Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Feng Ju

Feifan Wang

Contact

Physical Sciences Team

Simulation-based Real-time Production Control

In many production systems like semiconductor manufacturing, food industry, and battery production, the amount of time a part can spend in successive buffers is limited in many production systems because of possible quality concerns. If a part's residence time exceeds these limits, it must be trashed, which results in waste and lost output. To prevent excessive residence durations and maximize output rate while decreasing scrap rate, machine operations must be dynamically controlled based on the status of the system in real time. However, lengthier multi-machine lines with different residence time restriction structures are too complicated for the control schemes now in use to handle efficiently.

Researchers at Arizona State University have developed a simulation-based real-time control approach to address residence time constraints in production systems. They have categorized residence time constraints into four basic classes - single buffer, nested segments, non-nested overlapping segments, and non-adjacent segments, covering a wide range of constraint scenarios observed in practice. The goal of the control challenge is to identify the best machine control actions that maximize production rate and reduce scrap rate.

This system uses a Markov Decision Process (MDP). Due to residence time limits, a feature-based approximate architecture and feature extraction technique are presented to handle the huge state space. During the training phase, simulation is used to estimate the parameters of the feature approximation architecture, which essentially approximates the MDP model's value function. The estimated parameters constitute the taught control policy, allowing for effective real-time execution by recommending the best machine actions based on the condition of the system at that moment. Factories may increase output dramatically, save money, and improve efficiency by optimizing machine operation and avoiding waste.

Related publication: Simulation-based Real-time Production Control with Different Classes of Residence Time Constraints

Potential Applications:

- Semiconductor manufacturing
- Food production
- Battery manufacturing

Benefits and Advantages:

- Improves productions and efficiency
- Reduces waste and cost
- Data-driven