INCORPORATING METHODS OF INTERVAL ANALYSIS FOR PROCESS CONTROL

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Abstract: The paper analyses the classical definition of the defects identification and recognition problem and compares the classical approach to solve this problem to the technique that incorporates the interval analysis. The main objective of the research is to provide a mathematical framework that proves the effectiveness of better method to evaluate and identify the current state of a technological object given the known set of its all possible states. The proposed approach divides the problem of technical diagnostics into two separate problems and provides solution to each one. The paper compares classic probabilistic approach to identification problem with methods based on interval analysis. The paper also defines criterion to estimate the applicability of interval analysis to any particular technical object.

Key words: interval analysis, process control, chemical diagnostics.

The problem of process control can be assigned to a set of engineering diagnostics problems. In classical definition of engineering diagnostics and defect recognition problems, the final objective of diagnostics is to assign the current state of an object being observed to one of the types of technological states given in advance. In order to conduct technical diagnostics, it is necessary to provide the types of technical states, corresponding boundary conditions and check the satisfiability of these conditions for each state variable. Let’s assume that the operational capacity of an object for some variable $x_j \in X$ is determined out of the inequality $\underline{d}_j \le x_j \le \overline{d}_j$, where $\underline{d}_j$ and $\overline{d}_j$ are lower and upper acceptable values for the variable x_j respectively. When the value of the variable x_j exceeds the interval $\left[\underline{d}_j;\overline{d}_j\right]$ a flaw condition is reported and the state of the object corresponding to this situation is reported as inoperable.

Thus, the technical diagnostics problem is in finding the state variables x_j of an object, which can be both observable and unobservable (controllability problem), and in assigning the state of the object to one of possible classes (recognition problem).

The controllability problem is in obtaining reliable diagnostic information. This problem, compared to classical problem, can be significantly simplified if we calculate the guaranteed estimate of a single generalized (unobserved) diagnostic variable X_j for the object being diagnosed. The variable X_j is calculated through the set of observed technological variables. The guaranteed estimate of a generalized diagnostic variable can be obtained if it is calculated over variation intervals of technological variables at a given interval, which should assuredly contain true values of those variables, rather than through instantaneous values of indirect technological variables. The guaranteed estimate should be calculated using the methods of interval analysis. The generalized diagnostic variable X_j is calculated through the values of indirect observed technological variables $Z_k = \left[\underline{z}_k;\overline{z}_k\right]$, $k = \overline{1,K}$, by solving the equation $F_j(X_j;Z_k;A_l) = 0$, where coefficients A_l, $l = \overline{1,L}$ can be both real numbers and intervals.

Operational reliability of chemical processes is ensured by methods of technical diagnostics. The most promising technique for chemical processes is parametric diagnostics on the basis of controlling the acceptable deviations of technological variables.