THE DATA FLOW AND DISTRIBUTED CALCULATIONS INTELLIGENCE INFORMATION TECHNOLOGY FOR DECISION SUPPORT SYSTEM IN REAL TIME

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Abstract: The *aim of this investigation* is to develop *unified models* of complex technological process as controlled object states knowledge presentation; *methods, algorithms and system* of complex technological process states monitoring (situation assessment) programs automatic synthesis according to preset target and capability of verification and optimisation considered; *special software prototype* realizing controlled objects automatic monitoring.

1 INTRODUCTION

The *aim of the fulfilled investigation* is to develop methods, models and algorithms oriented to concurrent on-line user software assurance for all sorts of measuring information (information fusion) specifying states of complex technological process (situation assessment) at all phases of complex technological process life cycle and control function in real time.

This aim should be achieved by here suggested artificial intelligent information technology. The suggested newly designed information technology is based on decision of basic research problem. This problem is monitoring and control of states of complex technological process (situation assessment). The basis of this artificial intelligent information technology is *flow computing* models exploitable by *state hipping* (*constraint programming*) in *real time* and in territorially *distributed computing network*. At the same time each network node represents *artificial intelligent agent*.

2 THE MAIN TASKS AND RESULTS OF INVESTIGATION

A profound study of theoretical results showed that there exists a great number of publications in the area of measuring information (MI) processing and analysis methods, on the other hand, research in the areas of design automation for monitoring software complexes, development of techniques allowing to arrange for parallel processing and analysis of measuring information in computing environment with changing structure are poorly reflected in literature. The impact of types and structures of the processed information on the composition and structure of the considered software complexes is not well investigated either.

Experimentally received positive results in software complexes for monitoring creation and implementation are of heuristic nature and based on developers intuition and experience; their elaboration requires running of time and labour consuming experiments at the synthesis stage. Moreover, the existing methodology and used software packages do not meet certain requirements for embedded special software of territorially

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distributed complex technological process systems with variable structure functioning in real time.

Known approaches provide ineffective solving of the following basic problems facing to the theory and practice of the computer-aided monitoring system (CAMS) or do not provide them at all:

– absence of uniform conceptual basis of construction of the information systems (IS) IF of MI, functioning in various states of application and a special-purpose destination system;

– impossibility of the formal description of all possible kinds of technical states (TS) in principal in view of their adequacy to events and processes, taking place at Analysis Object (AO) because of the application of the various mathematical apparatus – for various in destination purposes of MI analysis;

– presence of a plenty of forms of data presentation and accordingly, types of models of knowledge representation (MKR) about AO, caused by existence of subjective views and specialized approaches in the different interested organizations engaged in problems of monitoring of states of AO that interferes with accumulation, systematisation and distribution of a wide experience to practice of operation of advanced IT AA MI, proved their utility;

– impossibility, as a rule, to form automatically correct and optimum program AA MI on any set for concrete session of management of the purpose of the analysis in view of specific states of its realization with the help of existing scientific and practical approaches:

– inability of applied theories, models and algorithms known at the present time to carry out AA in view of essential features of MI coming for the analysis, among which it is possible to note its natural parallelism, stream type, poorly predicted intensity, presence of uncertain measurements, e TS;

– absence of a theoretical and experimental substantiation of structure and composition of SPO, capable to provide the effective solving of problems of the distributed CAMS and its basic (from the point of view of a saturation of the used mathematical apparatus) element – IS IF of MI;

– presence of the big expenses for the modernization and support of the big Program Complex (PC) IF of MI which reliability is inversely proportional to their volume;

– orientation of the used modelling-algorithmic support, basically, on one parametrical optimisation of speed of carrying out of IF, when speed of reception of the results of AO states monitoring depends only on capacity (and also on cost) of the used computer complexes- independently of their architecture and also of some others, less essential.

Monitoring automation for real-time supervision of complex technical objects (CTO) involves several unsolved problems:

– lack of universal methodological and methodical basics for structure-functional synthesis of information technologies and monitoring systems for CTO;

– the existing models, methods, and algorithms for processing and analysis of measuring information (MI) do not thoroughly describe its properties such as natural concurrency, flow characteristics, inconsistency, and uncertainty;

– there is no theoretical foundation for computer-aided design of real-time CTO monitoring software in distributed control systems;

– information fusion concepts and algorithms for integration of multi-domain telemetry data and practical knowledge are not developed yet.

Therefore the following tasks are very actual and are investigated (Okhtilev, 2001):

1. Review of existing research and technical approaches to solve in real time problems of monitoring and control for complex technical systems.

2. Elaboration of a joint conceptual framework to develop information systems (IS) functioning under changing application conditions as well as under different application missions (including methods of modelling “the changes” for estimated states and for controlled object based on calculus of variations).

3. Formal description of all possible kinds of controlled states (assessed situation) accounting for their adequacy to actual actions and processes on controlled object caused by application of different mathematical apparatus for various functional objects. Multi-model formalization intends for describe actions and processes on the controlled object.

4. Synthesis of automatically correct and optimal program for monitoring any target preset for a given control session having specific realization conditions.

5. Development of models and algorithms for state estimating oriented to essential features of *measuring information fusion* (natural parallelism, data-flow, weakly predictable intensity, fact of doubtful measurement, etc.).

6. Development of software prototype using basic suggested solutions for information fusion system design

The fulfilled investigations towards the development of information technologies and monitoring systems resulted in the following items (Okhtilev, 1999, 2000, 2001):

– system analysis of monitoring processes providing reliable estimates of CTO states under

conditions of a priori uncertainty and failures was performed;

– a unified model for description of weakly formalized information about CTO states was developed via declarative representation of knowledge;

– a concept of invariance for CTO states and monitoring process states was substantiated;

–theoretical basics for construction of topological space of CTO states were developed;

– methods of automatic monitoring program synthesis for a given goal were developed and tested;

– methods of monitoring program optimisation and verification were developed and tested;

– methods of correctness control for algebras over computation models were justified and investigated (Okhtilev M., Bogomolov S. and Dmitriev A., 1990);

– unified reliable computation-model based methods for local recognition of states were justified and investigated (Okhtilev M., Bogomolov S. and Dmitriev A., 1990);

– concepts of modern information technologies were adjusted for design and maintenance of software for state monitoring in real time (Okhtilev, 2000, 2001).

Advantages of the proposed approach to synthesis of intellectual information technologies and systems are based on new fundamental scientific

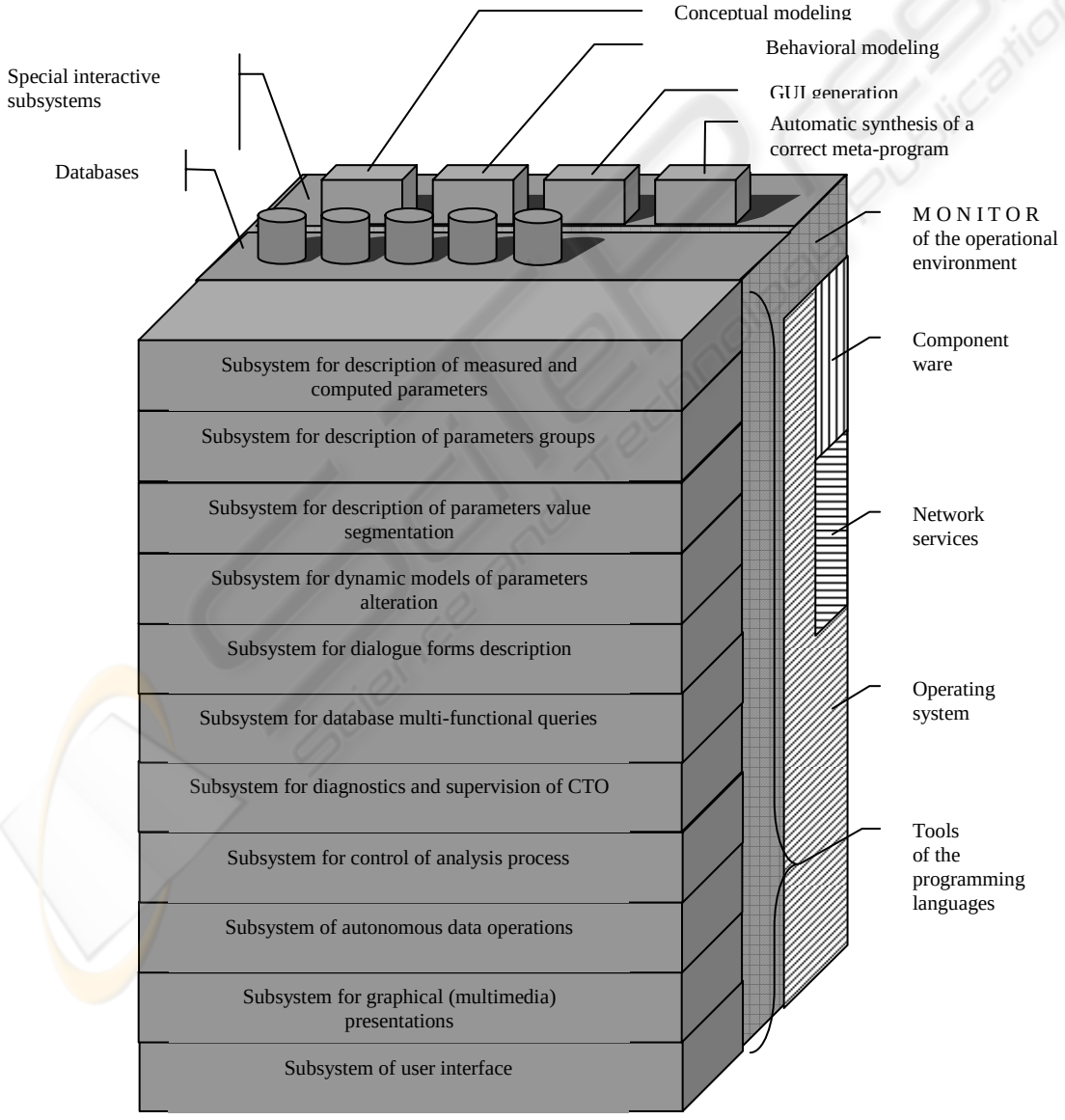

Figure 1: The structure of operational environment for CTO monitoring software.

results received in topology, algebra, mathematical logic, and the theory of artificial intelligence. This approach provides general scientific grounds for different important classes of CTO monitoring and control problems. The problems that had only heuristic solutions, if any, can be solved via the developed unified models and methods of information fusion, program synthesis, and verification.

3 CONCLUSION

Suggested intelligent information technology will allow to reduce costs and shorten complex technological process underlying the elaboration of a system for monitoring and control of states of complex technological process, and will facilitate significantly its further modification. At that systems for real time monitoring of states of complex technological process acquire principally new qualities. Particularly they allow to monitor in real time the states of complex technological process characterized by great number of measured parameters under reconfiguration of controlled object structures. Based on the proposed information technology the automation level for control of complex technological processes could be advanced, possibilities of control of objects at degradation of their structures extended, reliability and efficiency of control processes increased, possibilities of early detection of various technical faults as well as timely prediction of catastrophes allowing to make right decision and take appropriate prevention measures evolved. Moreover, suggested objects monitoring information technology can substitute most of currently operating software of the above analysed application when used for a development of embedded and scalable software. Implementation of the special software based on the suggested intelligent information technology looks promising for many critical applications.

The pilot versions of CAMS for CTO states supervision (in space systems and atomics) work in network of IBM/PC-compatible computers; it uses special operational environment (Okhtilev, 1999, 2000, 2001), real-time database management system, multi-window interface, and programming language C/C++. The structure of the operational environment is shown in Fig. 1. The prototypes of CMS belong under the class MMI/CACSD/SCADA/MAIS (man-machine interface/ computer-aided control system design/supervisory control and data acquisition/multi-agent intellectual system). A command is the basic instruction that a script file contains. Some commands require parameters that further define what the command should do. An expression is a combination of operators and arguments that create a result. Expressions can be used as values in any command. Examples of expressions include arithmetic, relational comparisons, and string concatenations.

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