum

Mosque, the ancient Afrosiyob settlement, the Ulugbek Observatory, the Registan Square and the Juma Mausoleum were selected from our historical monuments for digitization. Using advanced technologies, it is possible to carry out digital reconstruction of our historical monuments and display them in VR format. In our country, Nurulin Timur has carried out a 3D reconstruction of the ancient settlement of Yerkurgan (ancient city ruins dating back to the 9th-8th centuries BC-6th centuries BC) [7,8,9,10.] and the Oktepa Yunusabad fortress of Sogdian architecture (a monument dating back to the 5th-13th centuries) [11,12,13.].

Conclusion

Historical and cultural monuments are of great importance in the development of humanity and its spiritual maturity. Thanks to such cultural heritage, we gain knowledge and an idea about the lifestyle, economic forms, culture, and art of our ancestors. 3D technology allows us to more reliably and completely reflect this history, and is of great importance in the protection and long-term preservation of cultural monuments.

Monitoring and analyzing the deformation processes of historical monuments using modern technologies is important for ensuring their long-term preservation. As a result of the use of GNSS, lidar, drone and 3D scanning technologies, the condition of monuments is accurately assessed and restoration processes are carried out on a scientific basis. In the future, the further development and widespread introduction of such technologies will expand the possibilities for preserving our historical heritage. Modern geodetic instruments are important in preserving historical monuments, determining their current condition and preventing possible problems in the future. With the help of such technologies, accurate and rapid monitoring is carried out. This is a big step towards preserving historical heritage.

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