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Virtual preparation and commissioning of production systems including PLC-logic

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Vehicle manufacturing companies are today forced to handle and respond to a rapidly growing variety of vehicles, due to the environmental restriction on energy consumption and CO2 emissions. An additional requirement is also that these new innovative and environmentally friendly products are produced in already existing factories. A clear trend today is also that production volume has to be changed with short notice to meet market changes. Today's manufacturing systems therefore have to be both energy- and time efficient, safe, as well as flexible to manage this complexity. The challenge is to reduce the production preparation time by bringing together mechanical and electrical engineers into a common virtual environment achieving a more efficient cooperation, enabling automatic generation of verified control programs. Another challenge is reducing energy consumption by embedding detailed robot energy optimization into early scheduling. A third challenge is to increase production efficiency, increase human and machine safety and decrease the number of discarded parts by performing virtual commissioning of entire manufacturing stations, including complete robot programs, control logic and safety equipment including HMIs. A required step in order to handle the above described problems is to extend early process design and mechanical simulation with control logics to ensure an intended behavior. It has been shown that possible savings could be achieved if PLC programming and optimization is included in earlier production preparation phases together with new functionality based on formal methods.

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Statistical process monitoring and neural networks for early leak detection in a pipeline system of a steam boiler

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The paper presents the comparison between two approaches to detection of leakages in the pipeline system of a steam boiler, which works in a thermal-electrical power plant in Bialystok. The first methodology employs the Principal Component Decomposition (PCA) of a segment of real data, which contain historical measurements of 12 selected process variables. The second approach utilizes specific architectures of Artificial Neural Networks (ANN): Feed forward Multilayer Perceptron (MLP) and Learning Vector Quantization (LVQ) structures. Both methods belong to a class of data-driven approaches, as due to technical and economic limitations building a model of the plant is not feasible. The goal of our studies was to detect the symptoms of arising leak as early as possible, to warn the process operator and allow him to perform any planned actions, instead of an emergency shutdown of a boiler. The segment of historical data from normal plant operation was used to create the PCA model of a 'healthy' system in a reduced space of three principal components. The length of the segment and time delay (in reference to the current time moment) of data employed for model development, were determined experimentally. The PCA model, periodically updated, was used to establish the confidence ellipsoid, i.e. the feasible area occupied by the process variables of the 'healthy' system in PC coordinates. Similarly, selected and verified historical data segments, which represented both normal and faulty conditions, were used for the ANN training. Then the trained networks were used to classify current data segment as 'normal' or 'faulty'. In the series of numerical experiments we confirmed the ability of the above methods to detect leakages 4-5 days before the shutdown.

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