CONTROL AND COORDINATION OF ECONOMIC AND INTELLECTUAL ACTIVITIES BY INTEGRATED COMPLEX STRUCTURES

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Abstract: This paper belongs to the category of research for the development and implementation of heterogeneous structures they apply favorable inclusion of the human factor for control and coordination of complex activities from various fields: economic, intellectual, biological, military, etc. It can be considered as a new direction for the development and application of modern concept CPS (Cyber Physical Systems) where activities of the above areas are treated as physical processes specific to CPS. The proposed structure highlights the interaction between the human control factor and physical processes represented by the control numerical equipments and controlled processes. In this closed loop control structure, the information is represented in three forms namely: 1. Numbers in digital equipments; 2. Physical signals in controlled processes (economic or intellectual); 3. Documents in which the human factor is part of the control structure. The bodies composed of human factors (board, council, office, manager, etc.) interact with each other and with other components of the heterogeneous system by exchange of information that have the document as physical support. For the documents creation, transmission and operation, as a carrier of information, specific tools are used: workflow, .NET development platform. virtualization procedures sharepoint environment. A particular problem for the control systems of the economic activities is the breaks existence defined as time periods of inactivity when all or some state components are kept constant so that classical models are not generally available. They appear as a specific category of systems called State Blocking Systems (SBS). Examples of controlling an economic process, based on the law of supply and demand modeling the price evolution and an intellectual process for coordination of monetary policy are presented. The results obtained by numerical simulation point out the advantages of this approach.
Keywords: Control structures; Mathematical models; Control algorithms; Finite time response; Blocking systems.

1. INTRODUCTION

The control and coordination of economic and intellectual activities are complex problems because at the stage of conceiving and implementation of control decisions, the human actions are combined with a reality expressing the evolution of controlled economic or intellectual processes.

In most cases these processes are described by dynamic models, in particular higher order differential or differences equations. No matter how trained and capable a human operator can be, he can not successfully handle activities that are dynamic interrelated up to maximum of second order.

For example, for an n order discrete time process, the human operator must intuitively perceive the effect of the current decision over a time interval of n time units. Information carrier "in a human operator", as an object in the controlling process, is the document. A responsible control is perfotmed on the basis of documents. The document is an entity in the form presented both on paper "hard" and in "soft", virtual.

The system for control and coordination of economic and intellectual activities, developed in this paper, can be applied to a wide range of economic and intellectual processes. Specific examples are limited to economic processes where the law of supply and demand is true. Such processes are described by differential equations. In the studied economic literature, a few applied control solutions are based on differential equations.

Generally, the proposed mathematical models are in the form of expressionsns. Often they are functions of time that in the background actually represent particular solutions of some linear or nonlinear differential equations. A special work in this area is the book [1], but in which the models, based on the law of supply and demand, are of the first order [2]. In this paper we use higher order models that express the interdependence between the various operators. Unfortunately the practical evolution of of such processes is characterized by intervals of rest, so that the classical models are not generally available. A contribution of this paper is the application to economic and intellectual processes of the Finite Time Response (FTR) control algorithms [3]. Many financial and economic processes have significant benefits if it succeeds to obtain, in the the shortest time, the desired values of the controlled variables. After that these variables have to remain constant.

In contrast to technical processes, in most economic processes described by state equations, eg that manipulate stocks (stocks of material, financial, intellectual deposits) or processes governed by the law of supply and demand, the system state is available for measurements. Practically, based on observations, it can delimit a number of economic agents that interact in a specific environment, such as the sale of products market, financial market, market development projects etc. Based on these observations is defined the mathematical model structure, but with unknown parameters.

Another contribution of this paper is to use identification method based on distributions to determine the parameters of system state equations. In literature, distributions based identification is performed on parameters of an input-output model. In the present case of economic processes, because the state is available, we can actually determine the parameters showing the interaction weights of different economic agents.

In this paper we aimed to achieve an automated or at least part of helping automated decision making in the field of intellectual and economic activities. The aim is to combine, in the control process of economic and intellectual activities, the systemic mathematical description of the behavior and the information representation in the form of documents. These documents are produced automatically, but they are managed and modified by the human operator involved in the process of coordination and control.

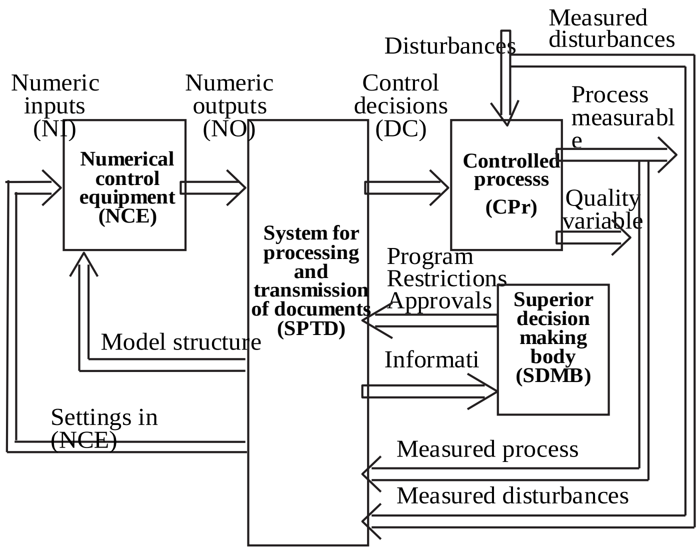
The aim is to design and implement these ideas through various software applications. These applications will manage the resources of enterprise, nonprofit organizations or commercial organizations as complementary solutions from SAP-AG. An idea of the research consists in combining the best of the various resources within the platforms and techniques namely .NET platform; SharePoint platform; techniques based on the method workflow and virtualization. As any signal that carries information is modified, processed, operated, so the document is subjected to such operations. For example, data entry, approval, submission for execution, etc.

2. THE INTEGRATED STRUCTURE OF THE SCCEIA (SYSTEM FOR CONTROL AND COORDINATION OF ECONOMIC AND INTELLECTUAL ACTIVITIES)

A system of control and coordination of economic and intellectual activities, according to this paper, is composed of three main aspects, namely: 1. Controlled process (CPr); 2. System for processing and transmission of documents (SPTD); 3. Numerical control equipment (NCE). It is proposed the structure of the as in Fig.1. This structure complies with the general structure of a control system highlighting the human factor in the process of information and decision. This human factor has the document as informational support.

2.1. Controlled process (CPr)

It consists of economic activity or intellectual activity characterized by a number of variables (quantities, attributes, characteristics) that have an evolution over time [3], [4]. On the set of these variables a causal relationship is defined, so that the process can be systemically defined as an oriented system [5]. There are a wide variety of mathematical models for economic activities and intellectual activities such as: differential equations, difference equations, tables, linguistic representations, representations by fuzzy etc., [6]. It can be determined a priori only the structure of the mathematical model, remaining as its parameters values to be determined by identification based on measurements of the input, output and state variables.



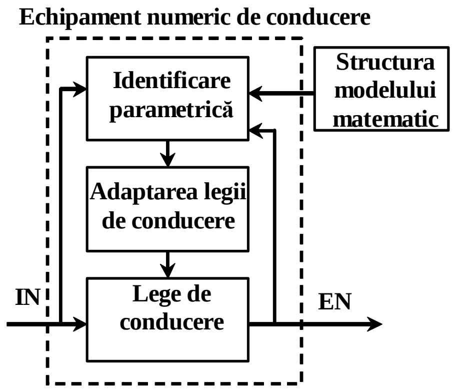


Fig. 1. Structure of the System for Control and Coordination of Economic and Intellectual Activities (SCCEIA).

Fig. 2. Sefltuning adaptive control structure of (SCCEIA)

2.2. System for processing and transmission of documents (SPTD)

The central element of this control structure is the block ”System for processing and transmission of documents (SPTD)”, subordinate to ” Superior decision making body (SDMB)”.
SPTD is composed of different organizational structures that involve human factors, but whose activity is based on documents. It is proposed to use informatics platforms. NET and Sharepoint for generating, distributing, updating these documents. The variety of the organizational structure is large, depending on the concrete application. Using the platform according to this research has the advantage that structures can be configured easily to represent a reality.
One can imagine two ways of achieving and implementing the SCCAEI namely:

a. The controlled process (CPr) exists, it functioned with a control based exclusively on the human factor. To increase the quality of control, an advanced structure as in Fig.1. is proposed. In this structure, the control decisions are elaborated by the ”Numerical control equipment (NCE)” where numerical control algorithms are implemented. In this control structure, NCE acts as operator guide, a guide for human factors that can make, according to social and human criteria, corrections on decisions developed by NCE. What is new in the approach of this paper is that it proposes a closed loop finite time response control (FTR) structure. In this structure, it takes into account the interventions and corrections applied by the operator, so that in the shortest time system to reach a desired state, required by ”Superior decision making body” (SDMB).
Obviously, in this variant, if desired or if NCE fails, the control can be achieved only through the decisions developed by human factors.

b. The controlled process (CPr) is designed and developed from the beginning to be controlled by numerical computing equipment, with all physical facilities for the transmission and processing of information. In this variant, the flow of information in SPTD and SDMB, namely issuance, movement and handling of documents, is fully automatic performed but the documents can be instantly issued, circulated and manipulated by the human factor in the system without generating shocks. Of course one can imagine and intermediate versions. SPTD receive programs and restrictions from SDMB from which the desired values of the system state are deducted. SPTD has incorporated into its structure some bodies and structures for collecting information about CPr (information "on the ground") namely the measured process variables and the measured process disturbances.

Because SPTD deliver control decisions (CD), that means it knows the applied inputs to CPr so that it is able to evaluate a series of quality variables of the CPr. In special initialization circumstances or if the control quality is worsening, by specialized bodies of analysis, SPDT appreciate the mathematical model structure underlying the CPr behavior. For example for an economic process, the observable economic agents which interact with the own system are delimited. Also the type of informational links is considered, for example linear or nonlinear differential equations, difference equations, systems with finite number of values for the input, output and state, etc. SPDT is informed of the rest periods (pause times) of CPr components. All such information is iteratively submitted for approval SDMB. In case of denial of SDMB, SPDT resume unapproved actions to obtain approval. After this stage, SPDT transmit information to NCE in a format compatible with it.

2.3. Numerical control equipment (NCE)

As any numerical control equipment, it has input ports through which are finally inserted in the numerical equipment numbers that we call "numeric inputs (NI)" and output ports through which are delivered to the outside numbers for use in one form or another that we call " numeric outputs (NO)". The input variables NI into the NCE, delivered by SPDT, contain in a format compatible with the numeric equipment, all necessary information for control activity.

We propose a specific control structure, namely ”Adaptive control structure with self tuning (ACSS)", as shown in Fig.2. This structure is appropriate for control of economic processes and intellectual activities because the system structure can well enough be appreciated. To identify the parameters of the state equations an original algorithm was conceived based on the theory of distributions. This identification method has been applied previously [7], for input output models only.

3. PLATFORMS AND TOOLS TO ACHIEVE SPDT

It aims to achieve SPDT in the control structure of Fig1, as a software applications, in the software category of ERP (Enterprise Resource Planning) or MRP (Material Requirement Planning). They will manage the resources of a enterprises, non-profit or commercial processes with a high degree of complexity.

All the SAP features can be used. Making SPTD is based on a series of concepts widely used in software as:workflow,primary and secondary processes, planning, carrying out control, transit visibility, etc.

It is noted WF (Windows Workflow), a Microsoft technology included in the .NET framework that facilitates the development of specific applications, emulation and implementing processes as workflows. In the central concept is the notion WF activity. There is a ready-built library activities. Essential is the engine performance of workflows. It includes services such as scheduling service execution unusual about service management, service tax rules. Accessible implementation possibilities are represented by the Microsoft platform MOSS 2007 and by the Sharepoint 2010 family of technologies. Sharepoint is composed of a collection of products and software elements where remarks: modules of processes management, search modules, platform for document management, collaboration functionalities based on web browser.

Another tool for creating applications from scratch of any kind is th e .NET platform.This is independent of the software architecture so that a large part of .NET assemblies can be recreated and executed on non-Microsoft operating systems (MacOS X, Linux, Solaris) [8].

4. MATHEMATICAL MODELS FOR ECONOMIC AND INTELLECTUAL PROCESSES

Concerning the development of mathematical models for economic and intellectual processes were considered two types of processes, namely: 1. Economic proceses based on supply and demand law and 2. Intellectual procese of monetary policy coordination.

The economic literature [1, 4, 9, 10], presents the problem of the evolution of prices in a market economy in general for a single operator.

In these approaches the price of a product is governed by the law of supply and demand, in the idea that the price remains constant if the demand is equal to supply. It is noted the paper [1] in which economic models are presented as differential or difference equations, but only for a single operator.

By an economic agent we understand an entity Ei (a product on the market) at the price Pi, provided, handled by an economic agent A_i or by a couple (Ai, Ej). There is an optimum value P* of

the price P_i which they would like an economic agent, for which the efficiency η_i is maximized.
The approach of this paper is considered that there n economic agents that interact directly or indirectly through the market reaction (the set of the economic agents beneficiaries and particularly of their buyers). We consider the evolution of economic processes in continuous time, so that dynamic processes are expressed by differential equations. From these we can deduce the discrete time models expressed by difference equations.

We consider n economic agents, $E_i, i=1:n$, each characterized by its activity value price $P_i(t), i=1:n$ at the current time t. It is considered the price $P_i(t), i=1:n$, of the economic agent $E_i, i=1:n$ governed by the law of supply and demand $\dot{P}_i(t)=\lambda_i\cdot[D_i(t)-S_i(t)], i=1:n$, where $D_i(t)$, $S_i(t)$, express the equivalent variables related to the demand and offer respectively, regarding the product of the economic agent E_i.

The factor λ_i allows to adjust the response speed of the price $P_i(t)$. As result from economic literature, the most difficult problem is to determine expressions for variables "demand" $D_i(t)$ and "supply" $S_i(t)$. Each component $P_i(t), i=1:n$, depend also on the values of other prices that interact with $P_j(t), j=1:n$. The demand $\mathbf{D}_i$ and the supply $\mathbf{S}_i$ of $P_i(t)$ depend also on its own factors $\alpha_i(t)$, $\beta_i(t)$ and on some external factors $w_i(t)$, $q_i(t)$ respectively. $D_i=\mathbf{D}_i[P_1,..,P_j,..,P_n,\alpha_i,w_i]$; $S_i=\mathbf{S}_i[P_1,\cdots,P_j,\cdots,P_n,\beta_i,q_i]$.

Particularly an affine model can be obtained, in a form with input u(t), the state x(t), the output z(t) and the disturbance p(t) $\dot{x}(t)=A\cdot x(t)+B\cdot u(t)+p(t)$, $y(t)=C\cdot x(t)+D\cdot u(t)$, where $x(t)=P(t)-\tilde{P}$, $P(t)=[P_1(t)\cdots P_i(t)\cdots P_n(t)]^T$.

Here u(t) incorporates the control parameters of its own subsystem and p (t) incorporates the control parameters of the external subsystems. The matrices A, B can be determined through an identification process as proposed in the next section.

In this paper we consider two categories of economic agents namely proper and external economic agents. The proper economic agents $A_i, i\in I_P$ are agents that can be influenced in the control process. This can be done by deliberately modifying some parameters, such as the free parameters $\alpha_i(t),\beta_i(t), i\in I_P$ defining the price $P_i(t), i\in I_P$. The set of proper agents define a so-called proper subsystem S_P, composed of state equations components $P_i(t), i\in I_P$. The external economic agents $A_i, i\in I_E$ are agents that can not be influenced in the control process but whose price $P_i(t), i\in I_E$ affects all prices including of the own agents. The set of external agents define a so-called external subsystem S_E, composed of state equations components $P_i(t), i\in I_E$.

Another example where applicable SCCEIA (System for Control and Coordination of Economic and Intellectual Activities), is the intellectual process of coordination of monetary policy, [4, 10].

Here the importance of control, particularly with FTR is great, aiming to stabilize financial markets by monetary action. This example is presented in detail in the book [1].

5. STATE BLOCKING SYSTEMS

Into practice, there are systems that can be found in two instances (two status), namely: the system can be active or system can be blocked (locked or pause). A particular problem for the control systems of the economic activities is the breaks existence defined as time periods of inactivity when all or some state components are kept constant, [11].

Throughout the consulted literature, there is no evidence of this phenomenon for the control purposes, [12], Such structures are commonly found in economic, financial, intellectual processes due to of break time periods when only some components of the state vector remain constant (partial break), or when all state vector components remain constant during breaks (total break). For example, banking, purchasing, sales activities, production activities are characterized by these phenomena.

Also many intellectual activities: training, design, consultancy etc., whose time evolution is described by dynamical systems, are characterized by time periods of partial or total break.
Of course numerous examples of technical systems can be given where such time periods of rest, more specifically called blocking periods, can appear due to physical phenomena: dry friction, mechanical stiffness, interruptions of electrical circuits, etc. Physically the phenomena are the same as in common systems, they have the same mathematical models, but in the blocking system pauses can appear. All these systems are referred in the paper as a special category of systems, called State Blocking Systems (SBS), [11].

Description of the system in the physical time, where the breaks are taken into account, makes description more complicated, which means its interpretation as a differential system with discontinuity on the right. If break intervals are removed we obtain a fictive time, called the activity time. During the activity time, mathematical models are simple. They are ones given by physical (economical) relations.

A system is SBS, if there is a time interval, called the blocking period, where at least one component of the state vector remains constant over this period, whichever is the applied input to the system.

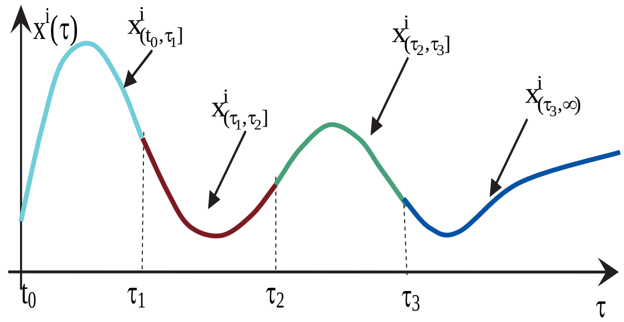


Fig. 3. Example of the x^i component evolution on the active time τ axes, as a function $x^i(\tau)$.

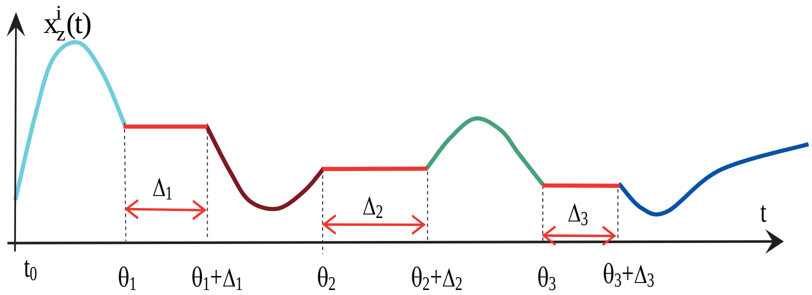


Fig. 4. Example of the $x_z^i(t)$ component evolution on the physical time t.

The mathematical description is carried out considering the concepts of blocking function, blocking process, the process of unblocking that controls the blocking status. The basic idea is to work in another time, called the active (working) time during activity period of time. We demonstrate that such a system is described by a simple smooth model easier to handle.

Consider a differential system with the state equation, [11] called the active system.

$$\dot{x} = f(x,u,t),\ x:\mathrm{R} \to \mathrm{R}^n,\ u:\mathrm{R} \to \mathrm{R}^p, t > t_0,\ x(t_0) = x_0, \quad (1)$$

The blocking operations of the active system (1) can be modeled by multiplying each function $f^i(x(t),u(t),t)$ of (3) by a time function $z^i(t), i = \mathbf{1}:n$, called blocking functions of the active system. They take values between 0 and 1. When $z^i(t) = \mathbf{0}$, the component $x^i(t)$ is full blocked (locked) and when $z^i(t) = \mathbf{1}$ the component $x^i(t)$ is full active (unlocked).

The SBS equations are

$$\dot{x}_z^i(t) = z^i(t)\cdot f^i(x_z(t),u(t),t),\ x_z^i(t_0) = x_0^i,\ i = \mathbf{1}:n \tag{2}$$

Thus the values 0 or 1 of the components $z^i(t) \in \{\mathbf{0},\mathbf{1}\}, i = \mathbf{1}:n$, can represent binary digits which determine the number q, as the value of the binary function $q(t)$ (2), specifying the structure S_q at time t.

$$q(t) = z^1(t)\cdot\mathbf{2}^0 + z^2(t)\cdot\mathbf{2}^1 + \cdots + z^i(t)\cdot\mathbf{2}^{i-1} + \cdots + z^n(t)\cdot\mathbf{2}^{n-1} \tag{3}$$

The vector $\mathbf{z}(t)$ thus defined looks like a new input for SBS, some components acting as manipulating variables and the other act as external disturbances.

6. DISTRIBUTIONS BASED IDENTIFICATION OF THE STATE EQUATION PARAMETERS FOR ECONOMIC PROCESSES

For the economic processes control, the most difficult problem is to determine the parameters of models, with specified structure. Generally, some economic bodies of analysis, are able sufficiently well to appreciate the existence of interactions between various operators, but less the strength of these interdependencies. From systemic point of view, this means we are able to know the structure of mathematical models but not the values of their parameters.

Given this situation, we propose the use identification algorithms of mathematical models parameters, particularly those described by continuous time differential equations. These algorithms must keep the significance identified parameters and not be affected by sample periods used in the identification process.

The best results which satisfies these requirements are achieved by using algorithms based on the theory of distributions, specified by the acronym DBI (Distribution Based Identification). In DBI, all time functions and their derivatives are associated with distribution, resulting a so-called mathematical model in distributions. Whether, in differential equations the independent variable is the continuous time variable t, in distribution the independent variable is represented by testing functions as elements of the so-called fundamental space of distributions theory. In differential equations, the unknown variable is a time function but for equations in distribution, the unknown variable is a distribution which belongs to the fundamental space [7].

This algebraic equation depends on the same parameters both in time domain differential equations as well as in distribution equations. The solutions of algebraic equation in distributions lead to the same values of parameter that cancels both the time domain differential equation and the equivalent differential equation in distributions.

7. FINITE TIME RESPONSE (FTR) CONTROL OF ECONOMIC SYSTEMS

A Finite Time Response (FTR) system is a system whose evolution, with constant input, enters steady state after a finite time interval, whatever has been the constant input value and the evolution before the time moment when the input become constant. [13].

The FTR property is specific to discrete-time systems. Control algorithms with finite time response are well known in the literature as dead-beat algorithms. State control FTR algorithm obtained by substitution method is remarkable. These algorithms are developed for linear systems only. Because of the blocked components and of the active subsystem uncontrollable components, an SBS system appears as an affine system with FTR control procedures unknown in literature.

It is developed a new procedure for the affine systems FTR synthesis, called the Equivalent Input Method (EIM). For this purpose it calculates an equivalent input which will determine, according to a quadratic criterion, the best approximation of the affine component. In this way the system is approximated by an affine system with an input variable equals to the sum of the original input and the equivalent input, having a residual affine component. This residual affine component has a smaller norm than the initial affine component.

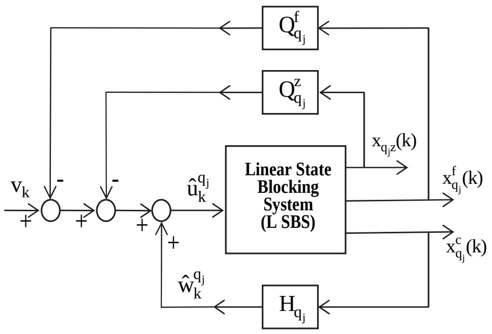


Fig. 5. Block diagram of the FTR control structure for state blocking systems.

The control law available for the structure S_{q_j} is

$$x^c_{q_j}(k+1) = \Phi^c_{q_j}(T)\cdot x^c_{q_j}(k) + G^c_{q_j}\cdot u_k + G^f_{q_j}\cdot x^f_{q_j}(k) + G^z_{q_j}\cdot x_{q_j z}(k)$$

The control law available for the structure S_{q_j}

$$\hat{u}^{q_j}_k = H_{q_j}\cdot x^c_{q_j}(k) - Q^f_{q_j}\cdot x^f_{q_j}(k) - Q^z_{q_j}\cdot x_{q_j z}(k)$$
$$Q^f_{q_j} = G^{c\,\otimes}_{q_j}\cdot G^f_{q_j},\ Q^z_{q_j} = G^{c\,\otimes}_{q_j}\cdot G^z_{q_j}$$
$$G^{c\,\otimes}_{q_j} = [(G^c_{q_j})^T\cdot G^c_{q_j}]^{-1}\cdot(G^c_{q_j})^T$$

H_{q_j} is determined by using classical deadbeat method for the pair $\Phi^c_{q_j}(T), G^c_{q_j}$. Fig. 5, presents the block diagram of the FTR control structure for state blocking systems.

Considering zero the residual affine component, a FTR linear system synthesis procedure is applied. In the real system, controlled by a FTR control law, the residual affine component creates at each step a disturbance that FTR algorithm seeks to cancel.

Justification for this approach is based on fact that the disturbance residual affine component is much smaller in norm than the original affine component. Under certain circumstances this residual affine component can be zero. To obtain the FTR control algorithm, the exact discrete time model of linear SBS is obtained,

$$x^c_{q_j}(k+1) = \Phi^c_{q_j}(T)\cdot x^c_{q_j}(k) + G^c_{q_j}\cdot u_k + G^f_{q_j}\cdot x^f_{q_j}(k) + G^z_{q_j}\cdot x_{q_j z}(k)\ .$$

An experimental platform has been designed in Matlab environment allowing implementation of various SBS and their control algorithms. Experimental results are presented to justify the approached method.

8. EXAMPLE

Consider the four agents economic process, based on the law of supply and demand, characterized by prices of their products $P^i(t), i = 1:4$, with manipulation possibility by an attribute $U^1(t)$, interpreted as the input variable [4]. Using economic laws between these variables, a linear or linearized differential relationship can be established. The values of these equations parameters can be obtained by experimental identification, using for example distributions based identification (DBI) algorithms [7].

A linear mathematical model can be obtained of the form (1) in variations with respect to the steady state values, with the notations $x^i(t) = P^i(t) - \tilde{P}^i,\ i = 1:4$; $u^1(t) = U^1(t) - \tilde{U}^1$. The result is the linear system (1), with $n = 4, r = 1, m = 1$ and matrices,

$$A = \begin{vmatrix} -0.025 & -0.310 & -0.055 & -0.050 \\ 0.305 & -0.080 & -0.385 & -0.090 \\ -0.055 & 0.380 & -0.130 & -0.180 \\ 0.045 & -0.090 & 0.175 & -0.370 \end{vmatrix} \quad B = \begin{vmatrix} 0.5 \\ 0 \\ 0 \\ 0 \end{vmatrix} \quad C^T = \begin{vmatrix} 1 \\ 0 \\ 0 \\ 0 \end{vmatrix} \quad D=0$$

It was created a Platform for the Study of Blocking Systems (PSBS), which allows a number of configurations through a three elements vector $nv = [nv_1\ \ nv_2\ \ nv_3]$ where: nv_1 is an integer representing the order n of the system. nv_2 is an integer that determines the manner in which the blocking structure is performed.

If $nv_2 \le \boldsymbol{0}$, then the blocking vector $\mathbf{z}(t)$ is composed of n independent components based on blocking schedule table. Each component $x^i(t)$ of the state vector is operated by the corresponding blocking component $z^i(t)$ that means, $x^i(t)$ is blocked by. $z^i(t), i = \boldsymbol{1} : n$.

In Figure 6, a 4-components blocking vector is considered. The system responses to a unit step input applied at the time $t_0 = \boldsymbol{0}$ starting from the initial condition $x_0 = x(t_0) = [2.28 \;\; 1.31 \;\; 1.50 \;\; 0.67]^T$, without blocking (natural evolution) and with blocking determined by the function from Fig.6 are shown in Figure 7.

Because n_v =[4 0 0], each component of the state vector was operated by the corresponding blocking function from Figure 6.

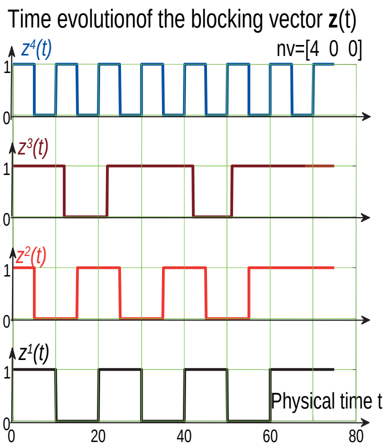


Fig. 6. Blocking functions $z^1(t)$, $z^2(t)$), $z^3(t)$), $z^4(t)$.

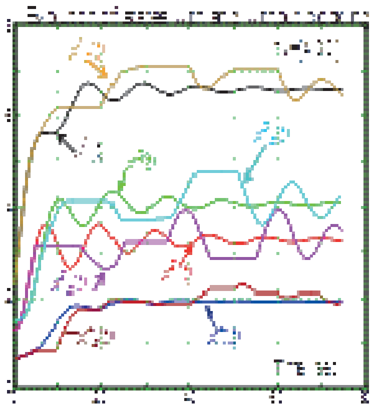


Fig. 7. State vectors for nv = [4 0 0], $x^i(t)$ is blcked by $z^i(t)$, i = 1:4.

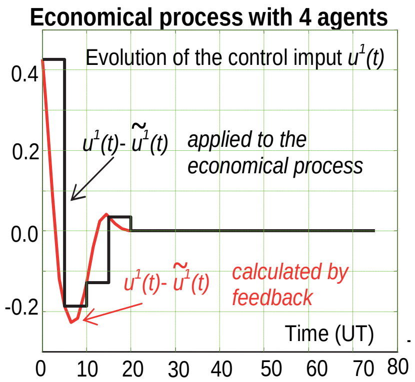


Fig. 8. Evolution of the FTR control variable $u^1(t)$.

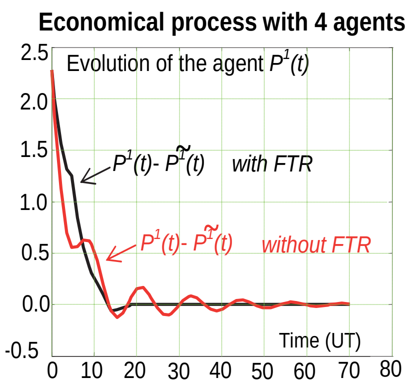


Fig. 9. Open loop and FTR closed loop evolution of $x^1(t) = P^1(t)$- $P^{1\sim}$.

The FTR control law H_q for the active subsystem with q=15 is given by

$$H = [\; 0.0995 \quad 0.6638 \quad -0.3938 \quad -0.1187 \;].$$

It is considered the system evolution starting from the nonzero initial state

$$x_{in} = [2.2800 \quad 1.3100 \quad 1.5000 \quad 0.6700]^T.$$

In Figure 8., the evolution of the FTR control input is presented. To the controlled process, a piecewise constant input (black) is applied. It is obtained from the calculated feed-back variable (drawn in red), through a zero order holder of period T.

Figure 9. illustrates the evolution of price $P^{1}(t)$,in variation with respect to its steady state value $\tilde{P}^{1}$, in open loop (drawn in red) and with FTR closed loop (drawn in black), starting from the same nonzero initial state. All three next figures Fig.10., Fig.11., Fig.12., illustrate evolutions of the $x^{i}(t), i=\boldsymbol{2}:\boldsymbol{4}$, representing $P^{i}(t), i=\boldsymbol{2}:\boldsymbol{4}$ in variations with respect to their steady state values $\tilde{P}^{i}, i=\boldsymbol{2}:\boldsymbol{4}$, $x^{i}(t)=P^{i}(t)-\tilde{P}^{i}$, $i=\boldsymbol{2}:\boldsymbol{4}$, in open loop (drawn in red) and with FTR closed loop (drawn in black), starting from the same nonzero initial state.

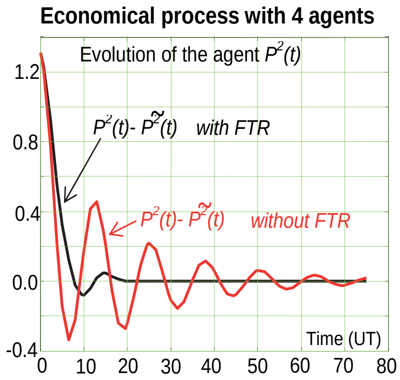


Fig. 10. Open loop and FTR closed loop evolution of $x^{2}(t)=P^{2}(t)-P^{2\sim}$.

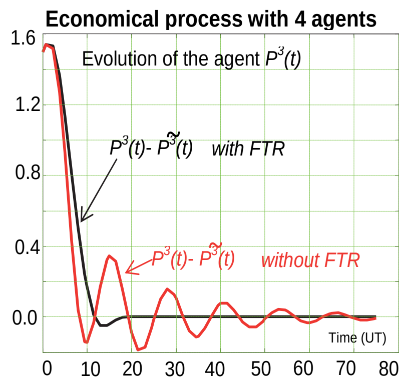


Fig. 11. Open loop and FTR closed loop evolution of $x^{3}(t)=P^{3}(t)-P^{3\sim}$.

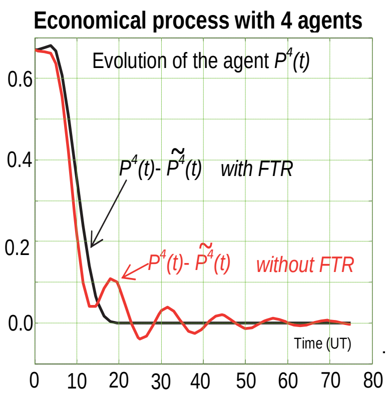


Fig. 12. Open loop and FTR closed loop evolution of $x^{4}(t) = P^{4}(t)-P^{4\sim}$.

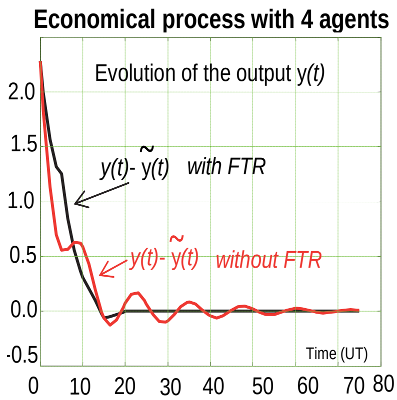


Fig. 13. Open loop and FTR closed loop evolution of $y(t) = Y(t)-Y^{\sim}$.

As the above figures, Fig. 13., illustrates evolutions of the variable $y(t)$ representing the economical process output variable $Y(t)$, with $C=[\boldsymbol{1}\ \ \boldsymbol{0}\ \ \boldsymbol{0}\ \ \boldsymbol{0}]; D=\boldsymbol{0}$ in variation with respect to its steady state value $\tilde{Y}$, $y(t)=Y(t)-\tilde{Y}$, in open loop (drawn in red) and with FTR closed loop (drawn in black), starting from the same nonzero initial state.

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CONDUCEREA ŞI COORDONAREA ACTIVITĂŢILOR ECONOMICE ŞI INTELECTUALE PRIN STRUCTURI COMPLEXE INTEGRATE

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Rezumat: Lucrarea se înscrie în categoria cercetărilor pentru dezvoltarea şi implementarea unor structuri heterogene în care se aplică incluziunea favorabilă a factorului uman pentru conducerea şi coordonarea unor activităţi complexe din cele mai diverse domenii: economic, intelectual, biologic, militar, etc. Se poate considera ca fiind o nouă direcţie de dezvoltare şi aplicare a conceptului modern CPS (Cyber Physical Systems) în care activităţile din domeniile menţionate mai sus sunt asimilate proceselor fizice specifice CPS. Structura propusă evidenţiază interacţiunea dintre factorul uman de conducere şi procesele fizice reprezentate prin echipamentele numerice de conducere şi prin procesele conduse. În această structură în circuit închis, informaţia este reprezentată în trei forme: 1. Numere în echipamentele numerice; 2. Semnale fizice în procesele conduse (economice sau intelectuale); 3. Documente, pentru factorii umani care fac parte din structura de conducere. Organismele constituite din factori umani (comitet, consiliu, birou, director, etc.) interacţionează atât între ele cât şi cu celelate componente ale sistemului heterogen, prin schimb de informaţii care au ca şi suport fizic documentul. Pentru crearea, transmiterea şi operarea documentelor, ca şi suport purtător de informaţie, se folosesc instrumente specifice: fluxuri de activităţi, platforma de dezvoltare .NET. proceduri de virtualizare, mediul Sharepoint. O problemă particulară pentru conducerea activităţilor economice o constituie existenta pauzelor, definite ca şi perioade de timp de inacvtivitate când toate sau numnai anumite componente ale stării sunt menţinute constante astfel că modelele clasice nu mai sunt în general valabile. Acestea sunt interpretate ca şi o categorie specifică de sisteme şi anume Sisteme cu Blocare a Stării (SBS). Sunt prezentate exemple de conducere a unui proces economic bazat pe legea cererii şi ofertei care modelează evoluţia preţurilor şi un proces intelectual de coordonare a politicii monetare. Rezultatele obţinute prin simulare numerică evidenţiază avantajele acestei abordări.