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A NEW APPROACH FOR GEO-MONITORING USING MODERN TOTAL STATIONS

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ABSTRACT
Image Assisted Total Stations (IATS) integrate the geodetic accuracy of total stations (TS) with the areal coverage of photos. A calibrated system permits the representation of observed pixel locations on the image sensor as field angles in the object space. Captured pictures are instantly geo-referenced and may be utilized for direction measurements with no requirement for object control points or subsequent orientation operations. Photogrammetric image measuring techniques in order to identify signalized as well as non-signalized objects may be integrated with functions of the base total station, such as exact angle and distance measurements. In this study present the innovative technique for geo-monitoring utilizing contemporary total stations.
Keywords: modern, station, monitoring, geo-monitoring

INTRODUCTION
An important part of engineering geodesy is the repeated or continuous monitoring and management of artificial or natural structures. It's a technique of collecting data about the present status of the seen item on a regular basis. Monitoring of deformation, whether caused by internal or external forces, is sometimes referred to as "deformation monitoring." Geodetic sensors and technologies are often used in geo-monitoring. [1]
Large-scale remote sensing technologies and local geotechnical assessments based on non-georeferenced point data are connected by these. All these are referred to as "Global Navigation Satellite Systems," "Terrestrial Positioning Systems," "Terrestrial Laser Scanners," and "Photogrammetry" (GB-SAR). Cost, resolution, range, reliance on weather or light conditions, energy requirements,
communication connection requirements, and access to the potentially dangerous monitoring region distinguish these technologies from one another. [2]
This does, however, imply that the two may work in harmony with one another. The data processing is still done individually, despite the fact that most of these different sensors1 are integrated into a single (universal) instrument. If you've ever wondered how to modify this reality, this article presents a fresh strategy that takes full use of the current total station's sensors. Laser scan and picture data from a whole station platform are immediately obtained in a shared coordinate system, which is the key component of the combined assessment. This comparison shows how effectively these two measuring techniques work together. In sequential TLS data, changes in line of sight may be easily seen as distance fluctuation. Displacements occur as (object) scaling in picture sequences and are difficult to identify if just image characteristics are analyzed. [3]
Instead of relying on laser scanner data, picture and template matching algorithms provide a more accurate way of detecting transverse displacements (in particular with weak-structured surfaces). In a traditional geodetic deformation study, the points and vectors generated by a combined data assessment may be used to construct 3D object points and vectors. It is consequently possible to identify unstable control points, as well as both significant and little movements of the objects being monitored. The novel method uses 3D displacement vectors generated from previous epochs to identify movement. [4]
The monitoring region is mapped out using pictures and point clouds generated by a single equipment operating in either a permanent or periodic mode. Analyzing distance data in this manner results in a depth image, where the pixel coordinates of an image correspond to theodolite angle values, and the

picture is shown in gray or color values. As a consequence, RGB panoramic photos now include a D-channel. Real 3D displacements in these RGB+D pictures may be recognized utilizing template matching approaches such as a normalized cross-correlation (NCC) of image sections. Several instances have shown that approaches based on images from the ground, air, or satellite are appropriate for constructing landslide displacement fields. Aerial laser scanning was utilized to create a "static" digital surface model (DSM) and a series of following photos from two IATS devices in stereo configuration to provide 3D information. As a consequence, minor camera motions and the adoption of a mono-temporal DSM are the most restricting criteria for nal correctness. Alternatively, the point clouds generated by future laser scans may be projected. Sliding window correlation in a plane perpendicular to the viewing axis allows for a straightforward 2D comparison while still maintaining the 3D displacement data. Both the reflected laser beam intensity and the gradient in distance between an object point and a TLS station are used as input data for these approaches' correlation functions. If the scanner moves even little, the transformation settings for each point cloud must be recalculated. Because just one IATS with a scanning function is employed in the suggested technique, these problems do not apply. An inbuilt dual axis inclinometer and measurements to nearby control points ensure the stability of the station's coordinates and orientation. It's even conceivable to employ GNSS baselines for surveillance. For the correlation or matching data, optical pictures are used since the algorithms for these have been well tested and are well adapted to this task. [5]

MODERN TOTAL STATIONS

In the horizontal and vertical axes, heodolites are used to measure angles. Total Stations are multi-sensor systems that offer very exact angle and distance measurements to prisms, and less accurately to practically any other surface, such as the ground. GNSS location, overview and telescopic cameras, tilt correction via two-axis inclinometers, and a scanning capability with up to 1000 points per second are all additional features. [6]

As a result, survey technique, particularly for monitoring activities, has undergone significant and ongoing development. Many survey activities now make use of a combination of GNSS and TPS, but combining scanning, TPS, and digital photogrammetry is still under investigation. All major surveying instrument manufacturers provide a total station with at least one (overview) camera built in. Thus, these devices are referred to as Image Assisted Total Stations in the literature (IATS). Leica Nova and Topcon Imaging Station series instruments also have an extra coaxial camera that benefits from the telescope's magnification. An overview camera has a larger field of vision, but a shorter ground sampling distance (better spatial resolution). In most cases, a basic scanning feature is also included. [7]

Between 15 and 1000 points per second may be measured. In the last several years, there has been a significant rise in the number of people driving. A laser scanner of the first generation, such as the Cyrax 2500, has a scan rate equivalent to that of the last described scanner. The electronic distance measuring (EDM) units used in a TLS are also found in certain total stations. Scan rates are still far below modern laser scanning systems, which have a scan rate of about 1 MHz, but this is still an improvement. TLS will always be quicker than scanning total stations because of the way it is designed. This is mainly due to the telescope's larger rotational mass compared to a TLS's smaller, lighter beam de ection unit. Keep in mind that up to 2,000 meters of EDM range is claimed (at a substantially reduced scan rate). Geo- monitoring projects formerly limited to natural targets with total stations and re- ectorless EDM may now be carried out with this system, which is several times more powerful than the current TLS systems. In a multi-sensor instrument, the most important benefit is the common coordinate system that is supplied for all built-in sensors, together with a proper calibration. Images and point cloud scans may be geo-referenced and orientated without the requirement for object control points or subsequent orientation operations. [8]

GEO-MONITORING APPROACH

By subtracting two 3D images, displacements in the line of sight may be readily observed.. Image sequences are a quick and easy way to model feature movement that is perpendicular to the (sighting) direction. As a result, these approaches complement one another and should be utilized in tandem to keep tabs on both natural and man-made items. As shown, the novel technique progressively acquires and analyzes image and scanner data. Processing and evaluating a single input signal consists of the following steps: [9]

1. The process of taking many images and stitching them together into one panoramic picture.
2. Using the total station's distance capability, the item is scanned and a depth picture panorama is calculated.
3. 3. Compiling 2D displacement vectors by matching two picture panoramas from different epochs.
4. The depth photos are used to calculate the third dimension of the vector points.
5. For statistically confirmed findings, do a geodetic deformation study.

A contemporary total station, as described in Section 2, is used to collect all of the data. Since all of the data is recorded in the same coordinate frame, a sufficient calibration may be achieved by employing a single device. An inbuilt dual axis inclinometer constantly checks and recalculates the station's stability. The angular values of contemporary instruments are automatically adjusted to compensate for slight tilts. The picture orientations must also be taken into account while making these changes, as previously stated (cf. Eq. 2). It is always essential to take a fresh orientation measurement whenever the instrument is tilted. An IATS offers a variety of options for solving this problem:

1. One of the most often used ways is the use of co-operative prisms in a completely automated survey.
2. Signaled passive targets, such as coded targets, may be identified using image analysis and identification algorithms. To put it a little more simply: Using natural, well-defined places as templates for future (re-)locations.
3. relative coregistrations and other point-based approaches (e.g. ICP).

ROBOTIC TOTAL STATION MEASUREMENTS

Impact of the setup point

In the age of robotic total stations (RTS), prism targets may be found and followed autonomously. Monitoring during tunnel building and assessing the stability of water dams, landslides and rock faces are among of the most typical uses of RTSs. Instruments are often kept safe from damage by being housed in a measuring chamber. [10]

Impact of the measurement path

Setup is merely one of several critical elements, as previously stated. In addition, the measuring route is a component. As a rule, geodetic measurements are done in the atmosphere. The monitoring of a rock face is used to illustrate the potential issues that might arise from inhomogeneous air conditions. In Austria, the "Biratalwand" is a cliff face that juts out into the Danube. Nearby, there are a public road and a railroad track. An automatic warning system was set up using two RTS that measured distance and angle to prims planted on the rock face at regular intervals. Only if atmospheric influences are taken into account can accurate coordinates be determined from these readings.

Impact of the target

The target is the last component that may affect the RTS measurement accuracy. Automated monitoring systems often employ prisms of different sizes and shapes as targets. So-called 360° prisms are very useful since they allow for measurements from any horizontal angle. Although 360° prisms have a systematic error pattern that considerably reduces the measuring accuracy, they are nonetheless a useful tool. A few tenths of a millimeter may be measured in an ideal condition (near orthogonal measurements to a round prism). Some millimeters of inaccuracy may be incurred by using a different prism or a less favorable orientation for the experiment.

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CONCLUSION

With total stations and laser scanners, precise measurements need a grasp of all possible error causes... In general, the three components setup point, measurement route, and goal need to be taken into account.

The instrument, the stability of the instrument support, and any necessary protective housings are all part of the setup location. Only when the sighting axis is not directly perpendicular to the glass pane should measurements be taken. There must be frequent checks to ascertain the instrument's internal tilt sensor zero point and prevent any blockages caused by the protective enclosure. In addition, the setup point's stability must be checked on a regular basis. The internal tilt sensor or external sensors may detect changes in tilt. External reference targets and GNSS sensors may detect positional changes.

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