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Investigation of Low-Cost Accelerometer, Terrestrial Laser Scanner and Ground-Based Radar Interferometer for Vibration Monitoring of Bridges

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Structural failures like the I-35W Mississippi River Bridge collapse on the first of August in 2007 is besides a huge economic loss often associated with personal suffering and underlines yet again how quickly existing inspection and monitoring methods may fail. Engineering geodesy has always been providing an important contribution to monitoring and deformation analysis of man-made structures. However, these geodetic approaches are restricted to a static point of view concerning the object's geometric properties. The dynamic characteristics of structures were not often taken into consideration. Admittedly vibration analysis of structures has increasingly become part of engineering geodesy and thus contributes more detailed information about the capacity and condition of e.g. bridges.

In this contribution the potential and limitations of a low-cost accelerometer sensor system and a terrestrial laser scanner (TLS) for vibration analysis will be presented in practice. Therefore a suitable sensor setup has been determined and measurements have been carried out. In addition oscillations of a bridge for reference purposes were observed with the IBIS-S system, which is based on the principle of microwave interferometry with accuracy down to the sub-millimetre and a sampling frequency of 200 Hz. This enables the possibility to determine real-time deformations of bridges.

The data of all three sensors have been analysed in terms of natural frequencies and damping coefficients using least squares adjustment. Furthermore acceleration measurements have been integrated and appropriate filters were applied to derive displacements which have been compared with those from TLS and IBIS-S. Hence this contribution provides information on which accuracies can be achieved for the derived parameters under real conditions which is fundamental for upcoming dynamic deformation analyses of structures.

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