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# PC CONTROLLED TURNING TOOL

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*Abstract*

*Design of PC controlled turning tool is presented in paper. Tool placed in the guides was driving using the stepper motor and a screw cooperating with the nut joined with the tool. To control of the tool was used PC with the step motor interface connected to the LPT port. Mounted to the holder tool allows machining shape surface using the universal lathe.*

***Keywords:*** *mechatronics tool, turning process, lathe, step motor*

## 1. Introduction

There are many small companies providing services in machining. To be competitive, they must offer short lead times, high quality and repeatability of the details. In the case of machinery equipment in a conventional machine, it involves the employment of large numbers of skilled workers, or the purchase of modern machining centers, which usually goes beyond the financial capacity of the company. To maintain the competitiveness of these companies, they have to use cheap and flexible as possible universal tool [3-6].

In cutting tools area the new direction are mechatronics tools (fig. 1) [1,2,6-8].

This special tools equipped with own engine and special control system made possible change its geometry. KOMET KomTronic [8] system add the special U-axis included in tool (fig. 1). This change are possible by using mechatronics system in process cutting. Mechatronics tools and its control system cooperate with the control system of numerical machine tools. In the industrial mechatronics tool are used to machine tools possibilities increase and automates the process machining.

The paper presents elaborated in University of Technology and Life Sciences (Bydgoszcz, Poland) the design of controlled PC turning tool, which makes the new possibility of machining using conventional lathes.

*Fig. 1. KOMET KomTronic U-Axis system [8]*

## 2. Mechatronics turning tool idea

In the Departament of Production Engineering and Mechanical Students Scientific Division our University conceived the idea of creating an intelligent tool, which can be fitted with any conventional lathe (fig. 2). The role of the operator have expired only in the material change in machine holder and start of machining process.

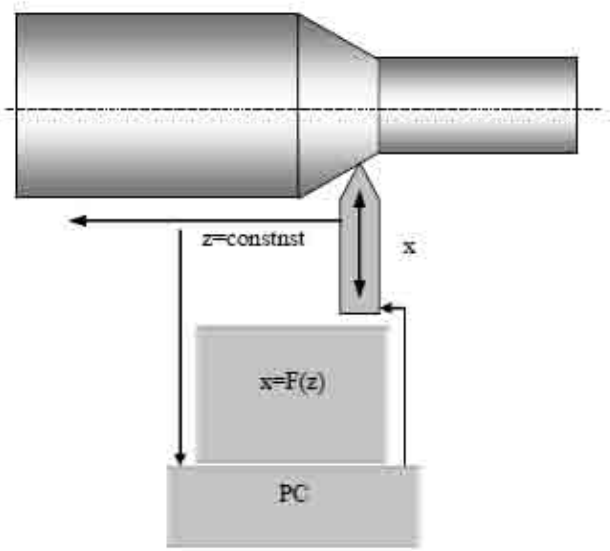


*Fig. 2. Idea of mechatronics PC controlled turning tool*

This mechatronics tool will be controlled using PC and connected to special interface which can control of *x* position of tool edge synchronically to change the *z* coordination changed with constant feed. PC controlled turning tool will be mounted in lathe holder and allows machining shaped surface as numerical control process.

## 3. Tool control system

To solve the problem of mechatronics tool construction was elaborated control system of this tool.

The concept of building system based on special tool that can be placed in the holder conventional lathe (fig. 3). The task was to prepare the tool object. Rotational speed of the object should be controlled using the inverter in such a way as to be able to change right / left turns, which make working retail in a few passages. The tool should consist of a with turning tool in a rigid body. Extension of the tool will take place through a transmission with a computer-controlled motor with a precise number of revolutions.

To control position of tool in *z* axis may be use many solutions:

- counter of gear ratio revolutions,
- precision interface for measure tool holder motion ex. digital calliper with computers interface.
- optical measure system with using computers mouse.

In first proposition computer software by counting the number of lathe spindle revolutions and using feed monitor the tool will monitor its position.

Second proposition is using digital calliper. It is the best solution with high accuracy.

In first experiments, very simple measuring system with optical mouse was used (fig. 3). Because this signal will be measured using pixels of screen its resolution will be 0.264 mm (Thinkpad tablet X41).

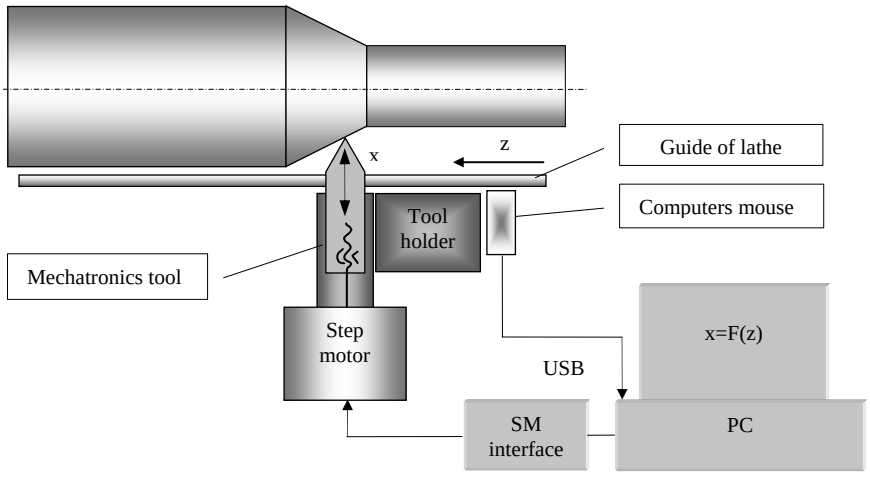


*Fig. 3. Control system of mechatronics turning tool with using of computer mouse to measure z position*

The control system task is: generation of surface machining program and control the machining process.

To control of the tool *x* position was used PC with the motor control interface. In first probe to stepper motor control was used USB interface, but this driver were able to obtain low level of motor control steps frequency. In control stepper motor better use LPT interface. In VB6 environment we can control this port using In and Out procedures. With using special software for NC machining it is possible to achieve very high-frequency pulses to ensure a very high rotational speed of stepper motors [9,10]. For this purpose with Windows platform, programs such as Mach3 [9], STEP2CNC [10], use special handling procedures to LPT port.

Pulse frequency of step-motor control is essential particularly important in the case of surface processing wide angle of inclination. Due to the constant feed in the direction of the used system allows to obtain maximum surface angle depends of radial feed (Fig. 4). More and more radial feed value make possibility to get more surface inclination angle. In presented location of *x* tool axis not possible is getting the surface perpendicular to axis of lathe. This requires positioning edge of mechatronics tool at an angle to the axis of lathe or stop of axial feed.

For the purposes of the model has been created using Microsoft Visual Basic 6.0 *TurnTool* software to control the machining process. The main aim before emerging software was simple and intuitive interface (fig. 5), which allows CNC programming tools for person with a basic knowledge of technical drawing and machining. Elaborated software make possible to do:

- design and visualize items model using simple CAD system,
- set the basic parameters of machining,
- generating machining program,

- simulation of machining on the basis of input data,
- control tool retrieval of data from sensors,
- control of turning process.

The program uses advanced procedures for creating an optimal program for machining of the workpiece in many passages, and its simulation on a computer screen. In the future it is planned to develop the system by using G-code editor, which allows to load an external program of treatment or manual modification, which is useful for advanced users.

## 4. Tool model

Tool design was developed using the Solid Works program (fig. 6).

Cutting tool with a threaded hole in the axle shaft was placed in a steel fence, which at the same time corps of tool. Tool placed in the guides was driving using the stepper motor. The stepper motor is coupled with axis of the threaded nut cooperating with the tool. The three-dimensional model of the tool used to generate drawings of individual parts, check and investigate the kinematics and calculate the tool stifness. It was carried out in ANSYS environment (fig. 7).

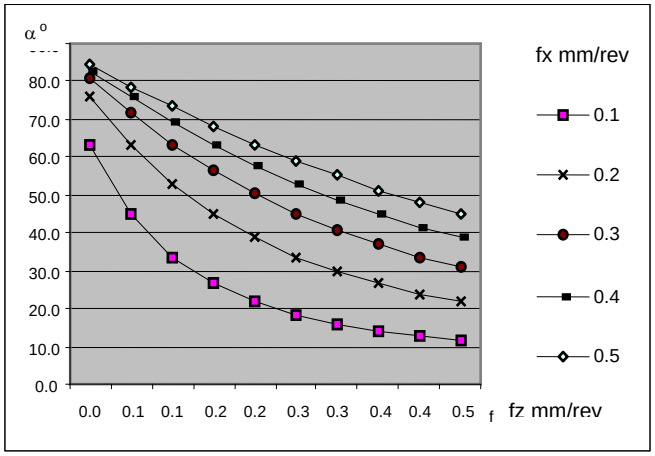


*Fig. 4. Axial feed - fz influence on surface angle for another radial feed – fx*

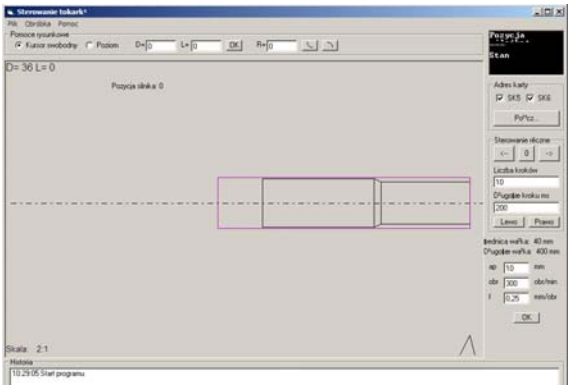

*Fig. 5. Main form of TurnTool software*

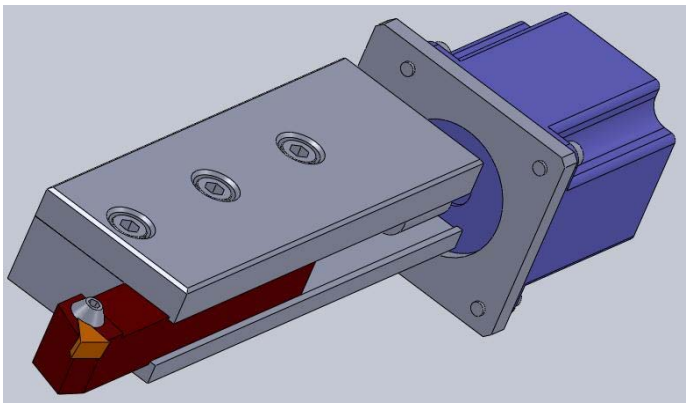

*Fig. 6. Virtual model of mechatronics tool*

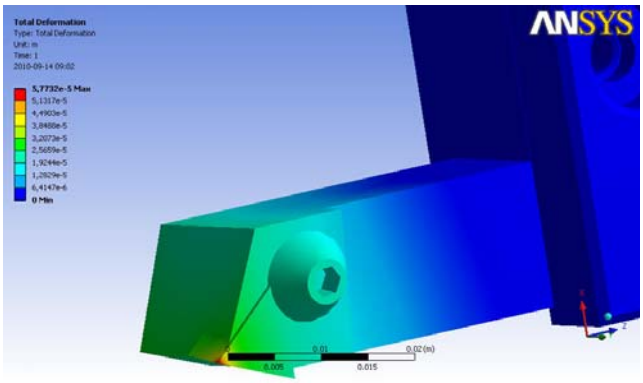


*Fig. 7. Results of FEM calculation*

## 5. Tools testing s

Tool designed and executed, was used to practical attempt to turning aluminium detail (fig. 8). Elaborated tool fitted to the lathe holder. The tool edge was situated on the axis of the lathe. To power the stepper motor controller uses a stabilized laboratory power supply (fig. 8).

Preset shape drawn in the *TurnTool* software, then generated $x=f(z)$ control file. Shaping workpiece surface turning was carried out automatically switched axial feed. Conducted tests confirmed the correctness of the tool motion speed without load. Then attempts were cutting the sample. Obtained as expected shaping surface treatment.

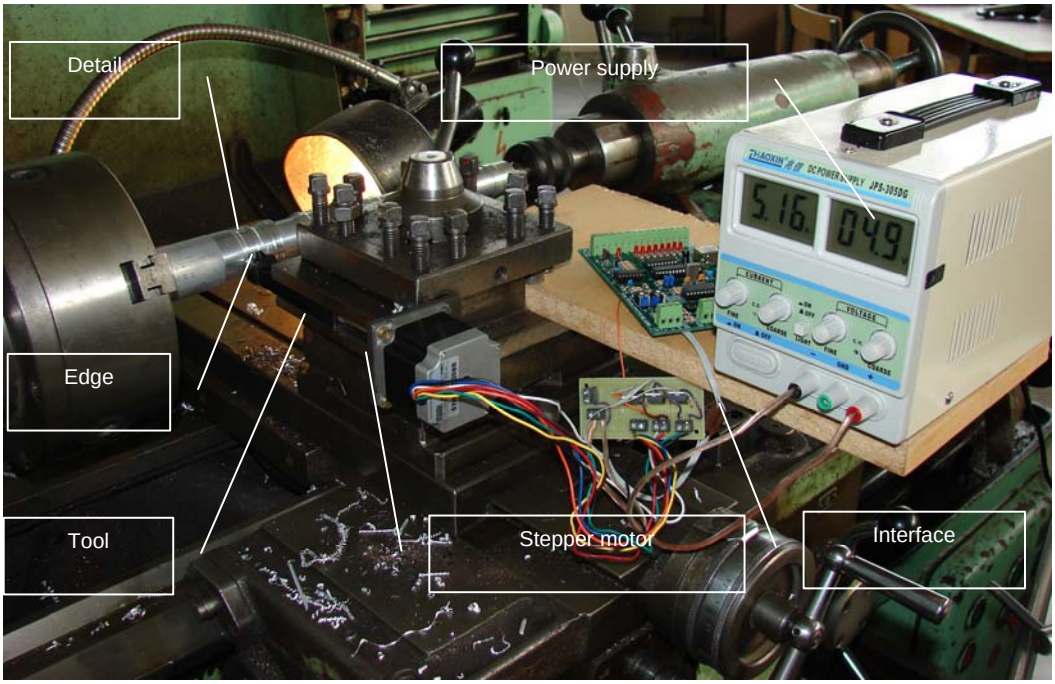


*Fig. 8. Turning using controlled PC mechatronics tool*

Because of the presence of radial cutting forces were clearing the slack due to gear favorable exacitude of processing.

Resulting of machining experiments showed no surface defects, and the dimensions corespondent to the values given. It confirms sufficient stiffness of the developed tool.

## 6. Conclusions

Showed in paper the controlled PC turning tool is a new idea in mechatronics tool. Presented design of tool and its control system and software show the new possibilities of automation machining using conventional lathe. Developed construction is very cheap – implemented easy to control stepper motor providing of process machining control. In the developed tools design equipping it will be useful with in trapezoidal screws, or even spherical. This increase the accuracy and correctness of the sustainability drive.

The mechatronics turning tool approach to building intelligent tool. The use of specialized tools mechatronic allows partial automation of machine tools conventional development by promoting efficiency and productivity.

The construction of such tools is now easier due to the widespread presence in the market of components for construction of such tools and especially the stepper motor including built-in gear, stepper motor controllers. There are also available other driving and the position measuring systems.

It is expedient to carry out further work and tools development including with the use of the second controlled axis. The next step in development of mechatronic tool will be the modernisation of tools software in direction of G-code file using to control machining process.

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