The Automation of Deflection Measurements of Engineering Objects Employing a Physical Pendulum and One-Mage Photogrammetry

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SUMMARY

Civil structures are subject to static and dynamic loads occurring while their exploitation, caused by the influence of external factors such as sunlight, wind, rain, periodical temperature variations, or changes of hydrological and geotechnical conditions. Regarding water dams, a crucial impact on examined structures may be triggered by the changes in the reservoir impoundment level. The appearing loads initiate the occurrence of elastic or permanent deformations and displacements. In the case of high-rise objects, it can be the reason for their vertical deflecting.

One of the basic control approaches used in surveying large engineering structures - especially water dams - is the plumbing method utilizing a physical pendulum. For other objects, one can use mechanical plummets composed of a suspended wire with a weight immersed in a tank filled with a vibration-damping fluid. The plumb line is used to measure the shifts of the suspension point projected on a so-called reading table located on subsequent observation object platforms.

The achievements of precision mechanics and optoelectronics allow designing survey devices supporting geodetic control to diagnose and forecast displacements and deformations on tested objects. Modern engineering geodesy and digital photogrammetry are closely related to automated measurement technologies focused on real-time observations. Such systems aided by analytical modules triggering alerts and messages constitute structural health monitoring systems widely used in civil engineering.

The article presents the functionality of a self-developed instrument enabling automatic registration of changes in the vertical deflection of tall objects regarding their subsequent platforms without losses of measurement accuracy. The device's main measuring principle relies on the image recording of signal traces using a digital camera. The reference signals should previously be

deployed on a frame attached to the object at a given level. In contrast, the control signals are located on a target suspended on a vertical wire near the mentioned frame. The data assessment is based on processing the registered pictures featured by free inclination angles related to the reference plane using projective geometry principles applied in photogrammetry. The observation results are associated with the external XYZ Cartesian coordinate system.