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Optimization of velocity feedback control parameters of machine tools drive axis

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Machine tool control has evolved over the years. The original mechanical principle was replaced by electric and then electronic. Modern machines use control software to control individual drive axes. The most commonly used method of driving axis control is cascade control (Fig. 1). This method consists of position, velocity and current feedback, which are nested. Each feedback includes a regulator. The parameters of these regulators are subject of optimization, [7].

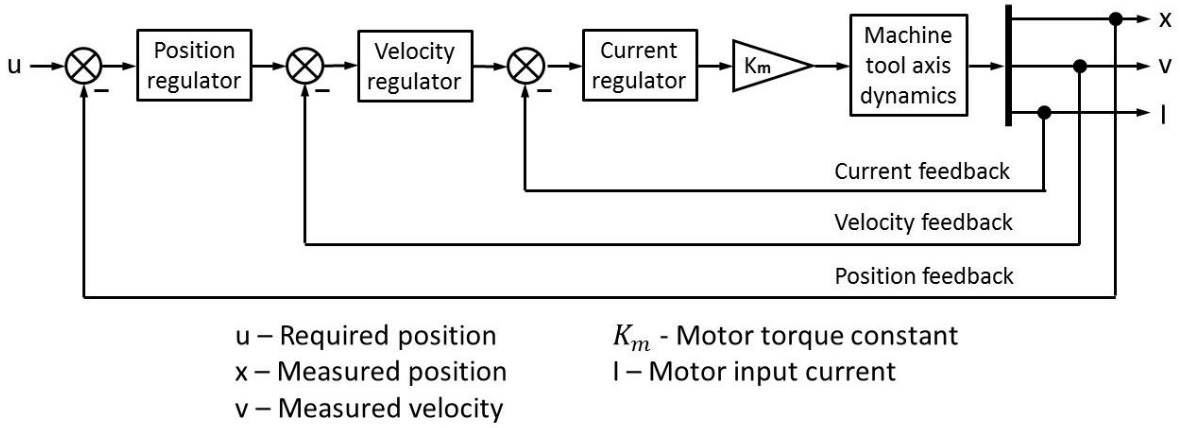

Fig. 1. Cascade control scheme, [7]

Optimizing these parameters is very demanding and requires a high level of expertise from the operator who performs the process. For this reason, there was a need to develop a general methodology. Development of this methodology and its subsequent application to the identified model of the real machine is the subject of this lecture.

The development itself can be divided into three phases: formulation of the optimization task, creation of the user interface (instructions for working with the program) and testing the methodology functionality.

First, a velocity feedback model (Fig. 2) in form of state-space was built. The velocity feedback was chosen because its tuning is the most difficult and usually brings the most problems. The model consists of two higher units (velocity regulator and mechanical system with current feedback) and negative feedback. The velocity regulator consists of a PI regulator, a series of notch filter and low-pass filter. A state-space description of mechanical system with current feedback can be obtained by modelling or identifying, [4], [1].

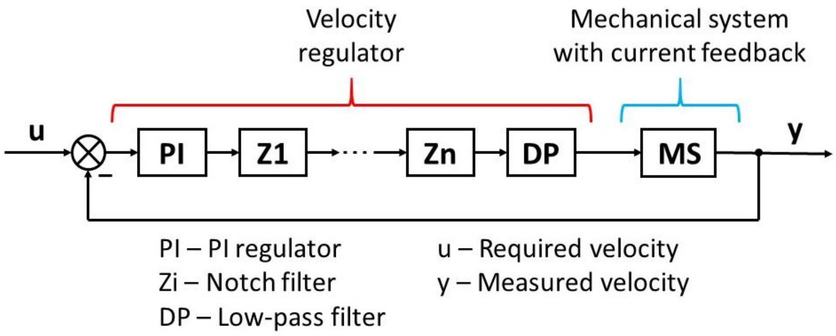

Fig. 2. Model of velocity feedback

Thereafter, the criteria of control optimization were selected. These criteria include the course of the amplitude Bode characteristic and the system response to the unit step. The distance of the system from the stability border was also considered. Based on these criteria, the target function was compiled as an input of the optimization algorithm. For the methodology two optimization methods were used: fminsearch [5] (local optimization) and the genetic algorithm [3] (global optimization).

The methodology was applied to the identified models of the real machine tool at different loads. Based on the results of the optimization, it can be said that the methodology is functional and can be used as an alternative to manual tuning by the operator.

Acknowledgements

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