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Abstract
In the semiconductor manufacturing, process shift or drift often exists. The double exponentially weighted moving average (d-EWMA) controller has shown to be able to compensate for such processes much more effectively than the single EWMA (s-EWMA) controller. The effectiveness of a EWMA controller depends heavily on the selection of its weight parameter(s), called “discount factor(s)”. It has also been shown in the recent literature that online tuning discount factor(s) dynamically is superior to using fixed discount factor(s) for processes with sudden shift or unexpected drift.
In this research, two Gradual Change (GC) variable EWMA control schemes in the literature are of our particular interest, including the Modified Gradual Change d-EWMA (MGC) controller and the Modified Variable s-EWMA (MVEWMA) controller. The common characteristic of both controllers is to gradually reduce one discount factor with time (while holding the other discount factor fixed for the MGC controller). The efficiency of the MGC controller has been established, but its application is limited to the simplest linear drifting model with white noise disturbance (referred to as the deterministic trend, DT, model.) The MVEWMA controller improves the inefficient problem of the s-EWMA control scheme for controlling drifted processes by adding a compensation constant to the Variable s-EWMA (VEWMA) controller, but its performance depends on the estimation of the drifting speed.
The aim of this research is to extend the application of the MGC controller from the DT model to the more general ARIMA(p, d, q) disturbance models. An explicit expression for the process output is established; following that, the transient behavior and the asymptotic stability condition of a MGC controller can then be addressed analytically. The efficiency of the MGC controller under the ARIMA(p, d, q) disturbance models is compared to the MVEWMA controller. The robustness of the MGC controller is evaluated via the comparison with a nonparametric based self-tuning discount factor (STDF) d-EWMA controller (which online tunes the first discount factor based on the ratio of adjacent process output deviations at each run and therefore requires no distributional assumption about the disturbance model).
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