SAMPLING DESIGN FOR CALIBRATION OF WATER DISTRIBUTION SYSTEM MODELS BY GENETIC ALGORITHMS

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The paper discusses sampling design for parameter calibration of water distribution system hydraulic models. Sampling design is closely related to the procedure of model calibration and both belong to a broad area of modelling, optimisation and use of hydraulic models for various needs. Calibration of hydraulic models is a procedure of determining individual unknown parameters of a hydraulic model, which minimises the differences between the measurements performed on a real water distribution system (WDS) and the results of the hydraulic model. To provide both quantity and quality of measurements, which have a great impact on model parameter accuracy, sampling design for calibration of hydraulic model parameters needs to be applied.

The main emphasis of sampling design optimisation is focused on the determination of optimal measurement points, where hydraulic quantities are to be observed. The sampling design problem consists of two normalised objective functions. The first objective function is used to increase the calibration parameter accuracy using the so-called D-optimality criterion, and the second one is used to reduce the number of necessary measurement points. Since the above-mentioned objectives are mutually contradictory, a solution has to be found which will to the largest extent possible satisfy both objectives.

The paper presents solving of the optimisation problem by using genetic algorithms (GA). The main objective was to develop a tool, i.e. a computer model for decision making support. The optimisation problem formulation for sampling design consists of two normalized objective functions to be maximized. A comparison of obtained results and verification of the model were carried out on a hydraulic model of a theoretical WDS of Anytown. The comparison to results of other authors demonstrated a high level of accordance with regard to the methods taking into account the correlation between individual coefficients of the sensitivity matrix.

Afterwards a sampling design analysis was carried out on a real life WDS of the town Sežana. The aim of the analysis was to find an optimal set of measurement locations on the WDS to collect quality measurements for the identification of calibration parameters. The application was performed to identify pressure measurement locations for calibration of pipe roughness values under independent multiple fire flow loading conditions, i.e. hydrant flushing, using GA. The used methodology and the use of GA as a search engine brought good results in the highly combinational problem of identifying optimal measurement locations on a water distribution system. The result of such a search process is a diagram of calibration parameter accuracy against the number of measurement points

and is shown Figure 1. From Figure 1 it was decided that a placement of 13 measurement locations throughout the WDS would be appropriate according to added accuracy of additional measurement points and would lead to a calibration parameter accuracy of 0.646. The relevant measurement locations are provided by the GA solution for 13 measurement points with their node indexes.

It can be concluded that the sampling design model was successfully applied to the real life WDS of Sežana and optimal measurement locations for the defined sampling design problem were identified. The GA sampling design model was found to be a helpful tool to identify and optimize the expensive data collection process for WDS model calibration.

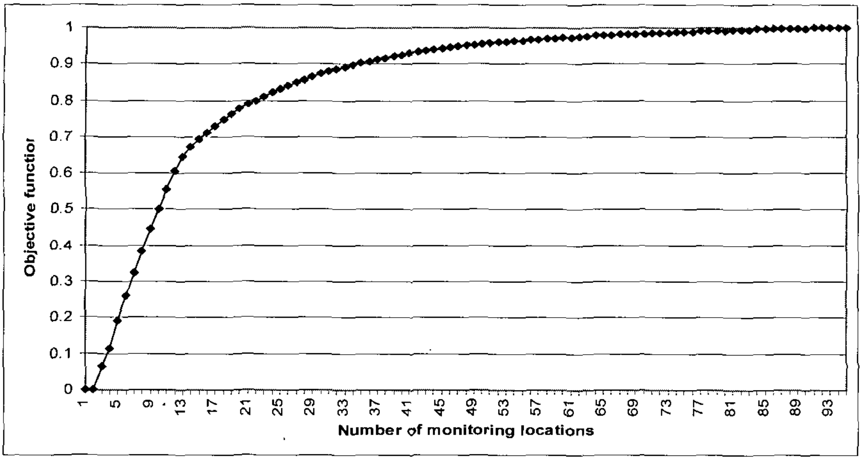

Fig. 1 Objective function of calibration parameter accuracy vs. number of measurement points for decision support on the sampling design problem

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