Modern trends in the development of decision support systems based on data mining

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Abstract. The article analyzes and defines the main trends in the development of decision support systems. It is shown that the most urgent is the development of decision-making systems based on data mining for the development and operation of technical systems and technological processes. In order to increase the efficiency of the micro-arc oxidation process, the developed structure of the decision support system in the process of obtaining oxide coatings is presented.

Keywords: Decision Support System, Data Mining, MAO Coatings Synthesis.

1 Introduction

The term decision support system (DSS) appeared in the early 1970s [1-2] for management problems based on flexible emergency decisions. Decision support systems are a class of information systems, within which the experience and informal knowledge of the decision maker is combined with the use of mathematical apparatus, computer technologies and, at present, data mining.

According to [3], decision support systems have the following main characteristics:

- use both data and models;
- help managers make decisions when analyzing complex problems that have a weakly structured or unstructured description of problems;
- are able to support (but do not completely replace) the process of developing leading decisions;
- are aimed at increasing the efficiency of the decision-making process.

Below are the distinctive features of the so-called "ideal" decision support system [3]:

- the possibility of using by decision-makers at various hierarchical levels;
- the ability to support decisions performed in a given sequence;

- support of the following stages of the decision-making process: intellectual analysis of tasks, development of alternative solutions, selection of the optimal solution;
- the ability to function and make decisions on the analysis of low-structured data;
- the ability to adapt both for use by one decision-maker and a group of people;
- the possibility of implementing various methods of decision-making;
- improving the efficiency of the decision-making process;
- the ability to quickly adapt to changing parameters both inside the analyzed system and outside it.

Figure 1 shows that DSS research consists of three groups of research areas:

- development of specialized DSS ("A" in Figure 1). In the period 1970-2000 about 500 DSSs have been developed and published for various applications (indicated by "B");
- development of the DSS theory ("F" - "I"), as well as the theory of design, implementation and evaluation of "C", "D" and "E", the study of related disciplines "J". The first group of research areas, labeled "F" - "I", is based on the strongly influenced DSS architecture [4], while the second group of research areas, labeled "C" - "E" is influenced by development [5];
- development of DSS for various fields of application, designated "A" and "B".

The trend towards the prevalence of Internet-based decision support systems has been clearly visible since the late 1990s. Modern systems of web recommendations are characterized by the following main trends: the use of complex methods of multi-criteria decision-making; application of technologies of virtual and augmented reality; expansion of the cognitive functions implemented in decision support systems; increasing the list of opportunities for decision-makers [6-7].

DSS are widely used in various fields of application such as telecommunications, banking, trade, large construction, development and operation of complex technical systems, etc.

The task of developing intelligent systems as applied to technological production processes is urgent [8-11].

2 Materials and methods

To improve the performance of decision support systems, data mining based on data manning is used.

"Data manning - automated analysis of massive data sets" - data mining - automated analysis of an array of data sets [8]. The development of automated information collection tools and data mining methods is progressing at a rapid pace.

"Information - information (messages, data), regardless of the form of their presentation." Data have the property of integrity, which consists in accuracy and completeness.

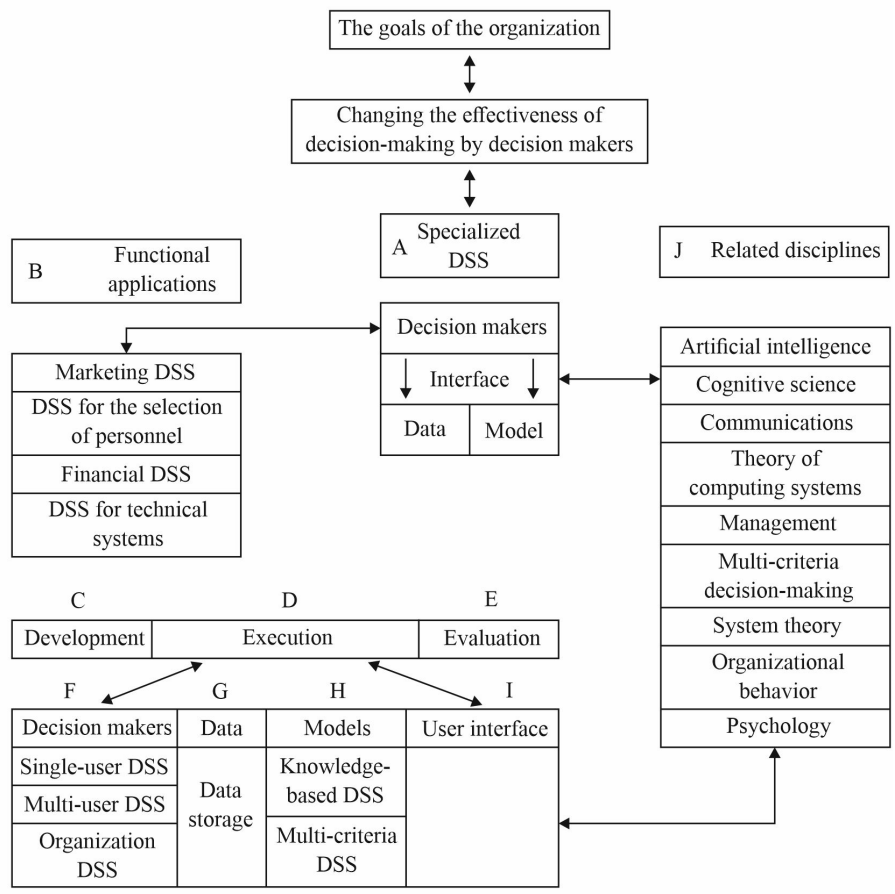

Fig. 1. Generalized block diagram of decision support systems and related disciplines.

Data mining allows you to automatically organize the search for data in large data warehouses, to identify and establish relationships and patterns. Data mining is based on the use of complex models and algorithms, including those performing data segmentation, forecasting upcoming events with a certain probability. Data mining algorithms automatically search for and identify patterns and trends in large data warehouses. Data mining has the following basic properties [9]:

- focus on large data sets and databases;
- prediction of likely outcomes;
- automatic discovery of patterns;
- creation of actionable information.

Data mining can provide solutions to problems that cannot be analyzed through regular and reporting techniques and queries.

Data mining systems are applied in three main areas:

- as tools for carrying out unique scientific research, development of intelligent technologies;
- as tools in research and development work in the development of technical systems;
- as a mass product for business application.

In order to increase the efficiency of the technological process for the synthesis of protective oxide coatings, it is important to create an intelligent system that makes it possible to reduce the technology development time by at least 2 times due to the automated selection of optimal technological modes, development of a methodology for the synthesis of oxide coatings with specified properties. Further, an intelligent decision-making system in the process of synthesizing protective oxide coatings by the method of micro-arc oxidation (MAO) is considered.

3 Results

The specified intelligent system consists of three main parts: hardware, information support subsystem, software (Figure 2).

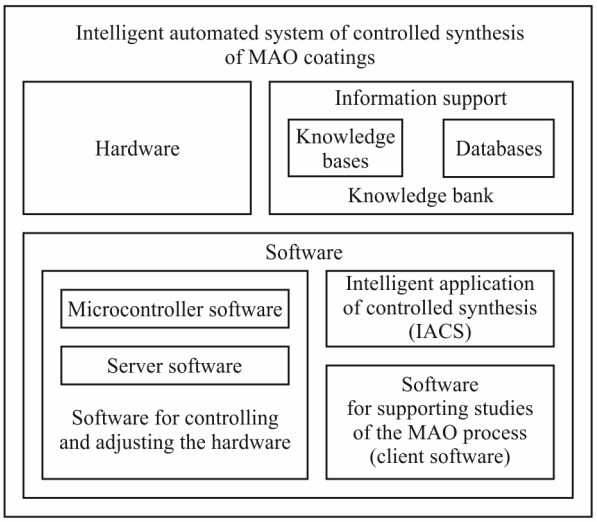

Fig. 2. Intelligent decision-making system in the process of micro-arc oxidation.

The basis of the information support subsystem is a knowledge bank (Figure 3), which contains a set of the following knowledge bases and databases:

- knowledge base of the properties of oxide coatings obtained by the method of micro-arc oxidation;
- knowledge base of the modes of the MAO process;
- knowledge base of models of the relationship between the properties of the resulting coatings, depending on technological modes;
- knowledge base of principles and methods for measuring parameters of oxide coatings, as well as technological modes;
- knowledge base of measuring instruments, their technical and metrological characteristics;
- knowledge base about the mechanism of surface modification by micro-arc oxidation;
- knowledge base of the requirements for the properties of oxide coatings, depending on their field of application (medical purpose, instrumentation, mechanical engineering, etc.).

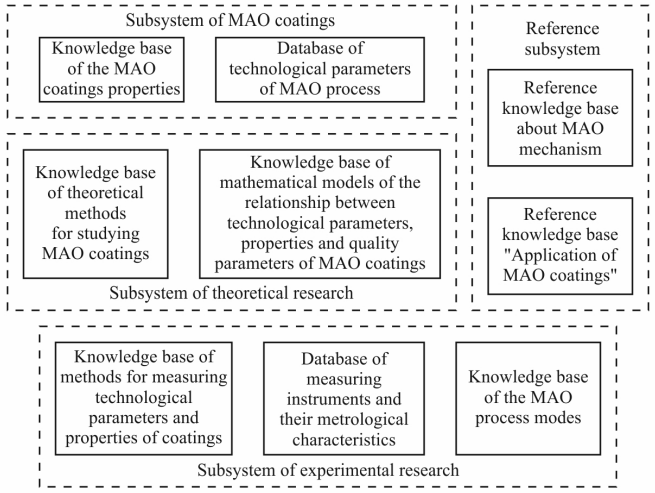

Fig. 3. Subsystem of information support of the decision support system.

The software controls, configures, calibrates the hardware, and also includes an intelligent application for coatings' synthesis; client software to support the implementation of the MAO process. The software of the microcontroller, which controls the hardware part of the research support system; server software that configures the system were developed. In order to implement the methods proposed by the authors for the controlled synthesis of MAO coatings, an intelligent application has been created [12]. Research support for the MAO process is carried out using software that processes experimental data, calculates errors in measurement results, displays data in a form convenient for users to perceive (tables, graphs).

The hardware is a computer-controlled automated system for the synthesis of oxide coatings. In turn, the automated system consists of a process current source, a power

supply unit, a measuring part, a microprocessor module, and a galvanic cell located in a protective enclosure (Figure 4).

The measuring part includes channels for real-time measurement of technological parameters (electric voltage, current, temperature, brightness of micro-discharges) of the micro-arc oxidation process and parameters of the synthesized oxide coating (thickness, porosity, etc.).

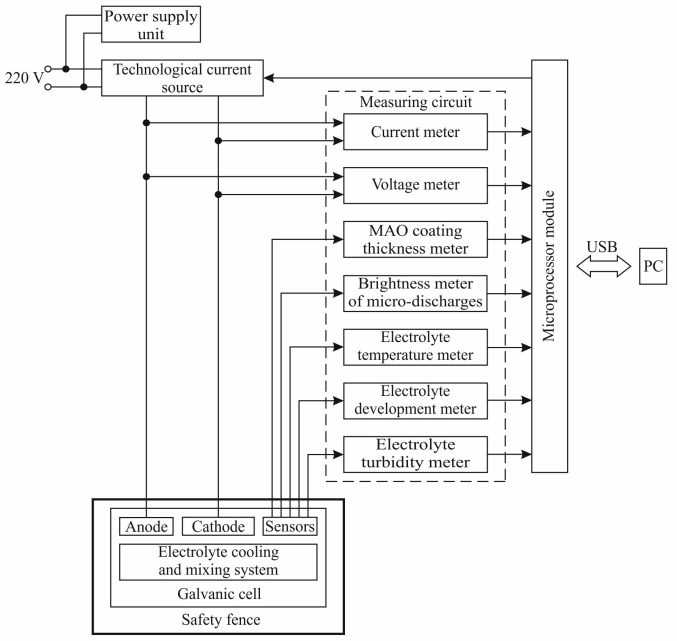

Fig. 4. The hardware of the decision- making system in the process of protective oxide coatings synthesis.

4 Discussion

The microprocessor module generates control signals both for the measuring channels and for the process current source. The microprocessor module includes digital signal synthesizer, galvanic isolation unit, a microcontroller (consists of an analog-to-digital, ADC and digital-to-analog converter, DAC), an 8-channel multiplexer and a UART port; USB-UART interface converter based on FT232RL microcircuit.

Thus, the automated measuring module as part of the decision support system, controlled by software, makes it possible to establish the relationship between the parameters of the micro-arc oxidation process and the properties of oxide coatings, to select the technological modes that ensure the synthesis of oxide coatings with the given properties.

5 Conclusion

An original structure of an intelligent system for controlled synthesis of MAO coatings, including a decision support system based on data mining received in real time from the output of the hardware was developed. In turn, the hardware part consists of the following elements: a technological current source (includes a power module and a switch); power supply for low-voltage electronics; measurement and control modules, USB-oscilloscope and galvanic cell.

The decision support system programmatically implements unique models of the interconnection of influencing factors and parameters of synthesized coatings, methods for choosing the optimal technological modes proposed by the authors. The proposed system made it possible to reduce the technology development time by at least 2 times, to minimize to 0.5% the relative error in measuring the electrophysical parameters of MAO coatings, which contributes to an increase in the efficiency of the micro-arc oxidation technological process.

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