Team uses Petri nets to solve automation problems

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An expert in robotics and automation problems, especially those involving manufacturing systems, NJIT Distinguished Professor and IEEE Fellow Mengchu Zhou will have two articles published in the upcoming proceedings of the 2013 IEEE International Conference on Robotics and Automation. Both papers were recently presented at this conference.

"Novel Method to Simplify Supervisor for AMS Based on Petri Nets and Inequality Analysis" offers a better and more efficient way to help managers control a computer-controlled manufacturing system by using mathematical modeling tools, known as Petri nets.

"In the framework of automated manufacturing systems (AMS), Petri nets are widely used to model, analyze and control them," Zhou said. But when it comes to resolving deadlocks, which can be of paramount importance for keeping the system running, the emergence of such deadlocks can reduce the system throughput to nothing.

Most automated systems use computerized supervision to resolve such problems. But Zhou's paper proposes a new and better way.

A control policy can be converted into satisfyinga set of inequalities, each of which corresponds to a siphon in a Petri net structure. In the worst case scenarios, the number of siphons can be exponential as will the number of inequalities. Taking into account the independent and dependent inequalities, Zhou and his research team suggest removing the

dependent inequalities while preserving only independent ones. This method can significantly reduce the time spent by the computerized supervisory control system. The article provides examples to illustrate the effectiveness and efficiency of this method.

"Scheduling of Single-Arm Multi-Cluster Tools to Achieve the Minimum Cycle Time," proposes a new and highly-efficient and much needed algorithm to compute for an entire multi-cluster tool. Such tools have been widely used in semiconductor wafer fabrications leading to various chips used in computers, cell phones and other electronic products. Maximizing the throughput of a multi-cluster tool means huge economic benefits to semiconductor manufacturers.

Zhou and the researchers have suggested a one-wafer optimal periodic schedule and discovered that the key to such scheduling is robot waiting times. They developed a resource-oriented Petri net model such that the robot waiting times are well modeled. Based on their model, optimal conditions were derived and the scheduling problem was reduced to determining robot waiting times. By the derived conditions, an optimal one-wafer optimal periodic schedule for a multi-cluster tool can be obtained by scheduling its individual cluster tools one by one.

Zhou recently received an IEEE distinguished service award from the robotics and automation division for his dedicated work since 1988. Such efforts included establishing the IEEE Transactions on Automation Science and Engineering as well as conferences. He's been a stalwart proponent, too, of the latest thinking and research in automation in logistics; agricultural robotics and automation; smart buildings; and sustainable production automation.

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