# Spatial Approximation of Terrestrial Laser Scanner Profiles by Considering Observations with Stochastic Information

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## SUMMARY

The monitoring of structure works, as bridges, tunnels and embankment dams, is in various engineering disciplines an important task. The main goal of this monitoring includes the evaluation of their life cycle, and the developing of concepts to increase their expected life as well. The geodetic task, hereby, is to deliver independent concepts for both, the measurement metrology and evaluation methods in order to provide the deflection with or without load. Deformations in structure works, to be monitored, could be determined frequently by means of kinematic terrestrial laser scanning (k-TLS). In an interdisciplinary project between the Geodetic Institute and the Institute of Solid Construction (both at the University of Hanover), a prestressed concrete bridge has been investigated. As contactless surveying approach, the k-TLS was used to measure the deflection of the bridge construction. The deflection time series resulting from approximated laser scanner profiles are processed by means of artificial neural networks (ANN's) to provide an independent and absolute reference strain values. In further research works, the nonlinear profiles have been spatially approximated using approaches of free-form curves, B-Splines and Bézier-curves. These show much better results compared to the section vise block mean values around discrete profile positions. Statistical hypothesis tests have shown, that resulting residuals of the free-form curves approximation still contain random and systematic effects, which arise from the sensor itself, from the surface structure of the object and from the environment. In many cases, the uncertainty of output parameters is computed by assuming that the distribution function of the measurements is normally distributed with zero mean and equally weighted and stochastically independent variance-covariance-matrix. This assumption may be unjustified and the uncertainty of the output quantities (parameter and residuals) so determined may be incorrect. One tool to deal with random and systematic uncertainties of the input parameters and the resulting mixed-distribution of the output quantities is given through the Monte Carlo techniques. This study deals with two main topics: the refined simulation of different configurations by taking different covariance structures of the input parameters (2-D coordinates of TLS profile), and the statistical analysis of the resulting residuals in order to improve the physical observation models.