



XIIth International Symposium «Intelligent Systems», INTELS'16, 5-7 October 2016, Moscow, Russia

## Intelligent systems: development and issues

K.A. Pupkov\*

*RUDN University, 6, Miklukho-Maklaya str., Moscow, 117198, Russia*  
*Bauman Moscow State Technical University, 5, 2-ya Baumanskaya str., Moscow, 105005, Russia*

---

### Abstract

Intelligent systems are used to construct an automatic system performing afferent synthesis of objective formulating program of action. Systems of regulatory control and management of various nature objects are also developed and obtained for practical use to get desired useful effect. All these problems offer the challenge of in-depth study in human and animal brain functionality that have to be solved.

© 2017 Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the scientific committee of the XIIth International Symposium “Intelligent Systems”

*Keywords:* intelligent system; adaptable management; systems of automatic control; brain functionality.

---

Intelligent system, as a last paradigm of artificial, self-registering and adaptable management of various nature objects was firstly defines basing on theory of functional systems (Anokhin P.K.), describing system organization of life form functions that has an objective law of the usefulness of the final effect and the result<sup>1</sup>

The conception of intelligence system was defined at the end of 90s of XX century. It is a set of technical means combined by informational process and interacting with one person (or group of people) or working independently, that is able to make a decision basing on information, knowledge and incentive to produce an objective and find a rational way to achieve the goal<sup>2,3,4</sup>. This definition appeared in 1989.

At this period of time systems of regulatory control and management of various nature objects were developed and obtained practical use. Searching for effective control laws, adaptation to environmental activity, changing of parameters and control system structures were caused by complexity of problem solving, performed by control objects that sometimes exposed to extreme environment influence. Knowledge base appeared as a part control system including experts information, artificial neural networks, realizing education and self-education.

---

\* Corresponding author.

*E-mail address:* [pupkov@iu1.bmstu.ru](mailto:pupkov@iu1.bmstu.ru)

Systems of automatic control, using mentioned features of their implementation, were called intelligent. But it is far from being a truth!

That's why it is time to give more detailed explanation of differences between classical automatic control system and intelligence system.

During comparison living organism functions and automatic system operation, problems of objective synthesis, making decision and instructions have a great importance. This problem is called "programming". It's important to mention that anthropomorphic expressions like "thinking machine", "memory" or others are confusing this theme.

The machine program as a part of automatic system performing complicated and long calculations and implemented as physical signals is the best proof of machine mechanical abilities. Such machine has a great speed and number of operation and saves on thousand man-hours.

But it's principle of operation, no matter how it is complicated, is predetermined by machine construction and human thought.

These features of "programming" are more obvious in human activity. For instance, hammer nails, corkscrew extracts cork, they all depend on program implemented by people and physically realized in appropriate form and construction. The fact that machines in the most complicated constructions turned out to be automatic (self-acting) machines with result of action inverse estimator, i.e. final useful effect, is a result of regular occurrence and all the expedient adaptive human actions in relation to the outside world were developed in accord to it.

Describing general features of automatic system programming we can draw a conclusion that it is a predefined (predictable) and more or less hard way to get desired useful effect. In one case this way can be very difficult and long, in other one – short and simple. If we can find even a remote resemblance of human organism functions?

If we compare actions of human and the most complicated machines, we may notice that human actions can be characterized as actions with "high flexibility, changeability and a sort of arbitrariness". But it's not enough. Let's define some specific traits of human nervous activity organization:

- Each instruction, even for the most complicated automatic system is predetermined before it's constructed. It can't be formed in process depending on current environmental conditions. Automatic system can't take environmental conditions into account and make an instruction.
- Human "programming" of actions is a result of dynamic synthesis of inner and outer factors. The objective and decisions to perform some defined action are being formed only after this afferent synthesis. The number of these syntheses, just as combinations of external condition, is unlimited, that's why the number of ways to program human actions is unlimited too.
- Human question "What to do?" is a dynamic function that depends on outer and inner current afferences. This question doesn't exist for an automatic system, it's actions are predefined and calculated during construction. Or, figuratively speaking, if automatic system had an ability of afferent synthesis and performed it's actions depending on this synthesis, it will produce shoes in shoe factory department, being constructed to produce cans. If we suppose that one automatic system is able to take part in thousand separate actions in implementation phase, it's incorrectly to think that the question is in number of combinations. To be more precise, other constructive and resource base is required to perform dynamic and different functions of human organism. Infinite molecular changeability of living matter is required. It means that difference is undoubtedly qualitative.
- These features of human and animal behavior shaping are not exclusive. They all take place currently. Human and animal brain has a great ability to anticipate (to predict) future events and to form behavior based on future events. It's hard to imagine an automatic system suddenly changing its construction and starts working "precautionary", as Pavlov I.P. said, in reference to future events.

Physiological features of conditioned reflex as precautionary and signal action consist in the fact that synthetic work of all the afferent parts, especially in the brain frontal part. This synthetic work is certainly completed by forming the behavior in the closest fit to the aggregate of afferent influence on the body. There are no similarities to mechanical associations.

That's why we have to state two extremely important traits of animal and human behavior modeling that are unlikely to be modeled at the present time.

The first trait: human and animal perceive afferent warning system actively, as opposed to automatic system. Human and animal collect afferent signals for the process of afferent synthesis.

They actively direct their receptor surface towards outside world different factors and examine them for some time. It is a orientative-trying reaction that Pavlov I.P. called “reflex”: “What?”.

Substantial increase of relevant receptor apparatus excitability takes place thanks to brainstem reticular formation during active selection of outside world afferent warnings.

Thereby afferent synthesis that always takes place before particular action is a dynamic and active process and it is no coincidence it was figuratively called “constructive” process (I.P.Pavlov). It is hard to imagine an automatic system “sniffing” and “inspecting” operator or worker thinking what to produce basing on this information...

Therefore, in spite of the fact that automatic system and animals function basing on the same cyclic functional feedback system, their adaptive activity are substantially different.

The second trait: features of central nervous system programming.

In living system, the question “What to do?” is being solved right after the phase of afferent synthesis of objective. But special afferent apparatus is being created before the appropriate action forming that is the result of afferent synthesis. Predicted result of the action is being formed. This apparatus named action acceptor makes a final comparison between attempts and results. All the mismatches stimulate new actions until main afferent qualities of the action acceptor are satisfied.

Afferent synthesis, action “program” forming and verification of normal completion for human and animal are dynamic and adapted to outside and inside condition. So it’s incredibly to model “robot” able to formulate “program”.

The activity of ordinary automatic system starts with operation forming (program execution) and it never starts with afferent synthesis of objective. This first phase is always done by operator. At the present time such systems are called intelligent5.

Thereby animal adaptive behavior as an integrated functional system includes such systems, that are divided between human and automatic system in modern devices.

Our task is to find ways to construct an automatic system performing afferent synthesis of objective formulating program of action and formulating apparatus of checking future actions – action acceptor, at the same time. These systems are called artificial intelligence systems or intelligence systems. The most important part of intelligence system is knowledge base. In nature it’s presented in memory. Namely in memorizing. It’s much more complicated phenomenon rather than elementary process of depolarization. First of all, memorizing is a system process. Only ramified system of relations corresponding to the stored feeling that is excitation system can be memorized. This process is important because these “traces” remain to be system and organized for tens of years in spite of the same nerve cells took part in other reactions and human impressions. What kind of energy base supports solidity of this memorized system? This question offers the challenge of in-depth study in human and animal brain functionality. Professor A.A. Lyapunov wrote that “more detailed modeling of nervous system process requires more specific information about how it works”. It lead us to thought: “You have to understand natural to create artificial”.

## References

1. Anokhin PK. Problemy tsentra i periferii v fiziologii nervnoy deyatel'nosti. N.Novgorod, 1935.
2. Pupkov KA, Kon'kov VG. Intellectualnye systemy. Moscow: Published by Bauman Moscow State Technical University; 2003. 348 p.
3. Pupkov KA. Intellectualnye systemy: proplema teotii i praktiki. Moscow. Izvestia Vuzov. Priborostroenie 1994; **9-10**: 5-7.
4. Pupkov KA, Kon'kov VG. Intelligent systems. Moscow: Published by Bauman Moscow State Technical University; 2003. 348p.
5. Vassilyev SN. Intellectnoe upravlenie dinamicheskimi systemami. Moscow: Fizmatlit; 2000. 352 p.