DICCA SEMINARS

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Location: A7 (Villa Cambiaso)

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Combining measurements and models for virtual sensing of civil engineering structures (Geert Lombaert and Kristof Maes)

Developments in computational power and simulation tools have enabled us to build detailed computational models that closely mimic the behavior of real structures. At the same time, developments in sensor technology, data acquisition and data transfer allow us to observe structures in a more detailed and comprehensive way than we imagined twenty years ago. The level of detail that is reached in simulation as well as in our capturing of reality through monitoring naturally calls for a fusion of experimental data and numerical simulations. This idea also underlies the so-called digital twin of a structure, a simulation model fed by sensor data that reproduces the actual behavior of the structure and evolves with the structure throughout its lifetime. In this presentation, we will discuss the fusion of experimental data and numerical simulations within the framework of the Kalman filter. This framework was originally developed for linear time-invariant systems with known input. Data and simulations are fused in a way which is consistent with observational as well as modelling uncertainties. Since its original development, it has been applied to a wide variety of problems in many different fields and areas of application. We will illustrate its application for virtual sensing of civil engineering structures and discuss recent extensions for systems with unknown input and time-variant systems. These developments are crucial for applications in civil engineering, where it is hard to directly measure loads, where systems evolve in time (e.g. due to environmental conditions), and where components may show nonlinear behavior or even switch from one regime to another (e.g. stick-slip). It will be shown how such combined state, input, and parameter estimation can be used for monitoring of civil engineering structures and indicate challenges in the application of these methods.

Short bio:

Geert Lombaert is full professor at the Department of Civil Engineering of KU Leuven in Belgium. He obtained his master and PhD degree in 1998 and 2001 from KU Leuven. He was postdoctoral researcher at Ecole Centrale de Paris in 2003 and visiting scholar at the University of California, San Diego in 2008. He became associate professor in 2009, and is since 2017 full professor. His main research interests are structural dynamics, environmental ground vibration, uncertainty quantification and probabilistic mechanics, structural health monitoring, input, state & parameter estimation, human induced vibration, and structural optimization.

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