International Journal of Innovative Computing, Information and Control
Volume **7**, Number **7(B)**, July **2011**

ICIC International ©2011 ISSN 1349-4198
pp. 4139–4148

CONTEXT-KSVM-PLS BASED RUN-TO-RUN CONTROL FOR NONLINEAR MIMO PROCESSES

Junghui Chen, Kai-Yuan Liu and Jose Munoz

R&D Center for Membrane Technology
Department of Chemical Engineering
Chung-Yuan Christian University
No. 200, Chung Pei Road, Chung-Li 32023, Taiwan
jason@wavenet.cycu.edu.tw

Received April 2010; revised December 2010

Abstract. *In the past, most research studies on multi-tool and multi-product (MTMP) processes were focused on linear single-input, single-output (SISO) systems. In this paper, a novel run-to-run control methodology is developed for nonlinear multiple-input-multiple-output (MIMO) MTMP semiconductor processes. The methodology is based on the integration of two methods: the kernel support vector machine (KSVM) and the partial least squares (PLS). PLS is used to transform the original variables to latent variables and the use of KSVM is to relate one latent input variable to one latent output variable. The nonlinear relationship of input and output variables is obtained by mapping the latent variables using a kernel function into a feature space where linear regression is done. In the proposed methodology, referred to as kernel support vector machine and partial least squares (KSVM-PLS) algorithm, a control law is derived for each pair of latent input and output variables. To demonstrate the effectiveness of the KSVM-PLS method, it is applied to a chemical-mechanical polishing process in semiconductor manufacturing.*
Keywords: Kernel support vector machines, Partial least squares, Run-to-run control

1. **Introduction.** In recent years, both academia and the semiconductor manufacturing industry had a strong interest in the development and applications of run-to-run (RtR) feedback control [1-3]. RtR, a model-based control method, is used to get optimal values of the control inputs for the next run so as to keep quality variables close to design specifications. RtR utilizes a model that is determined from known control inputs and ex-situ measurements of the past runs. The usefulness of a process model for a particular control thread is limited since the results are valid only when a specific tool is used to produce a specific product. In multi-tool and multi-product (MTMP) processes, the number of control threads can be very large because of the use of many tools and the production of several different products. The volume of production of different products is highly uneven. Some products are produced in large quantities and many production runs are required while the other products, called low-runner products, are produced in small quantities and only a few production runs are needed. In such a "high mix" production setting, a model built for control threads of low runner products will not be accurate due to inadequate input-output data. A general model should allow sharing of information among different control threads so that the relevant parameters of the model, such as the tool specific constants and the product specific constants, can be determined [4-7]. The studies on non-threaded modeling and control of MTMP processes assume that the process model is SISO and linear. To date, no studies related to non-threaded modeling and control of MIMO MTMP nonlinear processes have been undertaken.