THESIS PROPOSAL

Title

Energy Efficient Control Policies for Smart Manufacturing Systems

Main topic

Manufacturing industries have always focused on productivity improvement and quality achievement, but, in the last years, the environmental impact becomes critical as well. In the case of machines executing machining operation, the control of machine states is one of the most promising measures at machine level. This measure aims to reduce the energy demanded when the machines are idle by using start/stop features such that the machine is switched off/on according to certain rules. By triggering the resource into a low-power standby state, it is possible to reduce up to 80% of the typical consumption of the machine in non-productive phases. To restore the productivity of the machine tool you may need a warm-up / start-up switch, therefore the power-on / ignition switches must be properly handled. Critical barriers for a practical implementation are usually related to system productivity, therefore, any new solutions must keep high the production performance and, at the same time, improve system sustainability. Also, production systems might face changes during their use phase, e.g., changes in production, changes in production planning, etc. Therefore, system characteristics may change and the control policy implemented at machine should adapt itself to the new environment conditions. Also, as system complexity increases, the control might become complex and the optimization of control parameters is challenging, above all when information at machine level are limited and the time to solve the problem on hand is strict. As a consequence, time-based and buffer-based policies are effective but they might be myopic when system complexity increases.

Thesis works aim to analyze **energy-efficient control policies based on the real system state** and applied at machines in complex production systems. Mainly, the optimization problem on hand is to minimize the energy consumed per part while assuring a certain target throughput. **New policies** might be proposed and evaluated in terms of potentialities. The problem will be formulated in a **stochastic programming framework** and solved using **simulation-optimization methods**. **Discrete Event Simulation models** will be used to represent the problem. Test cases or realistic data collected from industries will be used to validate the developed solutions. Numerical cases are used to represent a variety of production systems so that numerical experiments within the thesis allow **to provide useful insights for the energy management of manufacturing systems.**

Main steps of thesis development

1. Identification of the related literature and review;
2. Problem description & formulation;
3. Solution method;
4. Validation and evaluation based on data (simulated data or real data);
5. Analysis of the results and findings.

Skill required: General purpose programming language, discrete event simulation (DES).

Candidate to 7-point thesis: YES

Effort estimation: 6-months full-time (commonly 9/12 months including 2nd semester exams).