AUTOMATED SYSTEM FOR QUICK CHOICE OF A RECONFIGURATION VARIANT OF A RECONFIGURABLE MULTIFUNCTIONAL MACHINE TOOL

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Abstract. The paper presents an automated system for choosing of a reconfiguration variant of a reconfigurable multifunctional machine tool. The system is developed in Java programming language. The choice of a variant the machine depends on the production task and is accomplished through different criteria, including previously defined technological indicators. The reconfiguration variant of the machine is visualized which makes it possible to demonstrate of the machine in condition of fully automated manufacturing during the process of complex machining of both rotation and prismatic parts and using different technological operations - turning, milling, drilling, grinding, etc.

Keywords: automated system, reconfigurable machine tools, multifunctional machine tools

1. Introduction

The main aim of reconfigurable machine tools is the achievement of high flexibility of their structure in order to respond to the defined production or market requirements [4, 8].

That determines the high priority of further research and reconfigurable production as the basic key challenge until 2020 [5, 7].

In literature [3] an active 3D computer model is presented of a reconfigurable multifunctional machine tool (RMMT), developed in SolidWorks environment. The machine has high potential for the reconfiguration of its structure in machining of different parts and high concentration of various technological operations.

In relation to methodology, [2] presents an approach method developed on the basis of the Genetic Algorithms Theory and 20 variants of a suggested concept of a reconfigurable multifunctional machine tool depending on criteria, including previously defined technological indicators are determinate.

The automated systems and simulation models of the technological systems hold tremendous promise for reducing costs, improving quality, and shortening the time-to-market for manufactured goods. Unfortunately, these technologies still remain largely underutilized by industry today [1, 6]. On the other hand the state-of-the-art in visualization supports engineering design decisions to understand better the models, algorithms, data, and design variants obtained during the process and to enable real-time response to user input.

On the basis of the developed methodology and reconfigurable machine tool concept in [2] this paper suggests an automated system for quick selection of a reconfiguration variant for machining of different parts – rotation parts, prismatic parts or parts with sophisticated configuration in a single machine (individual or in combination).

The paper is the logical continuation of the developed 3D model of the RMMT in [3].

2. Automated system for chose a reconfigurable variant of the machine

The developed 3D model of the RMMT [3] is characterized by the multifunctionallity of the possibilities of the machine to process different parts (rotation, prismatic or parts with sophisticated configuration containing rotation and prismatic surfaces) individually or in combination in a single machine.

Furthermore the machine has the ability to perform different technological operations (turning, milling, drilling, grinding, etc.) in conditions of fully automated manufacturing.

The basic version of Java - Standard Edition version 1.4.2.13 and the JMF version 2.1.1 for reproduction of video files are used for realization of the programme.

The free software BlueJ version 2.2.1 is used for programming and compiling the programme.

The programme interface comprises 9 windows, whose configuration is changed for each assembled variant.

Each window type shows a specific criterion for making the choice.

Figure 1 shows the initial window of the automated system and figure 2 – the screen for choosing the part type or the respective parts combination.

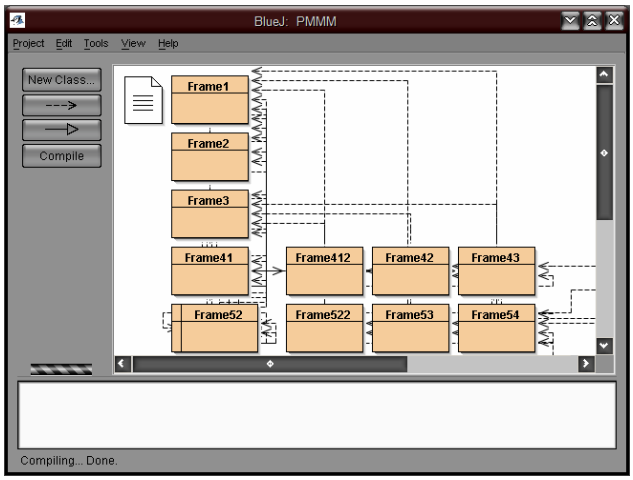

Figure 1. Initial window of the automated system

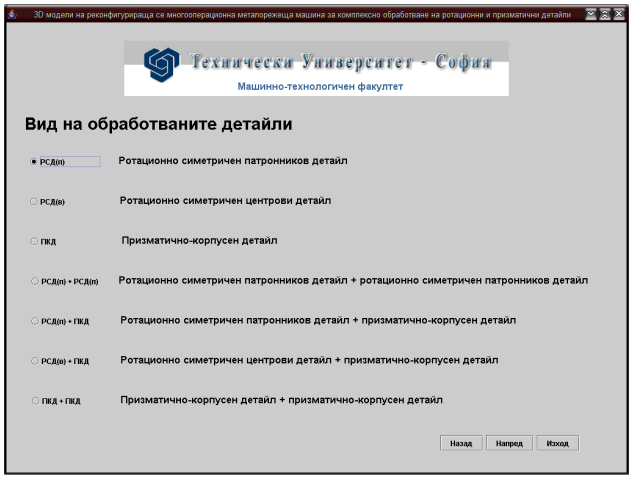

Figure 2. Defining of the work parts type

The choice of the machine reconfiguration variant depends on the production task and is made using different criteria, which include the following technological indicators:

- the work part type;
- the positioning of the machine type according to the position of the main spindle unit – horizontal, vertical or at a random angle;
- the number of simultaneously machined sides of the work part;
- the number of the needed tools and their exact position – in turrets or in the spindle unit chuck;
- the number of simultaneously machined work parts.

The programme includes seven variants for processing of rotation and prismatic parts (figure 2):

- three variants for single machining rotation parts (shafts L/D>5 and parts L/D<5) and prismatic parts;
- four variants for machining in the following combinations: two rotation parts (L/D<5), one rotation part (L/D<5) and one prismatic part, one rotation part (L/D > 5) and one prismatic part and two prismatic parts (or two sophisticated parts, consisting of rotation and prismatic surfaces).

Together with the technological parameters, the automated system provides the opportunity for generating 20 reconfigurable variants of the RMMT.

Further the situation of the main motor-spindle (figure 3) and the number of simultaneously machining work part sides was defined, shown in the screens in figure 4.

Figure 3. Defining the situation of the main motor-spindle

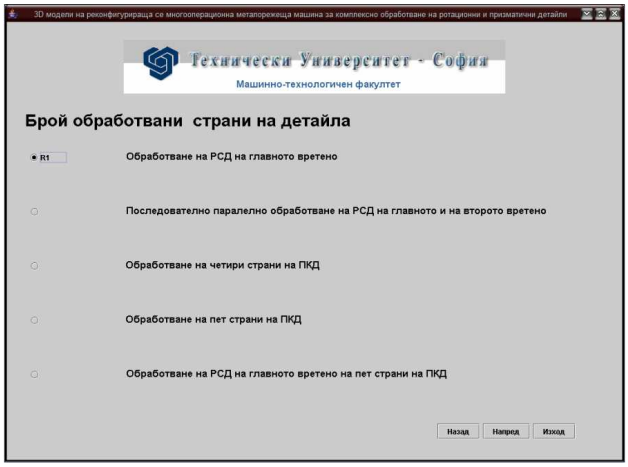

Figure 4. Defining the number of simultaneously machined work part sides

The number and tools situation (in turrets or in motor-spindles chucks) defined in accordance with the developed method [2] are shown in figure 5 and figure 6.

The programme interface allows the users to change their choice at each stage (screen) of defining the production task conditions.

Figure 5. Defining the number of the tools

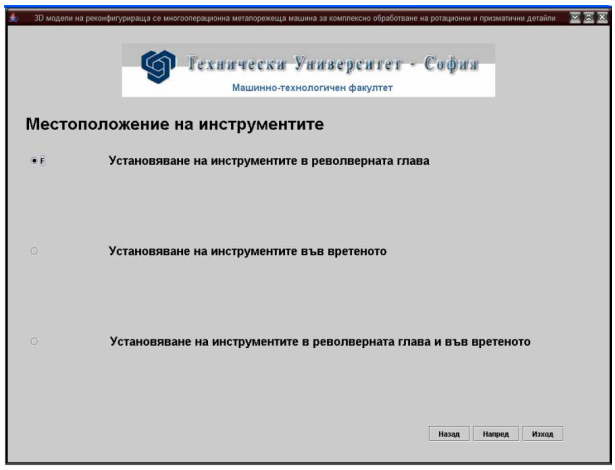

Figure 6. Defining the position of the tools

With the parameters set in so that they meet the requirements for the characteristics of the machine and production task, the respective optimal variant of the RMMT is synthesized.

Through using the Solid Works Animator the technological and construction possibilities of the machine the synthesized end variant demonstrated /animated.

The synthesized animated final variant of the reconfigurable multifunctional machine tool is shown in figure 7.

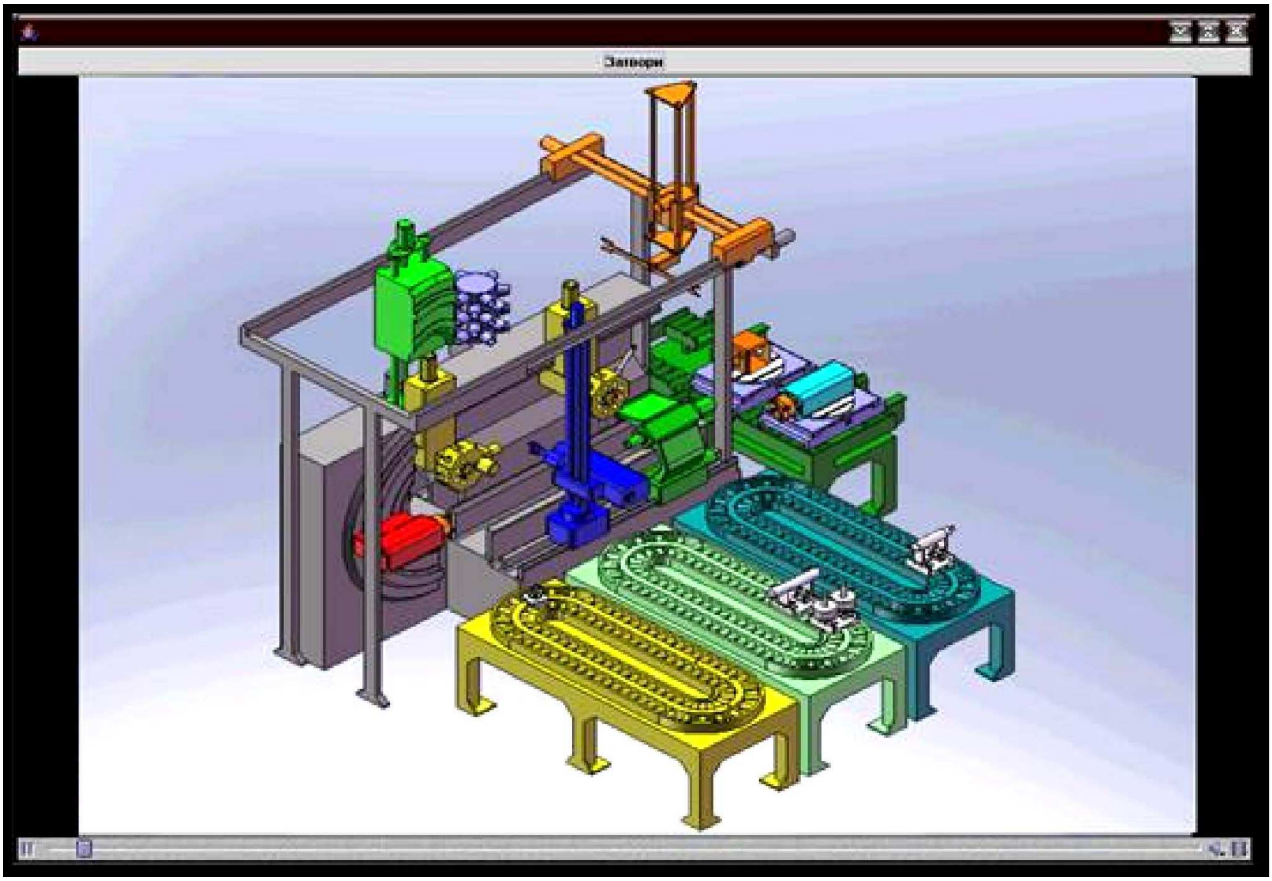

Figure 7. Final animation machine variant

3. Conclusion

The developed automated system creates possibilities for quick generation of 20 assembly variants of a reconfigurable multifunctional machine tool package meeting the production task requirements - rotation, prismatic or parts with

sophisticated configuration consisting of rotation and prismatic surfaces, individual or in combination in a single machine.

The usage of the developed automated system allows better spatial visualization of the machine reconfiguration and the work of the machine in conditions of a fully automated production process.

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