REAL-TIME DATA-DRIVEN AND MULTI-SCALE MODEL-GUIDED SYSTEM FOR BIOPROCESS DIGITAL TWIN PLATFORM

Dong-Yup Lee, School of Chemical Engineering, Sungkyunkwan University, Suwon-si, Republic of Korea
dongyuplee@skku.edu
Seo-Young Park, School of Chemical Engineering, Sungkyunkwan University, Suwon-si, Republic of Korea
Dong-Hyuk Choi, School of Chemical Engineering, Sungkyunkwan University, Suwon-si, Republic of Korea
Cheol-Hwan Park, School of Chemical Engineering, Sungkyunkwan University, Suwon-si, Republic of Korea
Sun-Jong Kim, School of Chemical Engineering, Sungkyunkwan University, Suwon-si, Republic of Korea
Jinsung Song, School of Chemical Engineering, Sungkyunkwan University, Suwon-si, Republic of Korea

Key Words: Bioprocess digital twin, Real-time data, Machine learning, Genome scale metabolic model

Digital twin (DT) has become a rapidly expanding approach in various manufacturing fields including biologics industry. Basically, bioprocess DT combines physical system and its complementing digital counterpart via real-time monitoring and data collection, thus enabling their interactive communications for enhancing operational efficiency and reliable product supply of biomanufacturing processes (Figure 1). DT can be realized through developments and applications of emerging technologies in advanced soft-sensor, data management, advanced data analytics with artificial intelligence (AI) and mechanistic models representing the cells and bioreactor for virtually mirroring their behaviors under adjustable process conditions. In this work, we established and developed key components of virtual part within the bioprocess DT platform. They include machine/deep learning algorithms for forecasting multi-step ahead profiles of cell culture performance, and genome-based mechanistic model of industrially relevant Chinese hamster ovary (CHO) cells for real-time simulations. Both components can be hybridized to describe their dynamic cellular behaviors and metabolic states given culture conditions, thus allowing us to effectively identify process bottlenecks and key engineering targets, suggest various control strategies to improve reliability, efficiency and efficacy of intricate bioprocess operations. [The research was supported by the Korea Innovation Foundation grant (2021-DD-UP-0369) funded by Ministry of Science and ICT, and the National Research Foundation of Korea (NRF) grant (No. 2022R1A4A5032720) funded by MSIT.]

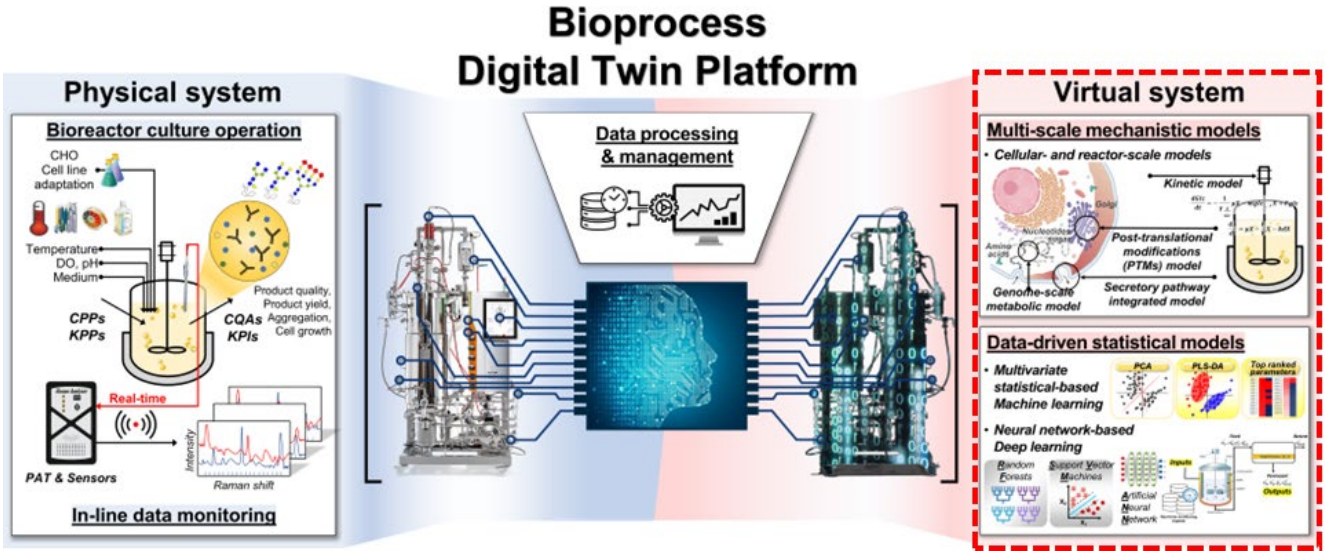

Figure 1 – Bioprocess digital twin platform consists physical and virtual systems. Given digitalized real-time culture profiles from In-line monitoring system, data-driven statistical model and genome-based mechanistic model can be combined to mirror and forecast the cellular behaviors and metabolic states of CHO cells (Ref: S.-Y. Park, C.-H. Park, D.-H. Choi, J. K. Hong and D.-Y. Lee, 2021. Curr. Opin. Chem. Eng. 33, 100702).