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Research area: Process aims
Process measuring and control technology

Key words:
Data-based modelling, process optimization, process data extraction, data coupler

TITLE:

Process oriented extraction and preparation of production data as basis for model-based improvements of complex procedural processes using the example of paper production

Background/Problem area

Mathematical modelling is a fundamental method for revealing and invoking the optimization potentials of procedural production processes. This technique is amongst others applied to simulations of cause-and-effect chains, forecasting, model-based controls and soft sensors. The workflow of mathematical modelling typically consists of

1. Determining target and cause variables,
2. Extraction of data base from a real process (extraction and processing of raw data),
3. Modelling and model validation,
4. Offline and/or online application of the model.

The various characteristics of mathematical modelling are scientifically well-proven. Nevertheless, just a few factory installations have been realized so far. Major reason for sporadic application is the complexity of the procedure that is necessary to gain usable data out of the process. Often it is this complexity and the expected initial investment in this context that prevents the realization of promising optimization projects in smaller and medium-sized business. The operating expense is caused by the following currently existing shortcomings:

- Time-consuming procedure to determine target and cause variables since the operational background that is necessary for this purpose is undocumented and distributed to different staff members. Thus, operational background is not available transparently to project participants.
- Real time series data is subject to various quality reducing effects such as process noise, atypical process states, sensor failure, data handling errors or outlier. The subsequent data processing is costly and time consuming.
- In general, a multitude of heterogeneous data sources exist. As a consequence, the data is provided in different dimensions and different chronological resolutions. This makes it difficult to perform a correlated analysis.

Objectives/Research results

Within modelling projects so far, the process of data pre-processing was often underestimated concerning its need and effort. Lack of methods and tools for data extraction usually caused substantial and incalculable costs in advance of data collection for the purpose of modelling. The current research project, which is realized in collaboration with LeiKon GmbH, a company with high expertise in process control engineering, started at the weak point in the process of generating data-based models: the low-effort data extraction from the real process. The project partners aimed to develop methods and tools of data extraction that significantly increase the efficiency of the total development of model applications. One outcome of the research project is a novel methodology for systematically and effectively determining all target and cause variables of model-based applications that are necessary for data extraction and data processing. The starting point of this methodology was a formal description of the phase model of a production. The phase model is a graphical representation of a production process that allows for precise specification of relevant variables including their characteristics of validity. A pilot application was selected and its production process has been captured in a phase model together with all the necessary target and cause variables. The essential result of the research project is a generic data coupler that provides data pre-processing methods online, i.e. the pre-processing methods are available already during data extraction. For this, the data coupler takes into account the specifications of target and cause variables that were captured in the phase model. Thus, in customer projects the data coupler will be able to provide, as an immediate result of a coupling process, pre-processed data that can be used directly for modelling or for applications of model-based processes. Moreover, model-based applications that require online extracted data such as soft sensors or model-predictive controls can be operated more robustly. The design and development of methodology and data coupler have been realized and verified in the context of a pilot application. Experiences obtained here have been iteratively included in the development work.

Application/Economic benefits

It is assumed to have eliminated or at least significantly reduced a major hurdle for the use of model-based applications in industry. We know from experience that the process of extracting data for projects with 50-100 measurement points currently requires about 1-2 weeks; this corresponds to about 30% of total expenditure. This period should now be reduced to 1-2 days. The project addresses explicitly and for the first time this step of the modelling and develops a practical solution. Hence, analysis and optimization projects that include model-based applications become economically attractive for operators of process plants. Using the example of the pilot application, the development results and their benefits have been validated.

Project period: 01.09.2009 – 31.08.2011

Remarks

The research project ZIM-KF 2037905KM9 is being funded by the German Federal Ministry of Economics and Technology BMWi and is carried out in collaboration with LeiKon GmbH, Herzogenrath.