



## Selfie with a view on “Cybernetics and Systems Analysis”

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*Ukraine has solid background in Computer Science claimed with the first in the continental Europe computer MESM put into operation in 1951 in Kiev laboratory of Sergey Lebedev. Cybernetics and Systems Analysis (CSA) is the only CS Ukrainian journal indexed in Scopus and mentioned in JCR during 1997-1999. Sometimes good enough results published in CSA remain unheeded for years because very few scientists look inside it. We published our best results in CSA - an overview of author's CSA articles follows.*

Selfies are all the rage recently though years ago some people resented on seeing suchlike clumsy affair. Often selfies are justified by circumstances of either complete solitude or surrounding with busy crowd. The topic of most selfies is “me and something remarkable”. Many of them even suffer from ignoring any background with the only topic “I am surprisingly beautiful with this peculiar grimace”. I am going to avoid such excessive selfishness in my selfie and pay due respect to my contemporary - the best CS journal in Ukraine which has been published since 1965. Cybernetics and Systems Analysis (CSA) is the only CS Ukrainian journal indexed in Scopus and even mentioned in JCR during 1997-1999, I like to believe, because during these years we published a couple of papers [1,2] in it. In spite of the fact that the journal is republished translated in English by Springer, it lays aside of citation thoroughfares of civilized world. Sometimes good enough results published in CSA remain unheeded for years because very few scientists look inside it.

Ukraine has solid background in Computer Science claimed with the first in the continental Europe computer MESM put into operation in 1951 in Kiev laboratory of Sergey Lebedev. The further maintenance and development of the computer since 1956 was continued by Victor Glushkov who headed Cybernetics Institute of National Academy of Science of Ukraine created in 1962. The Institute which established numerous branches in universities all around Ukraine has become the center of Computer Science in Ukraine widely known by its achievements and bright scientists such as Zinovi Rabinovich, Vladimir Skurihin, Igor Velbitsky, Ivan Sergiyenko and others. It developed new kinds of computer hardware and software and fulfilled numerous application projects for production control, management, and artificial intelligence. Recently someone can trace implementation of “paperless management technology” and “state control system” concepts of Vladimir Glushkov in infrastructures of modern world. In 1965 a journal named Cybernetics has been founded and renamed in Cybernetics and Systems Analysis in 1991.

We published our best results in CSA [1-7] considering it the only journal in the world we can do it in before we started learning English anew to switch thinking in it; otherwise we cannot bring our ideas easily to others. Originally the CSA papers were submitted and published in Russian with a strict proof-reading procedure often accomplished with personal discussions on terminology, style, and phrasing. Then the papers were translated and published in English by Springer. Nice view! Ergo proper time to take a selfie has come. Let us overlook the papers I have published in CSA together with my respected co-authors during some twenty years.

Article [1] introduces a concept of a *multichannel transition* for Petri nets. Now I rather say the multiple firing strategy using an analogy with the maximal firing strategy of Salwicki. Recently widespread papers on “the exhaustive use of rule” in spiking P neuron systems do not even mention our multichannel transitions which first appeared in my Ph.D. defended in 1991. We illustrate the concept for a timed Petri net where time delays are associated with transitions. We applied them for production control in our Opera-Topaz system from where they come quite natural. Say, we have a job to do of duration in 10 minutes, modeled by a transition; we have 3 work-pieces and 4 machine-tools. Why should we do it sequentially in 30 minutes like in usual nets when we can start processing 3 work-pieces on 3 machine-tools simultaneously and finish the lot in 10 minutes? It looks like having unlimited number of each transition attached in parallel; moreover, usual Petri net is obtained as a special case via attaching a place having unit marking to each transition via a loop. We specified a state of such net using its marking and history of transitions’ firing that allowed us composing strict state equation to describe its behavior. Article [3] actually accomplishes results of article [1] with fundamental equation and invariants of timed nets with multichannel transitions. Similar to linear invariants of Petri nets we introduced invariants of state and behavior, so called *full invariants*, and considered *partial invariants* which preserve the marking only. Finally, properties of invariant nets have been investigated.

In addition, article [1] introduces a concept of *functional equivalence* for Petri nets, specifies the net transfer function, and presents an algebra that combines arithmetic, logic, and timed operations. Algebraic transformations of formulae correspond to structural transformations of a net preserving its transfer function offering a new kind of reduction technique. The concept of functional equivalence introduced for definite subsets of input and output places supplements known kinds of equivalences considered for reachability trees and free languages of a net.

Two articles [4] and [5] develop the topic of *functional Petri net* under a device “divide and sway”, respectively; namely [4] describes how to “divide” while [5] teaches how to “sway” afterwards. Among different types of subnets with contact places the functional subnet is the strictest one: input places have only output arcs and output places have only input arcs. We illustrated decomposition on models of networking protocols such as BGP and TCP. It was proven that a set of minimal functional subnets constitutes a basis and any functional subnet is obtained as a sum of some minimal subnets. For decomposition two techniques have been offered: with logical equation and via ad-hoc algorithm of polynomial complexity. The advantage of the logical equations technique is its applicability for more general kinds of subnets with contact places. Because of strict limitation on the connection of a functional subnet, to analyze the properties of a net [5], we decompose it into a set of minimal functional subnets, analyze properties of each subnet, and, finally, solve a sole composition system which dimension is equal to the number of contact places. The basic motivation is a speed-up of computations for big models.

In the state equation of a timed Petri net with multichannel transitions [1], we applied operations of continuous logic, namely, conjunction represented as the minimum operation. In this way we came to the task of *synthesis of a continuous (fuzzy) logic function given in tabular form* [2]. Synthesis of a binary logic function on its truth table is a well-known task. A

continuous logic function can be given with a choice table where all the variants of reordering arguments and their negations with the great-or-equal operation are listed; on each variant a function takes the value of an argument or a negation of an argument. We introduced concepts of *constituents of minimum and maximum*, similar to classical constituents of zero and unit in binary logic, to compose PDNF and PCNF. To handle an essential difference that not any choice table gives a continuous logic functions, a necessary and sufficient condition was formulated in the terms of overlapping rows of the choice table. Finally, for any choice table we obtained a set of continuous logic functions valid on definite subareas.

In 2007-2008 working on a project supported by NATO in verification of complex networking protocols, we came to necessity of obtaining results not only for a definite net but for a definite structure. In article [6] we introduced a composition of Petri net model having hypercube structure with parameters specifying the number of dimensions and size. As far as we studied properties of solutions obtained for any natural values of parameters we claimed working with *infinite Petri nets*. We studied grid structures composed of a model of generalized packet switching device and built infinite systems of linear algebraic equations solved in nonnegative integer numbers. Parametric solutions have been obtained to study properties of infinite Petri nets; complex deadlocks caused by loops of blockings, chains of blockings, and isolation revealed.

Finally we came to programming in the language of Petri nets. For years a concept of a universal Petri net had been hanging in the air, its existence proven for the class of inhibitor nets. Article [7] presents a *universal inhibitor Petri net* specified in an explicit form. It is a prototype of a Petri net processor which is specified by a Petri net and executes a program written in the Petri net language. The language is appropriate for concurrent programming and model-driven approach for software design. Lately smaller universal nets consisting of a few dozens of nodes were composed. However the advantage of a net described in [7] is the direct encoding of a program without references to other models of computation.

Perhaps, it's done with the selfie. The camera zooms out to catch outstanding scientists in Ukraine who dislike selfies in spite of very few "photographers" pay due attention to them. Recently, when Ukraine integrates into European and world structures and this process involves science as well, scientists of Ukraine reckon on world's welcome. Please look in our journals, at least, translated and published in English such as CSA, and cite our papers when it is appropriate.

## References

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