THE LABORATORY OF VISUAL PROJECTION THE COPRAS_FW_7.0 -TOOL SUBSYSTEM OF REAL TIME SARS

Anatolyi BALABANOV [1]
Igori ALBINA [2]
Technical University of Moldova, Automatica Departament,
Bd. Ştefan cel Mare nr.168, MD 2004, Chişinău, Republic of Moldova,
phone: (+373-22) 497694, fax: (+373-22) 497004,
[1] *balsoft@moldovacc.md,*
[2] *igor_albina@front.ru*

Abstract. This work describe the examples of practical usage SCADA TM5 which is a source of a trustworthy information at projection and carrying out of researches in the local SAR within the framework of ACSTP by the method of computer simulation in a programming space of visual projection of automatic systems COPRAS-7 by means of OPC. COPRAS-7 represents now the managing micro-computer (workstation) allowing to solve operatively a problem of the analysis, synthesis and correction functioning CAP under management SCADA TM5 and to carry out the continuous process of optimum adjustment of regulators under changing dynamic characteristics of control objects, using a wide arsenal of methods of optimization and synthesis CAP available in the list of functional and service tools KOPRAS-7. It is briefly described also new КОПРАС-7.
Keywords: Simulation, SCADA-, OPC technology, projection and calculation of automatic control system, local SAR, optimal control system.

COPRAS and SCADA TM5

Development of system decisions on ACSTP is one of the main stages of construction ACSTP and will consist from

- The analysis of regulation objects, statement of tasks of control;
- Synthesis of algorithms of the decision of functional problems ACSTP;
- Realizations of algorithms by software chosen SCADA (FBD, Tehno IL) either the built - in workstations or controllers;
- Other stages.

For carrying out qualitative, and frequently and the operative analysis of object, there is a requirement for reliable system of gathering and initial processing of the information. Such system should support the interface of an information exchange in real time. SCADA-system Trace Mode presented by firm AdAstrA Research Group, Ltd has these and many other advantages.

Support of an exchange under standard OPC (OLE for Process Control), and also support ActiveX and other provides flexibility not only in construction modern ACSTP, but also use TM5 in research work. Usage TM5 and КОПРАС - is one of examples practical integration of one of the best programs of data gathering and the specialized program for carrying out of scientific researches in the theory of automatic systems.

COPRAS - the COmplex of PRograms for the Analysis and Synthesis of automatic systems (www.kopras.fromru.com) has found wide application as tool means SAIR and visual programming at the decision of problems of projection SAC (simulation, analysis, synthesis, calculations, visualization, programming, correction, optimization, etc.) or at research of dynamic models of systems in technics (technical equipment), mechanics, etc., in educational process of high scools, licea and colleges by preparation of experts in the field of automatics, automation of productions and ACSTP, organizing on its basis a laboratory

practical work, course and diploma projection. COPRAS can be used also as demonstration means at studying many sections of higher mathematics, physics and the applied disciplines connected to necessity of the decision of the differential equations and research on their basis of various dynamic processes. Using COPRAS together with TM5 allows to solve the challenges as at a stage of development general-system decisions on ACSTP (analysis and synthesis), and during the period adjusting works (correction of parameters, algorithms, adjustments of regulators).

The mechanism of interaction TM5 with COPRAS is shown on Figure 1 where OPC-client and OPC-server are realized as the functional blocks COPRAS which are included in its library of operational, functional and service blocks, elements, functions and tools. Creation of such special blocks makes possible practical sharing TM5 with COPRAS for preliminary, operative and current research and verifying calculations local SAR modern ASCTP. COPRAS can be installed on the same PC where it is established MTR TM5, and COPRAS can play a role of the intellectual calculator of a highlevel in hands of the conducting engineer or the developer of ASCTP on base TM5.

The block diagram of interaction TM5 and COPRAS, and also a window of adjustment of parameters of block "OPC-CLIENT" are submitted on Figure 2. The given circuit allows to receive value of the channel from TM5 through block "OPC-CLIENT" and, having transformed it under the PI-law to take out it on OPC - server COPRAS, which can be read TM5 by means of its client part. The window of adjustment of block "OPC-CLIENT" will consist of the following fields:

- « the Name of the OPC-SERVER »
- the Field of display of channels of the OPC-SERVER
- « the Name of the channel » - is displayed the channel chosen for interaction
- « Type of data acquisition ».

COPRAS supports three types of data acquisition: synchronous reading, asynchronous reading and a subscription. At synchronous reading the client sends to server inquiry with the list of variables interesting him and waits, when the server will execute it. At asynchronous reading the client sends to server inquiry, and itself continues to work. When the server has executed inquiry, the client receives the notice. And, at last, in case of a subscription the client transfers to server the list of variables interesting him, and then a server sends to the client the information on changed variables from this list on a regular basis .

«The Filter on reliability » - Is based on an opportunity of quality check of the received data from the OPC-SERVER which happens three types (poorly, satisfactory, good). COPRAS filters accordingly (everything, satisfactory goog, only good).

Time of interrogation is equaled to a step of simulation, and limited only to opportunities of OS and productivity of system.

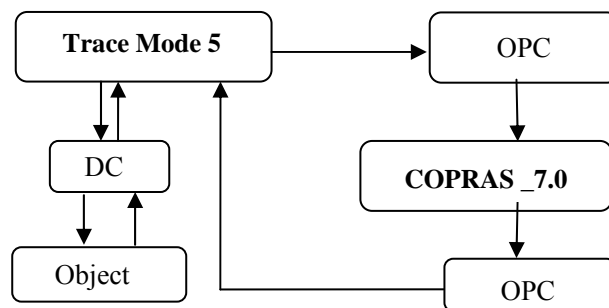The name of group for all cases is accepted "Copras".

Figure 1. The circuit of interaction COPRAS with TM5.

Values of block " OPC-SERVER " it is taken out on the OPC-SERVER of COPRAS - « Copras. Gate1 ». The name of the block is formed of a line "COPcanal" and numbers of the block in the block diagram. So for the block diagram (figure 2) a name of channel "COPcanal2"

Let's result a practical example of use of COPRAS together with TM5. At research and adjustment ASCTP for local keeping up system the transitive characteristic of object is presented as a curve resulted on Figure 3. Having executed

identification OC with the help of program ISIDORA (delivered complete with KOPRAS) the mathematical model of object has a kind of the differential equation of the second order.
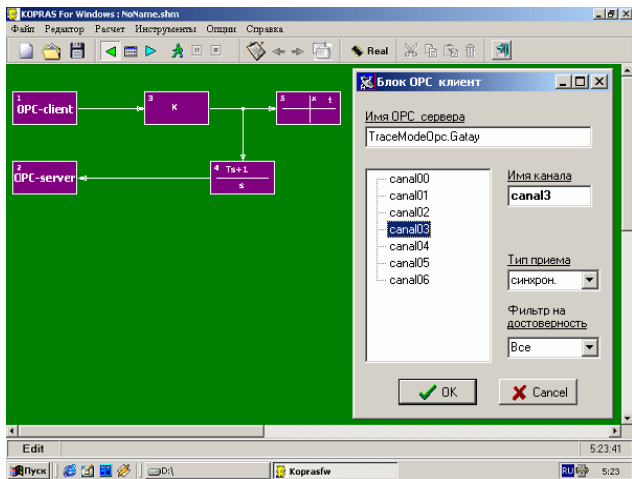
$$x'' + x = u \qquad (1)$$

Figure 2. The block diagram of interaction TM5 and COPRAS _7 on a working sheet and a window of adjustment of parameters of block " OPC-CLIENT ".

It is necessary to define the equation of a control part of the closed system with individual feedback (regulator) U=U (x), providing optimum transient on speed. The optimum system should for minimal time come in an equilibrium condition x=0, dx/dt=0 provided that control U <1.
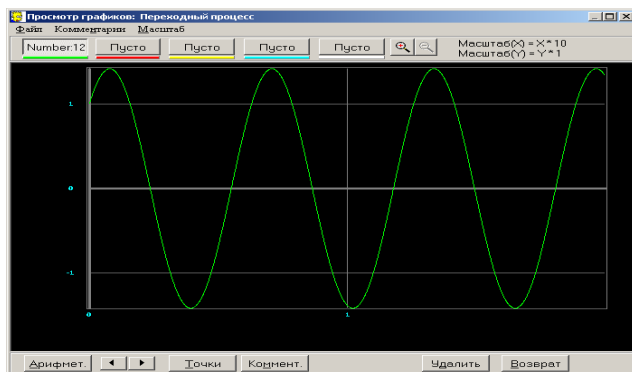
Figure 3. The transitive characteristic of object received in TM5 by means of an exchange on OPC.

For the decision of this task we shall take advantage of a principle of a maximum [1]. We shall transform the set equation

$$\frac{dx_1}{dt} = x_2, \quad \frac{dx_2}{dt} = -x_1 + u \qquad (2)$$

According to a principle of a maximum for a considered example function of Hamilton H is defined by the following expression:

$$H = \psi_1 x_2 + \psi_2\left(-x_1 + u\right) \qquad (3)$$

Solving system of the initial equations we find

$$\psi_2 = C_1 \sin(t - C_2). \qquad (4)$$

whence, with account U=± and using a method of a phase plane we find:

$$x_1 = 1 - R\cos(t + \alpha),$$
$$x_2 = R\sin(t + \alpha) \qquad (5)$$

On the basis of these expressions we find phase trajectories which are circles. How at u = + 1, they are described by the equation:

$$(x_1 - 1)^2 + x_2^2 = R^2, \qquad (6)$$

and at u =-1 it is received similar expression:

$$(x_1 + 1)^2 + x_2^2 = R^2. \qquad (7)$$

For control action, taking into account a principle of a maximum, we receive:

$$U(x_1, x_2) =$$
$$= U_{\max} sign(x_2 + signx_1)\sqrt{1 - [x_1 - signx_1(1 + 2n)]^2}) \qquad (8)$$

$$where \ n = 1,2,3,..,m$$

Let's simulate the equation (8) in COPRAS at the following entry conditions (figure 4):

$$x_{10} = -10, x_{20} = -10, |u| \le 1.$$
$$x_{10} = -10, x_{20} = -10, |u| \le 1.$$

The phase trajectory of movement of a representing point and line of switching are submitted on Figure 5.

Thus, obtained the initial data from TM5, we have managed with the help of COPRAS to carry out the analysis of object of control and to synthesize for it control device (CD) which provides optimum process on speed.

The executed calculation has allowed to make circuit FBD of the program such CD from the blocks TM5. This circuit is shown on Figure 6. One of the main advantages of COPRAS is the wide set of methods of optimization which does not demand from developers of a profound knowledge in the field of optimum systems. These methods are realized as the functional block Optim.
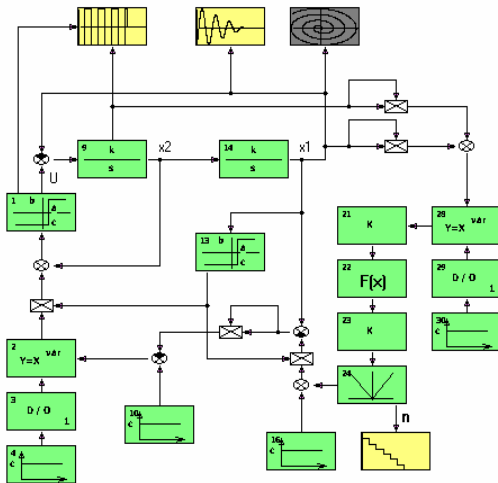
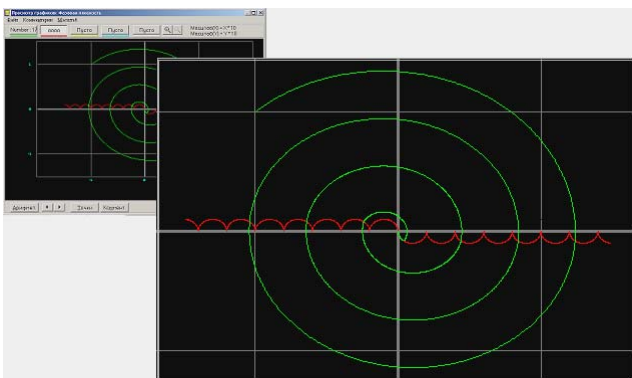Figure 4. The block diagram of a researched control system (8) in the в SVS КОПРАС.

Figure 5. A phase trajectory of researched system 1

For work with block Optim, it is necessary to specify all over again to the program parameters, changing which it is necessary to optimize the chosen criterion of an optimality (factors of amplification, constant time or attenuation of separate blocks). Submitting on an input of block Optim a signal from a point of system interesting the user and setting no more than 3 optimized parameters can be achieved required values of a parameter of quality (for example, time of regulation, overcorrection or time of achievement of the first max a dynamic mistake, etc.) process on an output of desirable block SAR.
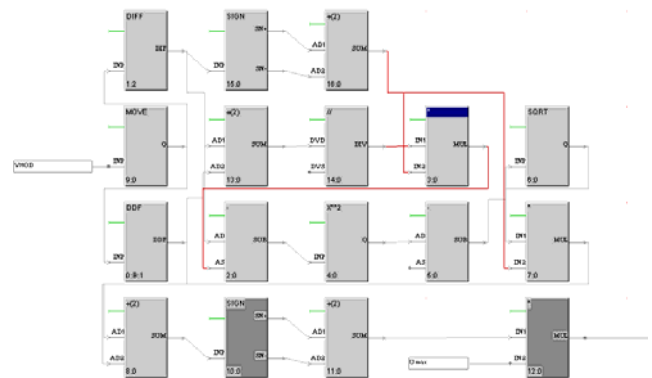

Figure 6. FBD-program synthesized CD (8), synthesized in TM5.

Optimization can be made by 4 methods.
- Poisk2 [4] realizes algorithm of division of a step half-and-half at dimension n=1 and Algorithm 2 of x 24;
- Poisk4 [4] realizes algorithm of square-law interpolation at dimension n=1 and Algorithm 4 of x 24;
- Nelder-Min realizes a simplex a method of Nelder-Mid;
- Huk-Jivs realizes a method of configurations of Huk-Jivs.

In the circuit can be some blocks of optimization (for example, one output of SAR and on an output of an element of comparison). After you have chosen the necessary block, there is a menu CRITERIA, and you can choose criterion on which optimization will be made. Initial approximation search are the values of parameters established before optimization. On

the ending of process of optimization in blocks the found parameters are established. Upon termination of procedure of optimization the corresponding message is given out.
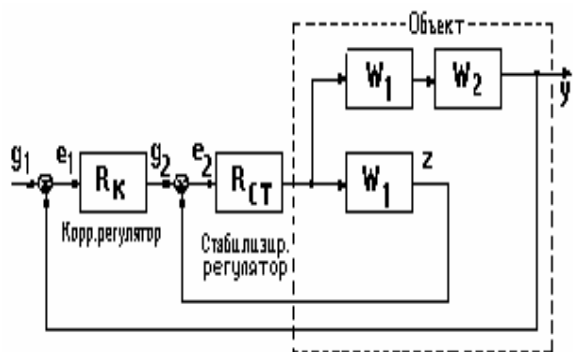

Figure 7. The settlement circuit cascade SAR

The CRITERIA of OPTIMIZATION accessible to use:
- Integral of a square of a mistake.
- Integral of a square of a mistake in view of value of a derivative.
- Overcorrection in absolute units.
- Time of approach of the first maximum.
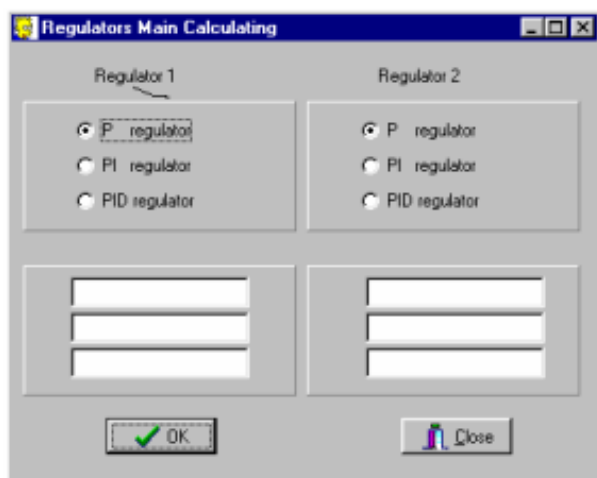- Time of regulation.

Figure 8. Selection of types of regulators and distribution of final results of calculation of parameters of the regulators of the chosen type

The given option of COPRAS allows to expect automatically values of parameters of adjustment of the typical regulators included in system of cascade regulation according to the circuit (figure 7), and using algorithms of indemnification of indignations in cascade SAR. At work in this option the program will request orders and values of factors of polynoms of numerator and a denominator of transfer functions W1 on the basic channel and W2 on an intermediate variable of object (figure 9), and also type of a regulator of each contour of regulation: P-, PI- or the PID-REGULATOR. The end of input of last information automatically includes procedure of calculation, which results - values of factor of amplification Kp, time doubling Tи and time of forestalling Td - highlight in a window (figure 8).

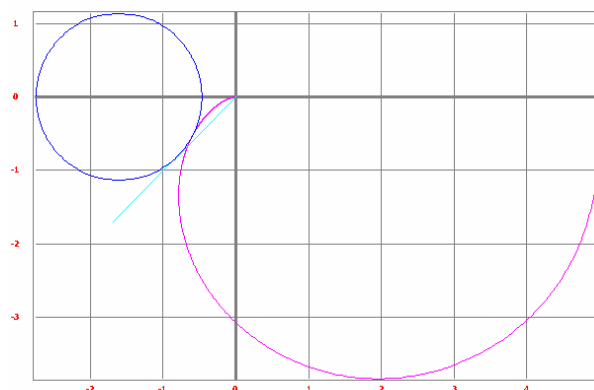Figure 9

Frequency synthesis

Has not remained without attention also frequency synthesis of systems. Function of optimum synthesis SAR by a frequency method has been entered into the menu "Calculation" on the set parameter of quality (by a parameter variability M). The essence of addition in the program will consist in automatic search of a circle which would concern simultaneously APFC of open-loop SAR and the straight line which has been lead under an angle arcsin (1/M) (figure 10).
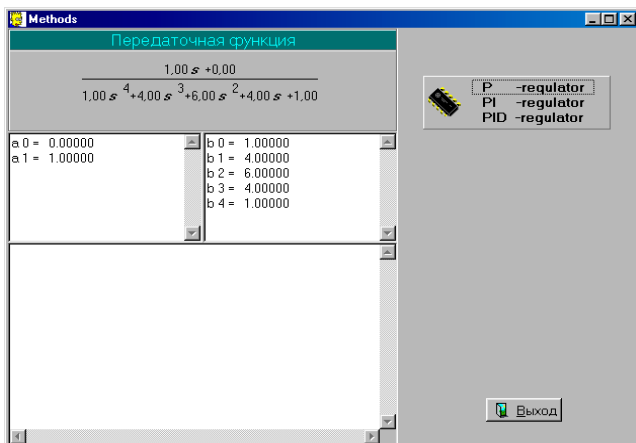
262

Figure 10. Select of the typical regulator

Figure 11. The representation of parameters at calculation typical (PI, PID) regulators.

In COPRAS 7.0. search of such circle, and as automatic search of a straight line, by a tangent to curve Kp/Tu constructed in a plane of parameters of adjustment of typical regulators is realized.

For start of the given procedure it is necessary:

- To cause function « Synthesis on the set M » from the menu "Calculation"
- To choose type of the regulator (P, PI, PID) (figure 10)
- Depending on the chosen type of the regulator to be set by parameters Timax, Timin, Tistep, and also by parameter of a variability of M (figure 11)
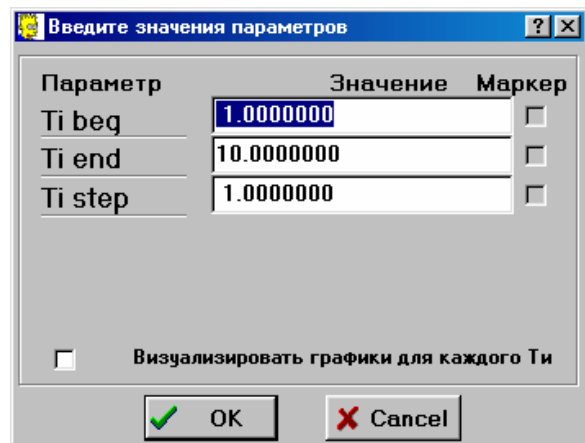
Results are mapped in a window shown on Figure 10.

References

[1] Voronov A.A. (1970) *Bases of Theori Control Systems v3. Optimal, multivariable and adap-tatifs Contriol Systems*, M:.-Energuia.

[2] *** (1998) *OPC Common Definitions and Interfaces Version 1.0.* - OPC Foundation, Oct 27.

[3] Balabanov A..A. (2003) *KOPRAS-Laborator of projection visual of control Sysytems*. User Guide.-Ch:.Technica, ISBN 9975-9448-7-2

www.kopras.fromru.com.

[4] Krutiko P.D. (1986) *Algoritmy i programmy rastheta avtomatitheskih system*.-:M:.Nauka.