645. Active control of the process and results of treatment

V. Gichan[1]
[1] Vilnius Gediminas Technical University,
Basanaviciaus 28, LT-10223, Vilnius, Lithuania
E-mail: *vladimir@zebra.lt*

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Abstract. The article analyzes the problems associated with the measurement and control of process parameters and the parameters of the work piece. Stabilization force parameters, of acceptable quality requires a regulator with variable structure and high precision of their measurement. Analysis of the frequency change in the power of idling can detect defects in the kinematics. Rate of change of load can determine the dynamic parameters of the cutting process. When handling gears stabilize the load can be performed by a pulsed method

Keywords: cycle of grinding, regulator with variable structure, power measurement, dynamic parameters, kinematic delay.

Introduction

In the industry are used in cycles of grinding with the active control of the cutting conditions and the accuracy of the work piece [1]. At the beginning of treatment feeder brings the grinding wheel to the work piece and cuts into it. This results in an increase in power consumption of electric drive range to a predetermined level. Next, a special stabilization system controls the feed mechanism so that the power level was constant. After removing the main part of the allowance, in the cutting zone is entered the device measuring the diameter of work piece. Additionally, this device measures the amplitude of the fluctuations in the size of the rotation frequency (deviation form) of the work piece. At a certain ratio of errors of form and an allowance begins the final stage of processing when the control system adjusts the flow to withstand pre-calculated optimal ratio of errors of form and an allowance. At the final stage, the decrease in power and the change in the error form.

The described method has reduced the processing time and save, and in some cases significantly improve the quality of treatment. In the practical application of the method needed to improve systems of automatic control of process parameters during the cutting process and improve the static and dynamic power measurement accuracy in the processing and idling.

System of variable structure for the regulation of technological parameters in cutting

When the processing tool is not in contact with the work piece, occurs opening a feedback loop control system (fig. 1). With the closure of the loop, proportional-integral controller gives a large overshoot.

Typical graphs of the controlled quantity (power or torque cutting) and the control action (flow) during the penetration tool into the work piece when the regulator with variable structure are shown in the fig. 2.

One can distinguish three regions of the transition process:

1. movement to the work piece at maximum speed;
2. reverse movement;
3. stabilizing force parameter values using proportional-integral controller.

In the first two sections, when the mismatch more than a certain level, works best for speed in this case the relay channel regulator. At the third turn on the proportional-integral controller and supports the controlled variable at a specified level.

In many cases, the precise stabilization force parameters significantly improves the outcome of treatment. For example, in fig. 3 shows the distribution curves of the processed hole taper bearing rings for internal grinding [3]. Curve 1 corresponds to the minimum scatter cone at the correct setting the cutoff frequency of the control circuit power when the cutoff frequency higher excitation frequency. Curve 2 (with two maxima) corresponds to setting the cutoff frequency below the excitation frequency. Curve 3 was obtained with treatment without the stabilization system.

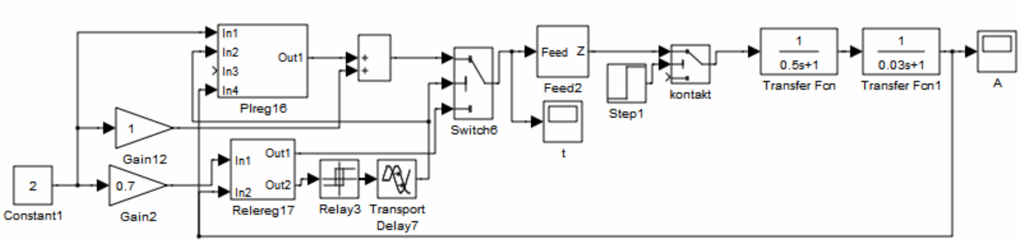

Fig. 1. Simulink-model controller with variable structure

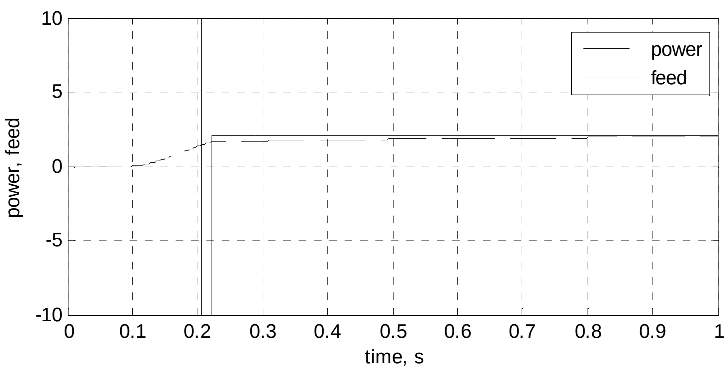

Fig. 2. Typical graphs of the controlled variable (power) and the control action (feed) at cutting in the tool into the work piece

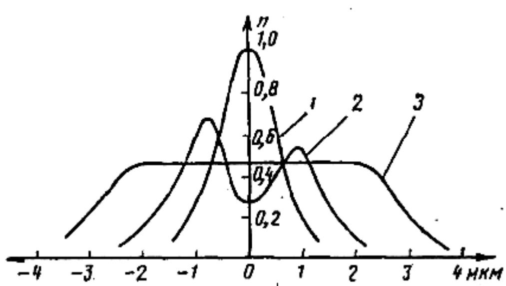

Fig. 3. Distribution of cone-treated rings

From the above implies the need to perhaps a more accurate measurement of cutting forces, which is most convenient to carry out indirectly, by measuring the motor power. Measurement of electrical power is convenient because it does not decrease the rigidity of the technological system.

Power measurement in the processing and idling

Method [4] definitions of the defects of the kinematic chain of consumption at idle power is based on comparison of reference and the actual frequency spectrum and is described in detail in relation to the diagnosis of kinematic chains gear hobbing machines [5]. Power fluctuations are usually caused by a defect of the kinematic pair. Moments of inertia of kinematic links reduces the amplitude of these fluctuations. To restore the true value of the amplitude should be carried out frequency correction channel power measurement [6]. Fig. 4 shows the change in frequency and power spectrum of motor idling.

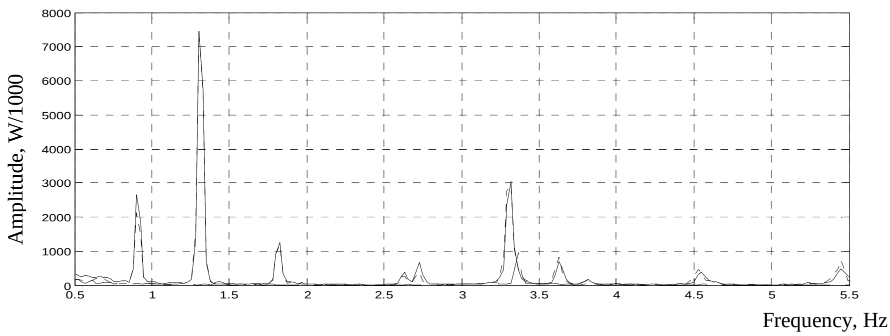

Fig. 4. The site frequency spectrum of power idle printing machine

Dynamic parameters of the cutting process can be changed as a result of tool wear and variations of the parameters work piece. These parameters are useful to determine prior to processing.

Measurement of dynamic parameters of the cutting process

A first approximation, the cutting process can be link with the transfer function:

$$W_p(p) = \frac{P(p)}{t(p)} = \frac{k_p}{T_p p + 1}, \tag{1}$$

where $P(p)$ is cutting power, $t(p)$ is plunge infeed and

$$k_p = \frac{P_y}{t_m}, \tag{2}$$

$$T_p = \frac{y}{t_m}; \tag{3}$$

where P_y, t_m, y are steady-state power, feeder, tightness.

Changing the output signal of an aperiodic link in the transition process is described by:

$$P = t_m k_p \left(1 - e^{-\frac{\tau}{T_p}} \right); \tag{4}$$

Where τ is time, e is base of natural logarithms. Expanding this expression in a series, and discarding the small of higher order, we obtain:

$$P = t_m k_p \frac{\tau}{T_p}; \tag{5}$$

after differentiation:

$$\dot{P} = t_m \frac{k_p}{T_p}; \tag{6}$$

rigidity, as is known, is the ratio of the strength P_y and tightness y , then dividing (2) (3) we obtain:

$$j = \frac{k_p}{T_p}; \tag{7}$$

(7) we obtain

$$j = \frac{\dot{P}_y}{t_m}. \tag{8}$$

Measuring at the beginning of treatment the rate of increase of radial force or power can be calculated parameters of the cutting process, the hardness, the gain control circuit, and do, so the system is invariant to changes in the parameters of the cutting process [7].

Regulation of force parameters in the presence of kinematic delay in facility management

Transfer function of the cutting process during grinding due to the kinematic delay caused by the rotation of the workpiece, differs from the aperiodic link. At ordinary speeds are considerably this difference is not. However, in the manufacture of gears by running speed of workpiece is much lower and, consequently, the kinematic time delay should be considered. In this case, to stabilize the load during cutting feed should include pulses once per revolution blanks [8]. This method of control, as shown, can increase the performance of cutting teeth at 30%. Fig. 5 shows the changes of the instrument and the power setting in the early treatment of teeth by running [9].

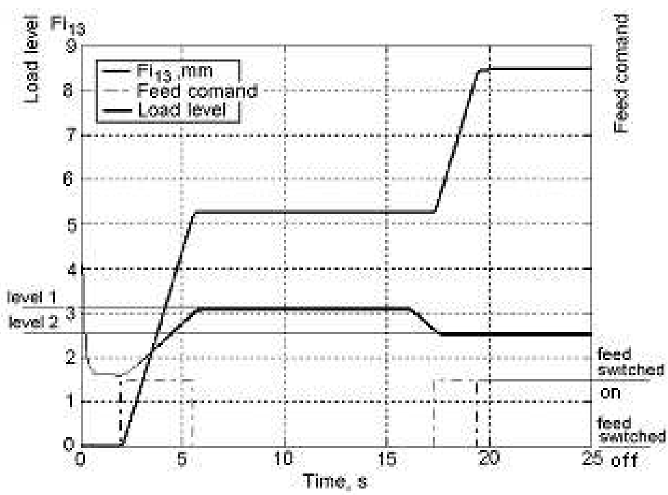

Fig. 5. Change the position of the tool and the force parameter in the modeling treatment of teeth with a pulsed feed

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This method is well suited for processing in gear hobbing machines with CNC. The use of electronic shaft offset printing machine [10] similarly use it in gear hobbing machine with CNC.

Conclusions

For precise and productive processing is necessary during treatment to measure the parameters of the cutting conditions and the accuracy of the work piece and manage them. Variable structure controller can reduce the deviation of the cutting forces and improve the accuracy of the work piece. In the original signal controller is necessary to eliminate the static and dynamic errors of measuring the force or power cut. Measurement and analysis of the power consumed by the motor idling, reveals the defects of the kinematic chain of the machine. By rise of the load at the beginning of treatment can determine the dynamic parameters of the cutting process.

Stabilization of the load with a significant delay kinematic can be performed by a pulsed manner.

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