Aplying mechatronic elements in developing and construction work centres.

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Abstract: Aplying mechatronics method in development and construction of machine-tools is fundamental idea for advance quality developed products. Other benefit are lower costs for engineering and development in this region. Mechatronics methods and her initiation in practices have the same benefit as apllying CAD/CAM systems for constructing and designing in industry in ninety years of the last century. Companies which underrated benefits of these systems before twenty years, now simply doesn't exist on the market shapping machines. The same significance have coming mechatronics methods.

Key–Words: Mechatronics, HIL (Hardware in the loop), visualization, VNCK.

1 Introduction

For standard milling and cutting machines exist on a market many software utilities, which easily make technology and calculating of real time for shaping cycle. But special machines, for example multi spindle work centres, practically haven't substitution in the area of standard commercial software for developing technology of cutting pieces. Specific problem in creating technology and also very narrow specialization of these machines, limited commercial developers. On multi spindle work centre is driven up to 56 machine axes. In standard practice is usually driven five, in special cases 7 axes at maximum. Driving of 56 axes is very specific branch, which set high demands in detection of collision moving mechanism in work area. Other requirement is very precision calculation of technology time of cutting pieces. Technology time, product precision and reliability is in large-scale production , limited factors for considering quality. Other limited factor is using two systems SIEMENS 840D which are connected as MASTER-SLAVE with NCU Link options, for driving. It is possible for collaborating and independent driving of all requirement motion axes.

The first task was to analyze the possibility of commercial software. In the case of short supply then implement software that would solve this special area.

The second reason was to link the practical use of Hardware In the Loop, which based on mechatronics model of the machine, enabling visualization and presentation of real calculations, the basic building block for the optimal design of the main component parts. It is essential to accelerate the development of a prototype, and lowering the costs of production engineering.

The third reason was an attempt to make accurate calculation of the machine cycle, which depends on the resulting productivity. Quality of technology is evaluated not only the quality of the work piece, as well as production time, which is tuned to the nearest tenth of a second.

2 Analysis and visualization techniques of collision in the machine's workspace

2.1 Blender 6.4.2

In the first phase were analyzed by use of animation software Blender [1] which is distributed in the GNU license and is primarily used for modelling and animation. Indisputable advantage of this software is especially high quality and the opportunities provided by being in computer animation. Blender important feature is the ability to import a large variety of graphic formats. This was just used to import geometry trouble working the machine, which was available in vector format VRML. Subsequently plugins written in Python, which implemented the ISO code of the transformation into 3D animation workspace. This solu-

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tion had several major shortcomings, which proved unsuitable for use Blender in this area. First it was the limited functionality of the converter ISO code, which allowed only a certain geometric transformation, ie a straight line and circular interpolation. The second and major shortages were very high demands on computing the Python interpreter. In practice, it can monitor up to two axes of machine motion. That the requirement of 56 motion axes was virtually unusable. Although this is an excellent animation software, is designed primarily for the purpose intended. The reason why it failed is the influence of large quantities of precision graphics functionality, but which significantly slow down the real-time animation. Programmer's interface in Python is also not an appropriate means for real-time simulations.[1]

2.2 EdgeCAM

EdgeCAM could well affect only one area of the machine spindle without any other ties to the spindle. It was virtually impossible control the entire machine cycle of the machine, especially a conflict between working independently of each axis. EdgeCAM system is designed for machine configurations with a standard five-axis geometry and is not prepared to deal with special problems.

2.3 Pro/Engineer

To detect and monitor collisions has been studied also CAD Pro/ENGINEER, which has some tools for monitoring and collision animation workspace. Its advantage was that the routine use of construction machine and its long experience with this system. Allows you to define the so-called drivers, which are capable of kinematics machine into motion. Pro/ENGINEER haven't any programming interfaces that would allow the existing graphics libraries to link the technological functionality. Therefore, this route was evaluated as unpromising.

2.4 Vericut 7.1

Primarily used to simulate the NC program errors and detection technology collisions. Animation workspace machine allows the monitoring of conflict between the state mechanisms and instruments very precisely. Its indisputable advantage is a very wide range of applications. It has very good graphics editor that allows any 3D object model, including tooling. The advantage is that it uses very limited graphics functionality which significantly improves performance in real-time animations. The VERICUT interpreters are also most control systems, which are commonly used in machine tools. The collision in the workspace Vericut solve very reliable. VERICUT disadvantage is that it can simulate up to 31 controlled axes of motion. Another drawback was incorrect or insufficiently precise interpretation calculating machine production time. Were measured rather large deviations between the calculated time and the time was actually measured on the machine. It was noted that this problem arises because the interpreter of Vericut ISO code system does not include the constant real control system, in particular the constant Kv and the constant Ryv (jerk). Therefore, there is the complicated shapes of work pieces to greater differences between actual and calculated time technology with more than acceptable error of 5%. The machine whose production Cycle time ranges in the order of units in more than tens of seconds is greater calculation error inadmissible.

3 Implementation of VNCK kernel for precise calculation of the technology times

VNCK (Kernel Virtual NC) option is a special software supplied by Siemens, which contains the standard core of the real control system. This allows accurate simulation of the real control system. The biggest benefit is that it allows to work with the same configuration parameters that are defined on the real machine. This ensures compliance with almost identical behaviour of the simulator and the real machines or parts of the studied mechanism. Simulations can include with great precision also dynamic properties of real machines. This solution proved to be advantageous in the preparation of mechatronics models and simulation methods using Hardware In the Loop, but also the requirement to calculate the exact time of technology.

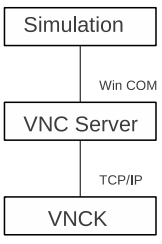

Figure 1: VNCK Schematic

Thanks to collaboration with Siemens, which lent to the core of this testing was implemented and tested in a real construction project multi spindle CNC lathe. VNCK System (Kernel Virtual NC) is designed in

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the way, which contains two basic components that are connected to asynchronous communication on a client/server architecture. VNCK server provides an interface for all messaging client commands. [2] User applications communicate asynchronously with the client and the server sends VNCK orders to be processed. Then they are equipped and sent back to user application. Communication between the user application and communication client is using Windows COM interfaces, which in turn use the TCP/IP protocol to communicate with VNCK kernel. [3], [4]

VNCK system includes a complete instruction set of the ISO code and has exactly the same functions as the standard Siemens 840D. This has the advantage that it can be used in configuration files on the machine which can be completely transferred to VNCK simulator. This achieves exactly the same environment on the real machine or on the machine simulator. The result was also significantly more accurate calculation of the machine cycle. Development environment of simulator was used in the graphic simulation program TMis [5], which was specially developed for CNC multi-spindle automatic lathes series of TMZ. The fundamental role, which the application TMis solved, is the calculation of machining time (cycle time). Because these machines use the most functionality of the system SIEMENS 840D (including spatial transformations), the integration of core VNCK is necessary. It's virtually impossible to create your own ISO code interpreter that would fully compensate the interpreter of the manufacturer. In addition to core functionality, which is preparing its own technology, you can also visualize the working area of the machine (in 3D), show slides of the machine moves, spindles and auxiliary technological components for example pickup, drilling and milling equipment. The software allows you to monitor the possible collision of tools, fixings and accessories and show the shape of the finished components, including chip removal.

4 Use VNC in the relation Hardware In The Loop

A subsequent goal is to use VNCK in relation to the mathematical model of a fully functional main parts of the machine. Current practice shows several approaches to solving the mechatronics machine model [5].

For the most accurate simulation is a comprehensive model of the machine, which is of course very demanding role of computing power due to large matrix and modal analysis of the state space model. The disadvantages are the high demands on the training model and quite difficult modifiability model [5].

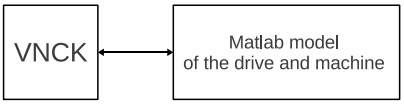

Figure 2: VNCK and Hardware In The Loop

For easy modifiability of the model are used specific models of machines and these nodes are connected in Simulink. This method has no such demands on computing power, since each node machine is modelled separately. The disadvantage is less accurate results.

Link model and VNCK mechatronics system allowed to create a virtual model that can simulate the strength and dynamic properties of individual components, resulting in better quality solution , but also significantly accelerate the development and also in significant cost reduction.

5 Conclusions of the analysis

The result of the analysis and subsequent works was found, that generally offer software products, in this case, do not realise all expected and anticipated requirements. The set of special machines and equipment also include multi-spindle automatic lathes type TMZ produced in TAJMAC ZPS. Survey shows, that much more viable solution is the path of its own software support. Commercially offered software products are designed to promote standard technologies, machine tools, and in these special cases satisfy requirements just partially or not at all [6].

VERICUT 7.1 satisfy the requirements of part and is used in routine use for monitoring and evaluation of the collision, especially for special adjustments, which are considered critical collision of holders, various utilities and mechanisms for which is not determining the exact calculation of time of the machining cycle. Blender System failed to comply with it and was not further considered. Its main focus is software in 3D animation without the requirement of real-time applications. Pro / ENGINEER fail due to the absence of a programming interface that would allow real-time functionality integrated into the environment of this system. TMis system was a compromise solution between the supply of market and technological demands capabilities in the self development in the TAJMAC ZPS company. The advantage of this solution is the possibility of editing software to customer tailor-made and to add functionality specific to a particular technology. Another important advantage is ownership of source code programs, which greatly increases the flexibility to address new customer re-

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quirements.

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