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# Phase I Monitoring of Between-Profile Autocorrelated Simple Linear Profiles

**Yihua Wang**
Department of Industrial Engineering and Management, National Yunlin University of Science and Technology
123, Section 3, University Road, Douliu City, Yunlin County, Taiwan
wangyi@yuntech.edu.tw

## Extended Abstract

The quality of a product or process is determined by a specific functional relationship between the response variables and the explanatory variables, which is referred to as a profile. Profile monitoring is used to detect changes in this functional relationship. If the functional relationship changes, it indicates that the process quality is out of control. Currently, studies on the correlation among linear profile data focus primarily on monitoring methods in Phase II, while no research has been conducted on between-profile correlated linear profile data in Phase I. To fill this gap, this study proposes a maximum likelihood ratio method for Phase I simple linear profile data exhibiting first-order between-profile autocorrelation. Numerical solutions are employed to estimate the model parameters. The study examines step shifts in profile parameters, including the intercept, slope, and standard deviation of the error term. To assess the method's effectiveness, the probability of signal is used to evaluate its ability to detect out-of-control data under varying conditions of autocorrelation, shift magnitudes, and change points.

Monte Carlo simulation results show that the proposed method performs effectively for moderate to large shifts, particularly when the change point is located at the midpoint of the data, where the in-control and out-of-control states are evenly distributed. Overall, when the intercept and slope change separately, the proposed method performs best when the autocorrelation coefficient $\phi = 0.1$, followed by $\phi = 0.9$, while the out-of-control signal probability is the lowest when $\phi = 0.5$. Considering changes in the standard deviation, the out-of-control signal probabilities are similar for $\phi = 0.1$ and $\phi = 0.5$, while for $\phi = 0.9$, the out-of-control signal probability is slightly lower.

The proposed method considers separate changes in the intercept and slope. When the autocorrelation coefficient is $\phi = 0.1$, 0.5, and 0.9, with change magnitudes of at least 2.0, 3.0, and 2.5, respectively, at change points $\tau = 15$ and 20, the out-of-control signal probability reaches 70–80%. When considering standard deviation changes, regardless of the autocorrelation coefficient, and with change magnitudes of at least 1.8, the out-of-control signal probability generally exceeds 80% at change points $\tau = 15, 20,$ and 25, demonstrating good performance.

## References

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