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Automated control system generation out of the virtual machine

Stefan Scheifele*, Alexander Verl

Institute for Control Engineering of Machine Tools and Manufacturing Units (ISW), University of Stuttgart, Seidenstr. 36, 70174 Stuttgart, Germany

Abstract

To drastically reduce the commissioning time of a machine tool innovative companies rely more and more on the possibilities of virtual commissioning - commissioning of real controls on virtual machines and plants in order to improve the accuracy and robustness of acting programs. These virtual machines and plants require data defining their behavior and appearance.
The mechanical engineering, which is focused on machine modules, uses engineering tools for configuration and parameterization of the needed control systems. These software tools have knowledge of the cross-relationships and dependencies of the individual modules to each other and derive the required data for the control systems (CNC, PLC, …) but also, e.g. the needed documents from a central database. It is desired to generate the required virtual machines and plants automatically and use them for the test of the control systems.
In the research project "CassaMobile" a module is understood as a self-sufficient unit, which includes all mechanical and electrical components to fulfil the intended function and either has its own control system or is controlled by a central control system. The difference from engineering by commissioning lists is, that the control system receives a list of all available modules through a query of the physical machine and that the modules are explaining themselves to the control system and not by a central data base. This is made possible by a module-specific configuration memory such as the CIMory (Configuration and Information Memory). An automatic configuration of the control system on the basis of CIMory data has already been presented.
This approach does not require a central data base out of which a virtual machine could be generated. However, the commissioning of the control system can be done only after the construction of the actual machine. To overcome this disadvantage, for "CassaMobile" a virtual equivalent was developed: by using the commissioning list, a virtual machine is generated out of virtual modules which is used for virtual commissioning of the control system. The virtual modules can be detected by the control system and have the possibility to explain themselves to the control system like their physical equivalents. The CIMory gets a virtual expression.

* Corresponding author. Tel.: +49-0711 685-82354; fax: +49-0711 685 72354.
E-mail address: stefan.scheifele@isw.uni-stuttgart.de

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1. Introduction

Modern engineering has developed modular concepts and enables it to provide economic production for various production tasks. By using this modular concept, many companies understand the term “module” not only limited to the hardware, but use them for mechatronic units. According to [1] the choice of system boundaries determines the complexity of the module interface. In this context, a mechatronic component by definition is a sub-system [2], which has as few external interfaces as possible. This also means that mechatronic components are limited to a single or a few equal functions [3], e.g. a spindle or a drilling unit, so that the mechatronic component forms a self-contained, autonomous unit. Accordingly, modern machine tool companies are able to build up a module pool, out of which a basic machine can be extended by mechatronic components to perform various functions.

In the literature, a "mechatronic component" or a "mechatronic module" is defined as an autonomous unit consisting of mechanical, electrical and control units [1]. In recent years, this definition has become softer. More and more, self-contained units are already considered "mechatronic" when they consist of mechanical and electrical systems, even if they have to be connected to a central control system to perform their function, so they do not own the needed control system function. This definition will be chosen for this paper.

If this modularization is driven further, a mechatronic component could have dependencies to other mechatronic components and could require them to fulfill its function. For example, the mechatronic component “spindle” could contain the component “pneumatic tool changer”. This requires the mechatronic component “compressor”. If the overall machine tool now contains more mechatronic units that require the mechatronic component “compressor”, either another component "compressor" or a stronger component "compressor" may be required. Commissioning tools know about this relationship and consider it by commissioning a machine tool.

Within the CassaMobile project [4], a mobile, flexible, modular, small-footprint manufacturing system in an ISO-container that can be easily configured for different products and processes by adding or removing production modules to or from the container. Doing so, a perfectly matched production system can be provided for every use case. (see Figure 1)

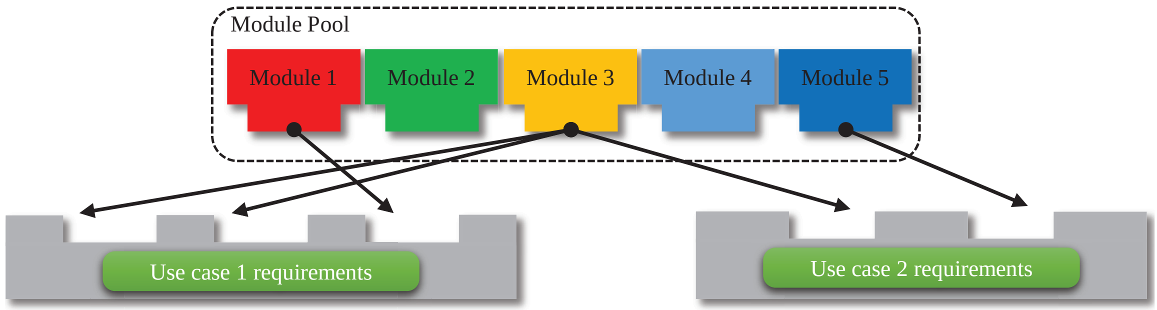

Figure 1: Concept of the Modular Production System (MPS) combining modules to fit the use case requirements [5]

According to the current state of technology, the research project "CassaMobile" defines the production units as completed mechatronic units, which are in turn composed of mechatronic components. They contain all mechanical and electrical components in order to fulfill its intended function. The manufacturing units themselves do not need their own control system, but can be controlled by a central control system (CCS). The control configuration and parameterization is automatically generated from information that is provided by memories, which are part of each