Using the Tool Complex G2 for Control of Electrophysical Complex

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Abstract

We present here a research project connected with using integrated expert system for control of electrophysical complex. This paper deals with the prototype of real-time expert system (RTES) developed by Gensym′s G2 tools. The electrophysical complexes are complex engineering-technical objects, which have many input and output parameters and often these parameters can be dependent on each other. Than electrophysical complexes have more one level allocate structure of control system and common number of parameters and values which control needed can be a couple thousand. It must be point that the demonstration prototype of RTES for control of electrophysical complex, which is working up in Moscow State Engineering Physics Institute (Technical University) will use to work different projects of creating elements and subsystems of RTES and also for teach a final-year students of Automation and Cybernetic departments to use modern software like as G2. Function of this prototype are realizing on DEC′s ALPHA/AXP platforms.

1 Introduction

The modern electrophysical complexes (EC) are complex engineering-technical objects. The distinctive peculiarity of it are the interaction of charge particles with electromagnetic fields. EC are multiparameter, unlinear and unstable objects of control with many input and output parameters and often these values can be dependent on each other. Than EC have more one level allocate structure of control system and common number of parameters and values which must be controlled can be a couple thousand.

The difficulty and time of design hardware and software providing of control system for same objects can be particularly shorten if use new technology like as system G2 Gensym Corp. [1]. G2 is the core of Gensym's family of artificial intelligence (AI) products.

G2 is a development environment for creating and deploying intelligent real-time applications. G2 can be used to develop applications that solve many problems commonly encountered in business, scientific, and industrial markets. While G2 is flexible enough to use for almost any intelligent application, G2 users typically apply G2's capabilities to complex situations that require:

- Monitoring, diagnosis, and alarm handling
- Scheduling and logistics
- Supervisory and advanced control
- Process design, simulations and re-engineering
- Intelligent network management
- Decision support for enterprise-wide operations

G2 provides a complete, graphical development environment for modeling, designing, building, and deploying intelligent applications.

An application in G2 is called a knowledge base (KB). All components of a KB exist as items. The knowledge and data in a KB are represented by special items called objects. Items and objects can appear graphically as icons. G2 calls the "blank pages" upon which you create and maintain objects workspaces. A logical hierarchy of objects and workspaces can be created to group and organize KB data. A large KB can be developed from smaller, more manageable pieces called modules.G2 development is based on object-oriented design. Knowledge representation maintained and extended through classes in the G2 class hierarchy.

G2 support either Motif or MS-Windows system styles, and tools for conversion between both styles.

At the core of the developer′s environment lies G2′s structured natural language for creating rules, models, and procedures. G2 includes concurrent execution of rules and procedures and the ability to reason about behaviour over time. G2′s natural language facilities allow to create users menu translations for none-European languages.

G2 includes network and interfacing capabilities through several mechanisms :

- Telewindows
- G2 to G2 interface
- G2 Standard Interface (GSI)
- G2 File Interface (GFI)

Telewindows allows more than one user to access the same G2 independently. The G2 to G2 interface lets two or more G2 processes to connect for the purpose of exchanging data. G2 supports either a DECnet or TCP/IP protocol. The GSI product is a network-oriented tookit used for developing software interfaces, or bridges, between G2 and other, external systems. The GFI interface allows G2 to read and write external data files.

G2 supports the use of foreign functions, which are functions written in C or C++. The foreign function interface is platform-undependent.

The specialists in specific knowledge can create fast and effective prototypes for future systems, test and take its to finish stage. Target of this paper is research of possibility of system G2 used to make the prototype of real-time expert system (RTES) for control of EC. The next section describes the prototype structure of RTES for control of EC. The section 3 gives an examples of G2-based KB of vacuum subsystem and G2-based KB cooling subsystem of superconductor magnets. Finally we conclude and open some perspective in this report.

2 Prototype structure of RTES for control of EC

Developing prototype of RTES [2,3,4,5,6] for control of modern EC is oriented towards solving next problem:

- schematic introduction of main processes happen in complex and in other subsystems and in different level processes;
- graphical interface with user to observe changes of main parameters, which describe work of complex system;
- automatic control work of complex and control system, registration of different deflection from standard or setting mode and inform operator about it, prealarm, alarm shut down, regulate mode, come back to work mode after consultation with user;
- study of users actions and teach user in training apparatus mode;
- make archives of all users actions and values of complex, working all information up, issuing all necessary information.

The modern EC include some difference subsystems, which provide receiving of charge particles, acceleration them, focus and transport them with definite requirements showing energy, energy spread, angle divergence and time characteristic of accelerated particles. The developing system was very difficult and multifunctional therefore was using unit principle of building the prototype of RTES for control of EC. In accordance of structure of EC was assigning separate units. Than we can union all units and receive the prototype of RTES with single KB. At present stage of work it was using three subsystems: vacuum, magnet and highfrequency power .

Let′s examine architecture, composition and structure main components of work-version prototype of RTES. It consist of as traditional components of expert system (KB, reasoning, work memory, explanation and acquisition) as and special components, allow interaction with equipment EC in real time (modeling subsystem, subsystem connected with equipment EC). KB of the prototype maintain description of equipment, belong to aboveforegoing life-support subsystems, in hierarchy of G2 objects descriptors and description of emergency situations identifying by means of rules and procedures of G2. Therefore KB of this version system maintain:

- objects that reflecting different kinds of equipment subsystems for support of vacuum, superconductor magnets and highfrecuency power;
- connections that reflecting joining of equipment;
- variables, which must receive values from different sensors (in RTES its come in from subsystem modeling outside world);
- lists that using for storage messages operator;
- workspaces to represent of EC structure charts ;
- rules for determination of concrete situations needed process;
- procedures for successive making of concrete actions (start, stop, shut down, tune subsystem of EC);
- formulas for work up of parameters which are receiving from sensors;
- functions for estimate of complex calculated values of concrete parameters.

Based on reasoning RTES realize deduction of conclusions or recommendations next types: notification of operator about deflection of control values (received or calculated),sending of control command to concrete equipment, start of complex control process etc.

In this version RTES by help of reasoning keep up only forward inference strategy. It must point that from nine types of rules G2 are using common rules next types: are exciting with changes of conditions(if ...then),are exciting with restart of system(initially) and rules-demon (scan).

Possibilities to use common rules G2 allow to abstract from concrete equipment and describe only common properties and lows, inherent sum total type of equipment that particularly to short of difficulty of forming KB.

Interaction subsystem secure of realize for two functions:

- constant delivery of messages about changes of main parameters, characterizing work of EC, on screen, and warning about emergency situations;
- possibility of operator′s influence to change function of EC equipment.

Modeling subsystem, which used instead of subsystem of real EC for imitation data of sensors include a component, joined with modeling of outside negative interaction (for example: leak in vacuum camera or heating of superconductor magnet) and component modeling of change of control parameters during the work of EC.

3 Some examples of KB fragments

In this section we describe some examples of G2-based KB of vacuum subsystem and G2-based KB cooling subsystem of superconductor magnets.

3.1 Example of realization vacuum subsystem of EC

Let′s examine few questions of KB realization of vacuum subsystem by G2. The main object is vacuum camera, in which must be high vacuum.

For example, vacuum camera can have three states: atmosphere pressure (P > 0,05 Pa), low vacuum (0,0007 Pa< P<=0,005 Pa), high vacuum (P< =0,0007 Pa).

Combine with it in KB is including three rules:

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for any preobr-pmm-46 M
   for any vacuum camera V connected to M
      if the pressure of M>0,005 then conclude that the state of V is atm_pr

for any preobr-pmm-46 M
   for any vacuum camera V connected to M
      if the pressure of M <=0,05 and the pressure of M >0,0007 then conclude that the state of V is low_vac.
for any preobr-pmm-46 M
   for any vacuum camera V connected to M
      if the pressure of M <=0,0007 then conclude that the state of V is high_vac.
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The other group of rules in KB are watching behind state of vacuum camera and pump out process, depend from are starting procedures, which control rising vacuum to necessary point, moreover, procedures starts the necessary equipment.

In case of happened unpressurized of vacuum camera it′s isolated. All attributes present on scheme and then it′s can analyzing work of system. The attribute "pressure of vacuum camera" save self history on 100 values. It′s permit to make a grath measurement of pressure.

3.2 Example of realization cooling subsystem of superconductor magnets

It is staying at questions of KB realization of cooling subsystem of superconductor magnets. This subsystem are include the different types of magnets with cooling substances: helium with temperature 5K and helium with temperature 2K.

When temperature of magnet equal temperature of outside the for any magnet open tap, which give the possibility of helium 5K come to magnet tank and temperature will staying 5K. After it the same operation is happening with helium 2K.

When temperature of magnets are 2K its will became superconductor. Now magnets are ready to accelerate beam . Follow are presenting samples of rules, which are controlling these processes (initially conclude that the temperature of every magnet = 2 and conclude that the state of every tap is closed and start relate for any magnet M):

for any srv S connected to M
if the temperature of M > 5 and the state of S is closed then start freeze 5 (M)

for any sfv S for any magnet M that is connect to S
if the temperature of M > 2 and the temperature of M <=5 and the state of S is closed
then start freeze 2 (S).

4 Conclusions

It must be point, that is working up in Moscow State Engineering Physics Institute (Technical University) demonstration prototype RTES for EC will using to work different projects of creating elements and subsystems RTES and for teach students to use modern software like as G2.

Functions of prototype are realizing on DEC's ALPHA /AXP platforms (with Open VMS 6.1 operative system).

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References

[1] D. Siegel, D. Riddell, "introducing G2 4.0", Marketing Bulletin.-Gensym Corporation,1994, November.

[2] V. Rybin, G. Rybina, V. Chuchkin, "Application G2 Software for Development of Demonstration Prototype of the Modern Electrophysical Complex Control System", Proceedings of Real-Time Expert Systems Conference. Moscow, CRDZ, 1995, p.93 -99.

[3] V. Rybin, G. Rybina, A. Haritonov, "The Real-Time Expert System Prototype for Control of the Electrophysical Complex", Proceedings of Dynamic System in Modelling and Control Conference. Moscow, CRDZ, 1996, p.53-55.

[4] V. Rybin, G. Rybina, A. Haritonov, "The Questions of Using System G2 for Design of the Prototype of Real Time Expert System for Control of Electrophysical Complex", Proceedings of KAI-96, Russia, Kazan, October 5-12, 1996, v.2, pp.225-230.

[5] G. Rybina, "The Questions of Design of Integrated Expert Systems for Diagnostics of Complex Techical Systems", Proceedings of 6-th International Conference KDS-97. Ukraine, Yalta, Sept. 1997. Intelegence System Developers and Users Association, 1997, Vol. 2. p. 421-428.

[6] V. Rybin, G. Rybina, "The Prototype of a Real Time Expert System for Control of Electrophysical Complex", Proceedings of 15th IMACS World Congress on Scientific Computation, Modelling and Applied Mathematics: Berlin, August 1997, Vol.4, Artificial Intelligence and Computer Science, pp.97-100.