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Titel des Beitrags: A framework for DSM-based pre-modelling analysis of complex systems

Abstract: In complex engineered systems/processes already small variances can lead to unexpected or even unstable behaviour. Hence, it is of vital importance to get knowledge about the dynamics, stability behaviour and robustness of such systems. However, exclusively trusting simulations can result in drawing false cause-and-effect-conclusions (Coyle, 2000). Due to that, structured modelling is gaining importance, because it allows a well-directed combination of simulations and theoretical analyses (Sterman, 2000). The DSM (Design Structure Matrix) is a recent decomposition principle for complex systems or processes. It displays the interacting elements of a system by marks (e.g. “X”) and allows an easy detection of decoupled process cycles. Therefore, the DSM is a simple but powerful graphical representation of a system, allowing structural analyses with a minimum of knowledge (Browning, 1998, Danilovic and Björesson, 2001), which makes it expedient to be included in a structured modelling strategy. This is for example done in (D'Avion et al., 2005), where a combined approach of the famous modelling method System Dynamics (Forrester, 1976) and the DSM is shown, with the aim of gaining knowledge about the
system’s uncertainties, which were incorporated into the DSM using well-chosen coefficients. In (Diepold et al., 2009), a structured process modelling approach by extending the DSM to a DynS-DSM (Dynamical System Design Structure Matrix) is described. The properties of the DSM are thereby used during the whole modelling procedure, which results in a discrete dynamical representation of the system’s significant cycles. The presented approach allows a direct transferability of structural analyses/changes onto the dynamics. Thereby, coefficients are used to handle the occurrence of relationships. In fact, incorporating coefficients into the DSM for modelling is common in the literature, but appointing them in a structured way is up to the author’s knowledge still an open problem. Additionally, they were not used until know in the pre-modelling phase, which consists of adjusting the model’s size and the reachable pattern quality. In this paper, a framework is introduced for a structured determination of those coefficients. The framework allows a variation of the analysis focus by the experts, in order to consider changing environmental or economical conditions. Based on the determined coefficients, a pre-modelling system order reduction to significant process parts is done as well as an error estimation of the reachable pattern quality. Thus, the framework acts as a link between structural analyses and mathematical modelling. In the following section the concept of the framework is expressed step-bystep. Significant steps are explained together with one possibility of their implementation, while further implementation possibilities as well as a full application example are given in the conference slides. In the final two steps the resulting benefits for the actual system’s modelling are shown.

Stichworte:
DSM; process/system; knowledge-based dynamical modelling; complexity management

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