Image-Based Condition Monitoring Using Change-Point Spatio-Temporal Process (CP-STP)

Suk Joo Bae[1], Munwon Lim[1]

[1]Department of Industrial Engineering, Hanyang University, Republic of Korea

With the emergence of smart factory technology, data-driven condition-based maintenance (CBM) has been developed to automate production process control within the engineering sector. CBM typically centers on diagnosing production statuses by utilizing real-time data from sensors. In general manufacturing field, the performance of production equipment gradually diminishes due to wear and equipment deterioration. To ascertain whether the process remains under control, we perform degradation modeling on the observed data from the equipment and engage in statistical inference. Within the modeling process, it is essential to describe changing degradation patterns and differentiate between normal and abnormal conditions promptly to avert failures. Consequently, it becomes necessary to detect the transition time to abnormality and establish multi-phase modeling based on these temporal points. In our research, we propose an image-based degradation modeling and change-point detection approach using a spatio-temporal process (CP-STP). This method enables us to articulate deteriorating patterns in image observations by considering spatial and temporal relationships. Simultaneously, we estimate change-points (CPs) to distinguish degradation under normal and abnormal production statuses with the appropriate number of CPs. To enhance the precision of parameter estimation, we employ the Markov chain Monte Carlo (MCMC) sampling method. Grounded in the Bayesian approach, we conduct posterior calculations by combining prior parameter distributions and likelihood functions. Through the application to real industrial image streams, our proposed monitoring scheme efficiently provides a bi-phase representation, delivering valuable insights into the manufacturing process's change-points.