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Geodetic Automation to integrate an expert system

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Abstract: Automating the execution of geodetic measurements and data processing is a natural evolution that the general tendency to reduce human interaction as much as eliminating as much as possible human errors in both the data collection and the processing thereof. The evolution of computers, computer programs and methods of collecting and transmitting them allows obtaining accurate results in real time, allowing immediate action and avoiding loss of life or damage caused to property. It appears lately worldwide trend continues tracking movements of hydraulic structures through continuous monitoring. Due to automation systems, graphics and other elements of a classic UCC documents may be obtained in real time, or at any time predefined recipient.
Keywords: geodetic measurements, hydraulic structures, errors, real time

1. INTRODUCTION

While the use of GPS devices enjoys a growing user behavior monitoring construction, there are many situations where accuracy, cost and maintenance of such equipment combined lead us to a solution between them and motorized total stations make this system the best answer for determining the movement of construction. Geodetic measurements of displacements and strains using total stations will be an important source of monitoring data for many years to come.

From the historical point of view, one of the major limitations of geodetic monitoring techniques has been difficult to perform measurements in an automated manner. While many non-geodetic and geotechnical devices for measuring deformations are easily adapted for automatic measurements, geodetic measurements made traditionally been considered a labor-intensive task, highly dependent on operator qualifications. While, total stations have advanced so, perform electronic distance measurement and automatic reading of the horizontal and vertical circles, but the biggest obstacle to automation will remain necessary precision targeting precision measurements, but fortunately, recent developments have solve this problem.

Precise actuators combined with the capabilities of the target automatic recognition has led to the emergence of a new generation of robotic total stations (RTS) to obtain angular accuracy of less than one second.

Outcome monitoring system comprises three main components (Fig. 1):

1. Local dam monitoring system (AMC) for monitoring the behavior of the dam structure and bedrock structure.
2. Surveying equipment: - Control GPS, robotic total stations, levels, etc.
3. Computing, network, and specialized software.

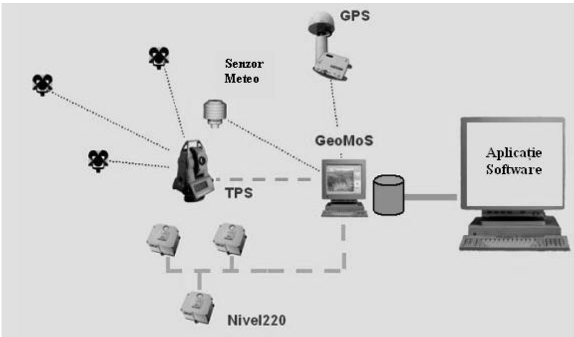

Figure 1. The scheme of automatic monitoring system

In order to reduce the costs of monitoring studies to seek a method to automate the process of observation.

For the implementation of the system can be considered two options:

- as a semi-automatic system, which sets the total station operator at each point of observation and software used to collect data to perform measurements;
- as a control, in which a total number of stations are installed permanently and make measurements according to a schedule. Safety, as well as to protect the equipment from environmental conditions, equipment would require permanent structures to be built into glass walls.

Of the two options, fully automated system is the most effective.

A fully automated monitoring system may be activated at a distance, much improved response time in emergency situations, while field staff will not be in danger.

The system could also be programmed to collect measurements as often as you want, day or night, without any cost increase. This represents a major advantage over semiautomatic system, if it is found

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that the required accuracy is not met, the system operator can schedule more frequent measurements, or may choose another time of day for data collection, or both. Labour costs in this scenario, would have reduced office-processing, maintenance and equipment checks.

The total cost of implementing this fully automated system will be dominated by the initial cost of construction and equipment purchases. Such costs, in turn, may be dictated by the total number of places of observation required, depending on the required accuracy of the system. Tracing movements are greater than 10 mm with an accuracy of 95%.

With a total station capable of achieving a standard deviation of 1 "for horizontal and vertical angles and the distance 1 mm, the maximum length of the sight to be limited to around 600 meters. Other sources of errors, such as atmospheric refraction will reduce the also precision thus targeting all lengths must be less than 500m as possible. Stability of automatic observation stations will be monitored by including observations from at least three reference pillars anchored in a solid layer of rock.

To provide an additional check on the integrity of measurements, some pillars located between the two observation stations shall be equipped with double prism mounted directly on top of another. Displacements measured at adjacent observation points can then be compared to verify the overall accuracy of the monitoring system.

As noted above, an automated using robotic total stations, proved to be the most practical and effective, in terms of economic efficiency monitoring a large number of points located on a dam. The creation of such a system, however, cannot be achieved by simply acquiring hardware and software. In addition to designing and building structures to accommodate robotic total stations, it would be necessary to develop a software system for collection and processing of the observation data.

LOCAL DAM MONITORING SYSTEM (AMC)

These machines are modernized, and their output signal is present in digital form so that it can be taken up without problems by specialized software. (Fig. 2)

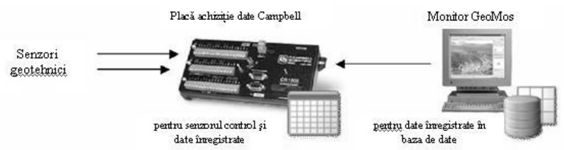

Figure 2. Interface for data acquisition

Also, for measuring the inclination of certain areas may be used sensors such as the following.

Figure 3. Leica electronic two-axis inclinometer

2.1. Surveying Equipment

For measuring angles and distances using robotic total stations with automatic recognition of prism mounted on concrete pillars. Where necessary they are protected by "shelter" with special glass walls to allow comments. (Fig. 4).

Figure 4. Robotic station location

Points monitored by the objective of the study is evidenced by prisms mounted on the body of the dam. (Fig. 5 and 6)

Figure 5. Prisms mounted in the body of the dam

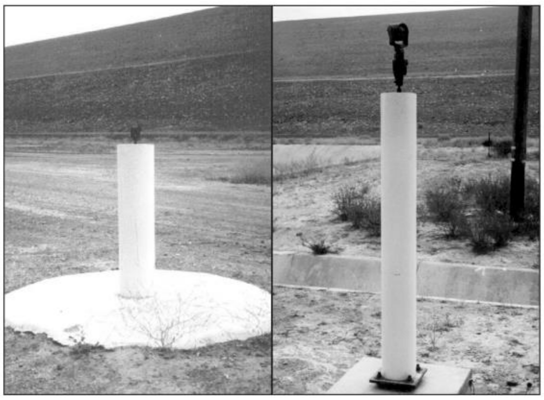

Figure 6. Prisms mounted on pillars

Power supply necessary for the operation is carried out by the mains or, if it is difficult to access can be made by means of photovoltaic panels. (Figure 7)

Figure 7. Total photovoltaic power stations

Also, the tracking system can use the GPS receiver, in which at least one should be placed at a greater distance from the dam, but no more than 3 km, for a more accurate calculation. The role of the GPS receiver to "wake up" the monitoring system, if the major movements are detected. At the signal from the GPS receiver will "alarm" monitoring software that will control one or more measurement cycles, which will result in the actual movements of the building.

GPS receivers operate continuously and are also powered by solar cells. (Fig. 8)

Figure 8. The location of GPS stations and fuel system

2.2. Considerations on software structure

As with any software package, software design should be made with careful consideration of the needs of its users. It emphasizes the need for a reliable system that could operate in a highly automated for long periods of time, and which would be flexible enough to accommodate future changes in the system configuration.

The main requirements for such software are:

1. Software shall operate in accordance with the latest version of the Microsoft Windows NT operating system.

2. To store its data in a relational database.

3. To support fully automatic operation modes, semi-automatic or interactive measurement.

4. Be compatible with total stations chosen for the system.

5. Be flexible, user configurable scheduling data collection activities.

6. To be compatible with the interface of the reception of the other physical quantities such as pressure and temperature sensors.

7. To support remote access through a communications network.

8. To have the ability to transfer data collected from different computers.

9. To perform an automatic restart of the measurement, after a power loss.

10. To perform automatic processing of data, including an analysis of the stability of reference points for each RTS observed.

It must be possible to store data from a total station in motion to be moved from point to point for comment.

The general condition will be that once the software has been set properly, it will start sending data automatically and at all observation stations to be combined into a database. Thus only routine maintenance such as total station recalibration or cleaning the glass walls of the observation shelter would require a site visit .

2.3. Visualization and interpretation of results

The results will be given in the form of a graph are the last measurement cycle, both in the horizontal and vertical movements of the structure being studied. Also they will be stored as a database that can be accessed over the network.

Also such software will be able to provide real time information on the movements of the building when it is required by the building administrator. If this dam may be necessary maneuvers drain - fill the reservoir.

Corroborating information provided by all sensors mounted on construction monitoring, monitoring software can generate three levels of alarm by comparing the data obtained with the limits imposed by the beneficiary.

Thus if one alarm level is exceeded can send a message to the person responsible for the system which in turn may check.

If level 2 alarm is exceeded can be switched optical and acoustic warning systems and responsible for the system to decide the measures to be taken.

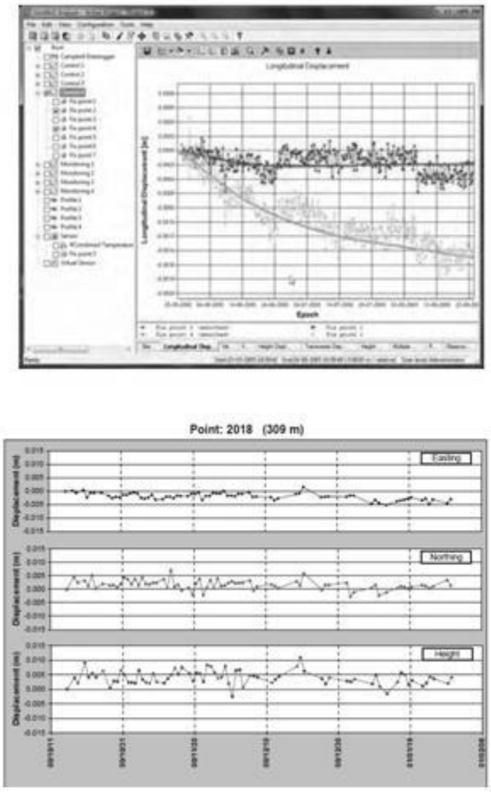

Figure 9. Graphical representation of displacements

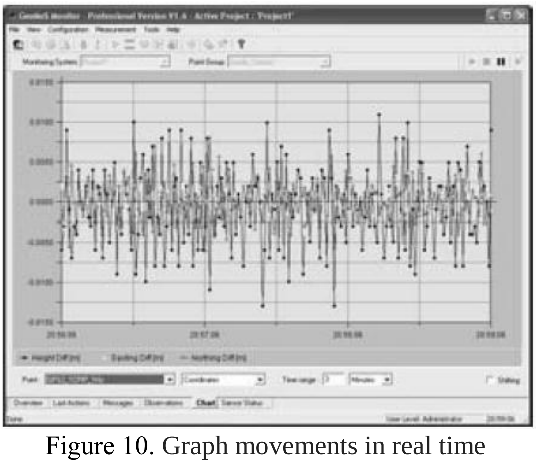

Figure 10. Graph movements in real time

3 If the alarm is exceeded, an alarm siren will be activated, the area will be evacuated and the system can inform responsible for another verification and other factors responsible for public safety in the area.

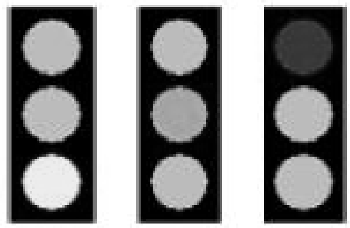

Figure 11. Intuitive alarm system

All equipment described above with geodetic monitoring software form a complex system that has many advantages over traditional methods of making performance monitoring construction. Among these advantages are:

- high accuracy due almost entirely eliminate human error;
- possibility of accessing the system from a distance;
- cycles possibility of making measurements at much shorter intervals than the classical way;
- determining displacements in a very short time and immediate alarm in case of danger;
- data acquisition and processing in real time;
- geodetic measurements correlate with those provided by AMC;
- decrease costs UCC activity.

In view of the above, the system shown is to be considered a viable alternative both technically and economically to carry out the classical system performance monitoring construction, it is recommended in the case of large constructions.

Data provided may be stored in databases and can be used in both classical and decision making using expert system to be integrated. These can be supplemented by previous experiences in various situations both in terms of input data, the decisions taken and the results obtained from the decision.

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