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SOFTWARE-IN-THE-LOOP TECHNIQUE: AN APPROACH TO SUPPORT RECONFIGURATION OF MANUFACTURING SYSTEM

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ABSTRACT

Reconfiguration is one of the demands in most of manufacturing industries in order to support unpredictable global business market and to fulfill the various types of customer needs. A virtual commissioning is used as a tool to verify the control system in a simulation environment before the real system is developed. One of the techniques in virtual commissioning is Software-in-the-Loop (SIL). The benefits of SIL technique is it can estimate the real state of control system during the simulation stage. This paper presents the understanding of the SIL technique by using an implementation of the simulation based control system to support the reconfiguration of a manufacturing system. The result of the demonstration shows that the SIL technique has a potential to be used as a tool to configure the reconfiguration of the manufacturing system eventough the reaction time is slightly longer compared to the system simulation.

Keywords: software-in-the-loop, simulation, reconfiguration, manufacturing, system.

INTRODUCTION

Nowadays, manufacturing industry is one of important industry and made a large influence in country's economic growth. It is now moving forwards to adopt the reconfigurable manufacturing system for their production lines in order to support the rapid changes market due to globalization. According to UNIDO (2012), the growth of the manufacturing output is increase about 30% with fluctuation of the growth rate between -10% to 5%. This statistic has proved that manufacturing industries cannot depend on the steady market demand any longer.

For the solution of the problem, a new system needs to be designed in order to respond a sudden change of the market requirements. At the level of the industry's shop floor, this translates to industrial automation and control systems that quickly respond to change while maintaining stable and efficient operation. Given the high degree of automation in modern manufacturing systems, industrial automation and control systems have become central to factories' responsiveness, and arguably the key to competitiveness.

However, the technology e.g. advanced robotics and computer numerical control that has promised to improve competitiveness has also increased the complexity of this problem: modern industrial systems are by nature, distributed, concurrent and stochastic. The result is often a collection of 'islands of automation' that lack the necessary integration for truly responsive behavior. Without adequate control, these systems can display a 'fragility' that is disastrous in the unpredictability modern shop floor environment.

Many researchers have identified the necessity to develop novel manufacturing paradigms in order to achieve these requirements. The quasi-standard of rigid, hierarchical control architectures in today's industry has been unable to cope with the new challenges successfully, since the production schedules and plans are known to become ineffective after a short time on the shop floor. Established production planning and control systems are therefore vulnerable to abrupt changes and unforeseen events in production processes and do not allow a real-time computation of sophisticated decision models (Scholz-Reiter and Freitag, 2007) (Monostori *et al*., 2006) (Valckenaers and Van Brussel, 2005) (Koren *et al*., 1999).

Reconfiguration concept has been introduced in order to support this unpredictable market changes. Reconfiguration of manufacturing system allows changeable functionality and scalable capacity (Koren, 2006) by physically changing the components of the system through adding, removing or modifying machine modules, machines, cells, material handling units and/or complete lines. Most of manufacturing companies realize about the important of the reconfiguration, however Automated manufacturing systems are still not able to cope with unexpected events and situations adequately. Therefore It is therefore necessary to combine the advantages of automated systems and information communication technology (ICT) with the cognitive capabilities of common human workers.

Support by the improvement in ICT, simulation is increasingly used in every phase of the manufacturing system life cycle (VDI3633, 2010) due to the limitation of mathematical-analytical methods in analyzing the wide range of time-dependent and random system values, and the highly networked interactions manufacturing systems. The latest state-of-the-art simulation software offers hardware integration which makes the inclusion of a real control system in simulation environment possible. This type of simulation is known as simulation based control system.

This paper presents the results of simulation based control system in performing Software-in-the-Loop (SIL) technique to support the reconfiguration of a manufacturing system. It is structured as follows: Section 2 will present the state of the art of reconfiguration in