Review Article
Open Access
CrossMark

Global positioning system data in engineering infrastructure facility management

Abstract

There is no doubt that remote sensing (RS) method and geographic information system (GIS) takes a vital place for appropriate authorities in decision making as an excellent instrument for required information. This is the subject of effectively use of accurate information in all stages of engineering activities. For the time being it is one of the best technology aiming to conduct efficiently monitoring/observation and fix duly any provided changes with consideration all of required standards and engineering instructions during execution.[1–3]

The role of the RS method in space technology application is to collect relevant information required for engineering activities. It is main segment of geo-data use and collection method which opens opportunity for the further GIS development. From this point of view, it can be mentioned the role of GIS as the subject of storing, managing a great deal of data about the space images and all the related attributes to allow their manipulation, analysis and finally presentation according to expected choice.[4,5] Today RS and GIS is one of the best technology for performing engineering activities, computation data both space and field, prediction, retrieving through data processing with use of required software application, especially overlaying of different GIS layers extracted from multi remotely sensed data.

There is one more advantage of use of RS and GIS technology is being able to link all achieved information into the coordinate system both local and international framework. It makes possible of data use in flexible and good quality manner and storage in further needed case application.[6–9] In this paper is expected to demonstrate linear pipeline systems monitor based on the methodology of GIS development using RS method for initial data collection with aim of observation of any possible changes management. It has been developed GIS for monitoring of pipeline system performing integration of satellite image and field measurement with use of the geodetic survey. Moreover, it has been used lined stages of management processes of monitoring system with integration of spatial data and field measurements.

Keywords: spatial data, global positioning system, gis, monitoring, management of engineering processes, data processing

Volume 5 Issue 6 - 2018

Gunel F Bahramova,[1] Bahar N Aliyeva,[2] Sefer Kurnaz,[3] Rustam B Rustamov[4]

[1]Geotechnical, Encotec Company, Azerbaijan
[2]Experienced Geotechnical Engineer, SMEC Company, Australia
[3]Chief of Computer Engineering, Altınbash University, Turkey
[4]eiLink Research & Development of Khazar University, Azerbaijan

Correspondence: Rustam B Rustamov, eiLink Research & Development of Khazar University, Baku, Azerbaijan, Email r_rustemov@hotmail.com

Received: September 24, 2018 | **Published:** December 17, 2018

Introduction

Up to date GIS developments finds application in supporting various data formats which use for bases of life system infrastructure allowing engineers to integrate collected information for project design and construction of engineering facilities. There are advantages of GIS technology, which provide to gather spatial data and its analysis and integration for further decision making by appropriate authorities. It can be demonstrated contribution GIS development for engineering executions as below:

a. enabling engineers easily manage;
b. reuse;
c. share, and analyze data; and
d. saving time and resources.
e. GIS makes possible to develop tools for:
f. modeling information to support more intelligent;
g. faster decisions;
h. discover and characterize geographic patterns;
i. optimize network and resource allocation; and
j. automate workflows through a visual modeling environment.[10,11]

It is the facility to perform 2D and 3D visualization for the convenient use and monitor of data, to see any changes at any time, to trend all clients' expectations and even disseminate knowledge to engineers, managers, clients, regulators and field-based personnel. It is the source for achievement best and successful execution and management in all stages lined and scheduled for engineering implementation. No doubt that qualified information source is one of the main reason of the success of engineering activities. It takes importance starting from tender package development up to the as-built stage of project execution. From this point of view, it is necessary to select and define the method or any available instrument for collection required/needed data in any stage of engineering processes. It becomes highly important in cases of a big scope of engineering works indent do to be done for construction. It is very complicated to consider and undertake all aspects of execution expected to provide and face under project design requirements.

Why it is necessary? An importance of such approach of engineering execution is the availability of use of outcomes for a best management of engineering developments. Obviously, high accuracy data achieved by use of high technology, particularly with application of space technology advances can be play significant place in challenging successful management of the engineering activities in all the stages of engineering processes. It makes important engagement of engineers in geology/geotechnical/chemical and any other related scientists/specialists to take high attention to study the structure of the Earth and develop models/methods/instruments to learn about continental drift and simulate/predict/forecast the faults in the Earth's crust. Those investigations are the first stage of construction process of engineering activities. At the same time the study the causes and nature of volcanoes and learn about soil eruptions are very important for the soil study. As far as obvious landslides study are also important in engineering activity consequences needed to be undertaken during all stages of project design, construction as well as continuously monitoring to be duly provide corrections into construction process. It is important in the exploitation stage of engineering facilities as well.

Investigated Area/Planning/Environmental analyze

The area under investigation is located at 60km to the south-west from Baku, Azerbaijan in the Gobustan district, near the Goturdagh mud volcano (Figure 1). The landscape is hilly with low or absent vegetation. Geodesic survey for the fourth cycle of monitoring was started in December 2015 with installation datum monuments. The cycles of five monitoring were embraced on February, June, October 2016 and June 2017 and the last one were conducted on December 2017.

In accordance with the project requirements described within the frame of the scope of work it can be contained planning functions for site location with reflection of below segments:

a. environmental impact mitigation;
b. economic analysis;
c. regulatory permitting;
d. alternative siting analysis;
e. routing utilities, what-if scenarios;
f. visualization of concept options;
g. data overlay;
h. modeling; and
i. benefit/cost alternatives analysis.

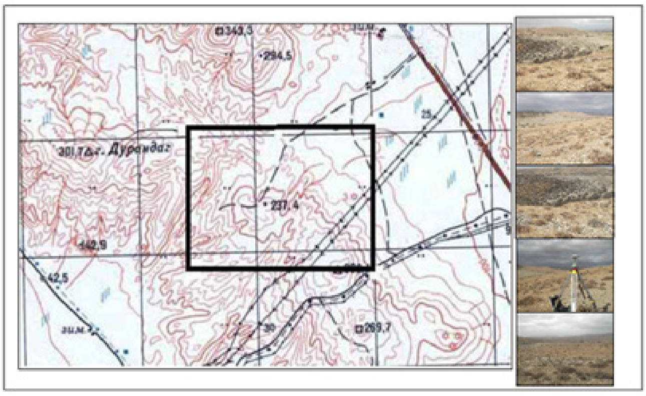

Figure 1 An area of investigation.

An environmental analyze provides to support project design elements including:

a. hydrology analysis;
b. volume calculations;
c. soil load analysis;
d. traffic capacity;
e. environmental impact;
f. slope stability;
g. materials consumption;
h. runoff;erosion control; and
i. air emissions.

In the stage of the environmental studies can be embraced and considered following segments of the project execution:

a. view project maps
b. site photos;
c. CAD or any other kind software used drawing files;
d. survey measurements; and
e. 3D renderings.

The fact is that geographical information system development for the environment studies makes possible to point out following important achievements where not clearly evidenced without the visualization of data:

a. view patterns;
b. trends; and
c. relationships.

Method of measurement

5 Datum (DM) and 15 Surface (SM) ground movement monuments and 6 Top-Dead Centre Target Points of pipe were installed during the first phase of field execution. Geodesic Surveyor performed field survey of ground movement monuments and Top-Dead Centre (TDC) Target points of pipe as a fourth cycle of monitoring to obtain their coordinates and elevation data. Together with the previous data obtained during first three monitoring cycles, these data is expected to be used for further monitoring stages.

The scope of fourth monitoring cycle was included the followings:

1) Measurement of angles and directions of reference network;
2) Determination of coordinates and elevations of surface (SM) ground movement monuments;
3) Determination of coordinates and elevations of Top-Dead Centre (TDC) Target points of pipe; and
4) Processing of the geodesic survey results.

World Geodetic System 1984 (WGS-84) was used as the reference geodetic system for horizontal projection. Kroonstad Datum (MSL Baltic Sea) was applied for the local vertical datum.

The coordinates of the Datum (DM) monuments were calculated with average square error of 5mm.

Equipment used for topographical survey

The topographical survey was performed by tachometric survey with the contour interval 0.5m with use of electronic tachometer TS 16 (by Leica) with plugged-in application program.

Topographical equipment has been checked at site prior to commencing work each day and when required.

Field works and measurement

In the initial stage of the field works it has been established DM points meeting the requirements identified by the owner of the oil pipeline system). Those requirements were important for the high accuracy of measurement achievement.

Measurements were carried out with use of electronic tachometer

TS 16 (by Leica) from the reference network point by three receptions with required closing to the adjacent datum (DM) monument. A landmark with reflector was centered on a measured point with use of tripod. Coordinates and elevations of each Top-Dead Centre (TDC) Target point were determined from two points of reference network.

Elevations of points were determined with use of trigonometric leveling method.

Geodesic and topographical information stored in the electronic memory of tachometer was imported into computer with use of Leica Geo Office Tools software. The average square error of measurements accuracy is 5mm.

Triangulation network represents the series of triangles. Coordinates of all Datum (DM) monuments are determined in WGS-84 system. Satellite positioning receivers SR20 (produced by Leica) were used for determination of plane coordinates and elevations.

Measurements were carried out in a static mode. Initially before installation of Surface (SM) and Datum (DM) monuments temporary points TP1 and TP2 coordinates were determined in WGS-84 system.

The process and conditions of measurement were the followings:

1. The basic receiver was located at the geodesic reference network point with known coordinates during the whole measurement process;
2. The second receiver was placed at the determinate point with satellite data set during 0.3-1.0 hours (depending on the distance from the basic station); and
3. Processing of field data consisting of adjustments of measurements and transformation of data (Pulkovo 1942 Zone 8) system was performed with use of Leica Geo Office software.

The purpose of triangulation network measurements was to determine the relative position of Datum (DM) monuments with the highest possible accuracy.

Spatial data management

The fact is that an investigation of soil contamination is a vital subject for study of the soil condition. It does not limit for collection of information relevant only to the materials and particles of the soil. It consists of study of all organisms as well as land cover aspects.

It can be reflected significant segment of soil required to be undertaken in engineering developments. The main areas for the initial stages of engineering facilities construction in the line of engineering activities would be executed mainly within the following aspects:

I. geotechnical investigation;
II. geological and geophysical investigation;
III. foundations;
IV. earthquake;
V. landslide studies; and
VI. industrial waste and contaminated soil.

Obviously, as it is mentioned above, now days the use of high technology application for the engineering needs such as application of remote sensing and GIS technology as the attractive instrument for this aim.

As it has been early indicated there are traditional methods existing for geotechnical investigations for soil studies. It is not sufficient and even in some case circumstances to use standard instruments for gathering needed information during engineering executions. From this point of view it demands separately use or integrate of remote sensing method with further GIS development and field measurements for achievement of high quality and operative data access. It creates excellent opportunity for successful management the processes making possible to develop good operation environment. In fact, it has been used in this case a global positioning system for monitoring engineering linear infrastructure facilities. In this regard is important selection the type and features of data collection and processing systems, which take a vital place in management of engineering activities. Figure 2 demonstrates stages of the processes of engineering activities management process. Those stages can be used in the similar cases of engineering activities.

The project execution stage considers all possible aspects of project execution such as:

a. tender;
b. design;
c. construction;
d. commissioning;
e. as-build;
f. handover; and
g. exploitation

The next step of project execution is the establishment of datum monuments (DM), position data measurement, analyze and processing settled up points.

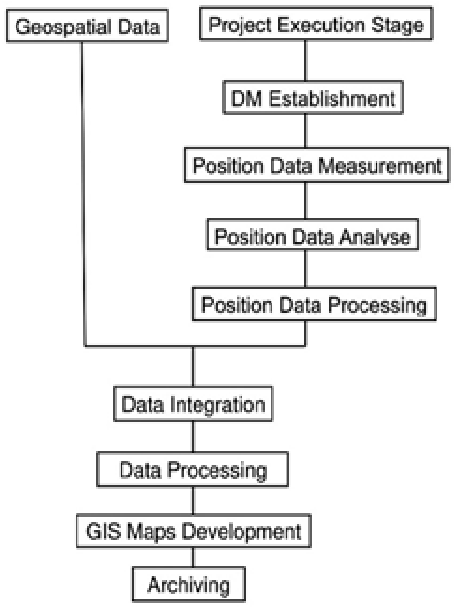

Figure 2 A stages of the data integration for engineering activities management.

In this paper as the pattern is undertaken geospatial data in the form of global positioning system and processed satellite data outcomes. Geospatial data with the processed field measurements has been integrated in the stage of "Data Integration". The final stage of process in the development of maps and archiving which is the excellent source for the consistent management all the engineering activities. The next stages of project execution are establishment DM, position data measurement, analyze and processing. In this paper as the pattern is undertaken geospatial data in the form of global positioning system and processed satellite data outcomes. Geospatial data with the processed field measurements has been integrated in the stage of "Data Integration". The final stage of process development is the maps and theirs archiving. It is an excellent source for the consistent management all the lines of the engineering activities.

Conclusion

This paper demonstrates monitoring of pipeline linear system based on the use of global positioning system with further development of global information system (GIS). It has been described details of GIS developments integrated into the geotechnical field measurements/processing. It is one more approach suggested in this paper the way of how to collect and gather required information for the success and needs of engineering activities.

In the meantime, paper shows stages of process, which can be used as the instrument for successful management of engineering activities in all available aspects. It has been pointed out segments of processes as the management element of space technology application in engineering facility monitoring systems.

Acknowledgments

None.

Conflicts of interest

The author declares there are no conflicts of interest.

References

1. Schnebele E, Tanyu BF, Cervone G, et al. Review of remote sensing methodologies for pavement management and assessment. *Eur Transp Res Rev*. 2015;7:7.
2. Abbott J. The use of GIS in informal settlement upgrading: its role and impact on the community and on local government. *Habitat International*. 2003;27(4):575–594.
3. Nas B, Cay T, Iscan F, et al. Selection of MSW landfill site for Konya, Turkey using GIS and multi-criteria evaluation. *Environl Monit Assess*. 2010;160(1–4):491–500.
4. Gupta Kshama, Sharma Shweta, Singh Amit, et al. Geospatial Techniques for Urban Regeneration, Heritage Conservation and Planning, Spandrel, Monsson-2016. *International Journal of SPA*. 2017.
5. Sugg ZP, Finke T, Goodrich DC, et al. Mapping impervious surfaces using object-oriented classification in a semiarid urban region. *Photogrammetric Engineering and Remote Sensing*. 2014;80(4):343–352.
6. Aliyeva BN, Rustamov RB. Integration Space and Field Data In Land Use Studies For Engineering Solutions. *International Journal on Technical and Physical Problems of Engineering.* 2013;5(4):130–133.
7. Hashimov A, Aliyeva BN, Rustamova SR, et al. An Environmental Impact Assessment With Use of Space Technology Advances. *The Tenth International Conference on Technical and Physical Problems of Electrical Engineering*. 2014;7(8):357–360.
8. Hashimov AV, Aliyeva BN, Rustamova SR, et al. Geotechnical And Space Data Fittings In Environmental Studies. *International Journal on technical and Physical Problems of Engineering*. 2014;21(6):98–101.
9. Sefer Kurnaz, Bahar N Aliyeva, Rustam B Rustamov. Advances of Space Technology in Geotechnical Studies. *Global Journal of Researches in Engineering: J General Engineering*. 2014;14(6):975–5861.
10. Sefer Kurnaz, Bahar N Aliyeva, Rustam B Rustamov. Soil Environmental Studies with Application of Space Technology Advances and Geotechnical Investigations. *Researches and Applications in Mechanical*. 2015;4:10–19.
11. Bahar N Aliyeva, Nargiz E Samadova, Rustam B, et al. Comparative Analysis of Traditional Method and High Technology Application in Earth Studies. *Journal of Earth Science Research, USA*. 2015;3(3):60–66.