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Robust uncertainty evaluation for system identification on distributed wireless platforms

Antoine Crinière (1), Michael Döhler (1), Vincent Le Cam (1,2), and Laurent Mevel (1)

(1) INRIA, I4S, Rennes, France (antoine.criniere@inria.fr), (2) LUNAM Université, IFSTTAR, COSYS, SII, F-44340 Bouguenais, France

Health monitoring of civil structures by system identification procedures from automatic control is now accepted as a valid approach. These methods provide frequencies and modeshapes from the structure over time. For a continuous monitoring the excitation of a structure is usually ambient, thus unknown and assumed to be noise. Hence, all estimates from the vibration measurements are realizations of random variables with inherent uncertainty due to (unknown) process and measurement noise and finite data length. The underlying algorithms are usually running under Matlab under the assumption of large memory pool and considerable computational power. Even under these premises, computational and memory usage are heavy and not realistic for being embedded in on-site sensor platforms such as the PEGASE platform. Moreover, the current push for distributed wireless systems calls for algorithmic adaptation for lowering data exchanges and maximizing local processing. Finally, the recent breakthrough in system identification allows us to process both frequency information and its related uncertainty together from one and only one data sequence, at the expense of computational and memory explosion that require even more careful attention than before. The current approach will focus on presenting a system identification procedure called multi-setup subspace identification that allows to process both frequencies and their related variances from a set of interconnected wireless systems with all computation running locally within the limited memory pool of each system before being merged on a host supervisor. Careful attention will be given to data exchanges and I/O satisfying OGC standards, as well as minimizing memory footprints and maximizing computational efficiency. Those systems are built in a way of autonomous operations on field and could be later included in a wide distributed architecture such as the Cloud2SM project.
The usefulness of these strategies is illustrated on data from a progressive damage action on a prestressed concrete bridge.

References

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