GRINDING SYSTEM MODELLING TO SIMPLIFY DECISION MAKING

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In accordance with the Systems Engineering (theory of technical systems) one of the important initial stages of a system development is an adequate representation of the system from the concept stage to the running one. The system design includes its description, modelling and simulation, which may be represented in the respective formats: verbal description (text) in ordinary languages, graphical representations (block diagram, graphs), special signs systems (e.g., programming languages), mathematical model, a timing diagram, the combined method, etc. Selecting an appropriate way of the system representation depends on the purpose of the study. If the purpose is to create conditions to ensure the desired course of a process, when the process is the developing system, then it should be said of the system operation and control algorithms. In this case the technical system is being developed in the form of a control system model. In this modelling (versus simulation) the system is a mathematical abstraction that is taken as a model of a dynamic phenomenon which represents the dynamic phenomenon in terms of mathematical relations [1]. Such a system is characterized by the input $\boldsymbol{u}$, state $\boldsymbol{x}$ and output $\boldsymbol{y}$. The input $\boldsymbol{u}$ in the form of a set of time functions (e.g., in time domain) is the external forces (input variables) which are acting upon the grinding process that represents the dynamic phenomenon mentioned. The state $\boldsymbol{x}$ is a form of the system state-space representation, which with the input affects the output $\boldsymbol{y}$. The output $\boldsymbol{y}$ in similar form is the measures of the grinding process result, i.e. output quantities belonging to the ground part (part accuracy, surface finish and surface integrity).

In this connection the state $\boldsymbol{x}$ of the system is a vector function of time (e.g., in time domain) as well as both the input $\boldsymbol{u}$ and output $\boldsymbol{y}$. In grinding it may be corresponding signals like those of grinding forces $\boldsymbol{F}$ in Newtons, temperature $\boldsymbol{T}$ in Celsius or acoustic emission $\boldsymbol{AE}$ in RMS quantities. In grinding, the dependences of settings on process quantities such as grinding forces $\boldsymbol{F}$, temperature $\boldsymbol{T}$, and acoustic emission $\boldsymbol{AE}$ as well as on output quantities such as surface roughness and surface integrity (surface layer quality like grinding burns and residual stresses) may be mapped too on the basis of F. Klocke’ representation [2]. The model consists of the following state parameters: $\boldsymbol{Q'_w}$, $\boldsymbol{V'_w}$, $\boldsymbol{F}$, $\boldsymbol{T}$, $\boldsymbol{AE}$, where $\boldsymbol{Q'_w}$ is the specific material removal rate in $mm^3/(s \cdot mm)$, $\boldsymbol{V'_w}$ is the specific material removal in mm^3/mm. The application of this model for the development of both monitoring and technological diagnostics systems for a gear grinding machine with a CNC is given.

References:

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