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Abstract
In the semiconductor manufacturing, process wear-out or process drifting often exists. Traditionally, double Exponentially Weighted Moving Average (d-EWMA) controller is adopted to compensate for such a process, in order for the process output to reach its target value in a small number of runs and also to have a small process variance. The effectiveness of the d-EWMA controller depends heavily on the selection of its two weight parameters (named “discount factors”). Choosing small values of discount factors for a double EWMA controller minimizes long-run process variability and provides process stability, but it results in pronounced transient process effect. It generally requires a large number of runs to bring the process output to the target value. On the contrary, choosing large values of discount factors reduces transient process effect, but it causes large long-run process variability. To avoid unexpected shift or drift, it has been shown in the recent literature that online tuning discount factors dynamically is superior to using fixed discount factors.

In this thesis, three adaptive d-EWMA controllers in the literature are studied and compared. These three controllers are The STDF Controller (which adjusts the first discount factor according to the process output deviation at each run), The VSLMS Controller (which adjusts both discount factors using a “variable step-size least-mean-square (VSLMS) algorithm”) and The Time-varying Controller (which gradually reduces the second discount factor with time). An extensive Monte Carlo simulation work is carried out to study and compare the efficiency and robustness of the controllers. We consider process models, such as Deterministic Trend (DT) model and Integrated Moving Average (IMA (1, 1)) disturbance model, for the study of efficiency, and consider parameter miss-estimation or disturbance model misspecification for the study of robustness. In addition, a modified Time-varying Controller, named The Modified Time-varying Controller, is proposed to improve the efficiency of the Time-varying Controller under the IMA(1,1) disturbance model. Values of the controller factors needed for applying the Modified Time-varying Controller are also provided. Programming languages S-PLUS and C++ are used for all our simulation work.

For the DT model, the Time-varying Controller has shown to be the most efficient controller, while the STDF Controller is the most robust controller among the three controllers. Concerning a good balance between efficiency and robustness, the STDF Controller is suggested under the DT model. For the IMA(1,1) disturbance model, the Modified Time-varying Controller is the best controller among the four controllers in terms of both efficiency and robustness.
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