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PRINCIPLES OF INTERACTIVITY AND INFORMATION INTERACTION

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Abstract: The article defines the basic principles of interactive interaction between the object of activation and the object of execution. The developed interactivity approaches are taken into account when designing and analyzing systems. The formalization, systematization and classification of the basic principles of interactivity has been carried out. Influences on objects of activation and execution with defined conditions are shown. The principles of interactive interaction are presented structurally.

The principle of interactivity based on the characteristics of the object of execution having a memory and being able to adapt, improve and reorganize structurally or functionally in time is considered. The example of an algorithm that implements the multifunctional principle of interactive interaction is given.

Key words: interactive systems, control object, transition characteristics

1. Introduction

Nowadays, the theory of interactive systems is at the stage of its development and conceptual substantiation, despite the widespread application of principles, methods and technology of the interaction between different objects.

2. Principles of interactivity

The important elements of this theory are formalization, systematization and classification of the basic principles of interactivity.

The first formal definition is the 1-st principle of activation of the object functions. The object is considered to be any physical, technological, biological or social object. Thus, we can define what function determines the principle of activation, which is represented by a non-interactive structure (Fig. 1).

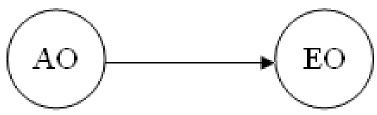

Fig. 1. The structure of non-interactive relationship between the activation object (AO) and the execution object (EO) that implements the principle of activation.

In biology, it is determined by afferent and differential connections between receptors and brain neurons. In technical systems, it is presented by the example of executing a function (a single or a specified one due to the list, by a single EO or a group of EOs) (Fig. 2).

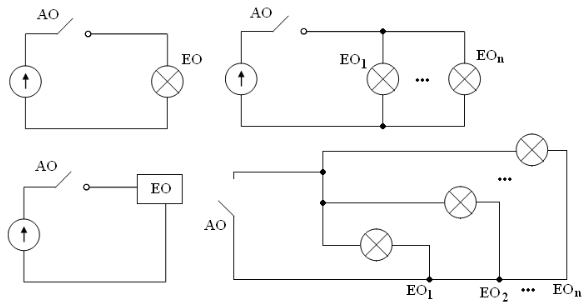

Fig. 2. Structures of a non-interactive system with one and many activation objects (AOs) and execution objects (EOs).

The described example of the principle of activation implements is only one of the narrow functions of the proportional binary execution of the activation function (AF), which is described by the Dirac function (Fig. 3).

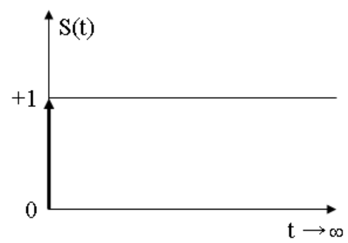

Fig. 3. Activation function of the execution object.

In non-interactive system structures the response of the EO is adequate, that is, the activation function is executed without a transient process (in the ideal case) (Fig. 4).

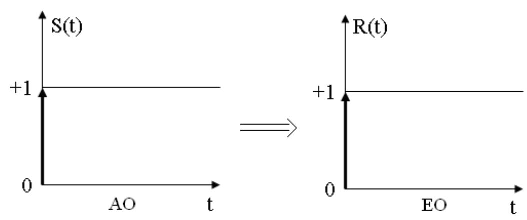

Fig. 4. The response of the EO as function R(t) to activation function S(t) of the AO.

According to the theory of automatic control, the response of the control object to activation by the Dirac function can show the following systemic characteristics [1]: the control object can be absolutely stable (a), stable (b) and unstable (c) (Fig. 5).

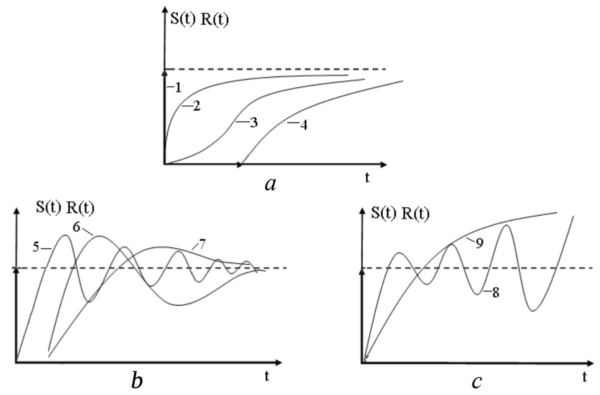

Fig. 5. Characteristics of the response of the control object to activation by the Dirac function with different transition characteristics.

In addition, the EO can be non-dynamic or dynamic if its executive response ***R(t)*** does not exceed the external influence ***R(t)***≤1 or exceeds it (5÷9), correspondingly.

In biological systems, the neuron response may also be different (Fig. 6). It depends on the stimulus effect of a harmonic signal on the peripheral neuron receptor, as it is shown in [2].

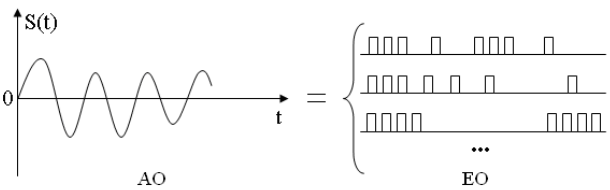

Fig. 6. Response of the peripheral neuron R(t) to the receptor S(t) activation.

The principle of activation is applied to systems, which are hierarchical in structure (Fig. 7).

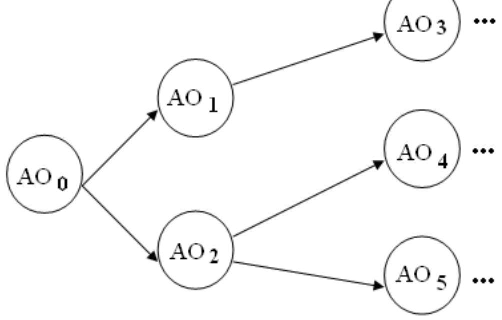

Fig. 7. Implementation of the principle of non-interactive activation in hierarchical structures.

The principle of activation cannot be applied or implemented in the case of information incompatibility of the AO and the EO. It can be, for example, the interaction between two subjects (humans) speaking different languages, interaction between the AO (person without proper computer knowledge) and the computer EO, execution of the instruction or function specified by the AO that is unknown to the EO or cannot be performed by the EO as a function ***R(t)***.

The principle of activation can be implemented using time delay (Fig. 8).

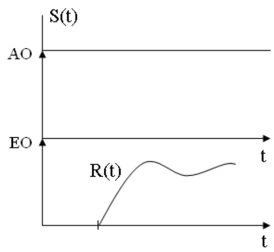

Fig. 8. Implementation of the principle of activation using the execution delay.

An example of implementing such an activation function is the infiltration of a computer system by the information virus, or device activation with the use of a delay timer.

The given definitions and characteristics of non-interactive relationship between the AO and the EO allow us to conceptually determine the number and types of interactivity principles. The 2-nd principle of the interactivity of system objects, which is the 1-st interactivity principle, is shown in Fig. 9, where, correspondingly, 1 is the activation function ***S(t)***; 2 is the implementation function ***R(t)*** of the EO; 3 is the interactive response (message) function ***Z(t)*** of the EO about the execution of the activation function ***S(t)*** as ***R(t)***.

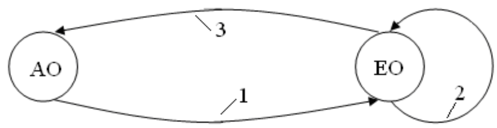

Fig. 9. Structural representation of the 1-st interactivity principle.

Therefore, the first principle of interactive relationship between the AO and the EO serves to formalize three information functions regardless of the class, type and structure of the AO and EO:

$$S(t) \to R(t) \to Z(t). \qquad (1)$$

According to the definition of the 1-st principle of interactivity, it determines the executive function $R(t)$ as its response to a function $S(t)$ in the form of the Dirac function, that is, a logical unit, as it is done by the implication function in digital microelectronics in accordance with the laws of Boolean algebra (Table 1).

Table 1

Implication function

OA	OB	Z(t)
0	0	1
0	1	0
1	0	1
1	1	1

That is, $Z(t)=0$ only when the AO implicates the function $R(t)$ of the EO.

The 2-nd principle of interactivity is based on the characteristics of the EO, i.e. memory, adaptability; it can be improved and reorganized structurally or functionally over time. The most common implementation of the 2-nd principle of interactivity is the interaction of the AO with the EO, which has correlation associative memory (CAM). Its structure is presented in Fig. 10.

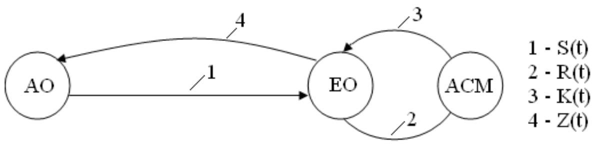

Fig. 10. The implementation of the structure of the 2-nd principle of interactivity, when the EO has correlation associative memory, which creates the function K(t).

The structure of the correlation reaction of the neutron system on the input information is presented in [3] (Fig. 11).

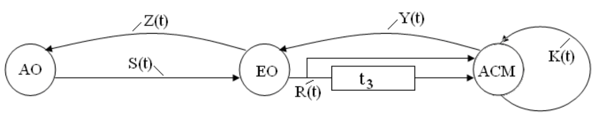

Fig. 11. Structural implementation of the 2-nd correlation principle of interactivity of information interaction between the AO and EO.

$Y(t)$ is the function of the adaptive (Markov) response of the EO processed according to the functions $R(t)$ and $K(t)$.

The 3-rd multifunctional principle of interactivity.

This principle is implemented during the information interaction of the AO, for example, the interaction between a computer system or a human operator and the interface execution mechanism (IEM), or between the subscribers of the computer network, in particular, in banking systems while carrying out remote control over technological objects by means of GPS.

In [4] the examples of protocol frame structures of interaction between a computer system and the IEM are presented (Fig. 12).

№	Frame type	Frame structure
1	Operator frame	start, T, N, S, {X}, {M}, {L}, stop
2	Data transmission system frame	Ci, Cj, N, S, M, L, TED, F
3	Database frame	T, N, S, X, M, L, I, TED
4	Control frame	F, Ci, Cj, Y, F F, Ci, Cj, Y, G, F F, Ci, Cj, V, Y, F F, Cj, Ci, W, Y, F

Fig. 12. Frame structures of interaction between CS and IEM.

The 3-rd multifunctional principle of interactivity for the given example is implemented according to the following algorithm:

1. The AO makes and transmits a remote request – whether the EO $S_1(t)$ exists and works.
2. The EO responds if it is turned on and activated by the function or the code $R_1(t)$.
3. The AO makes a remote request whether the EO is ready and able to execute a specified function (instruction) $S_2(t)$.
4. The EO makes response executing the function $R_2(t)$ showing that it is ready or not ready to execute the function $S_2(t)$.
5. If the EO is ready to execute the function $S_2(t)$, then the AO generates and transmits information $S_3(t)$.
6. The EO executes the function $S_2(t)$ according to the instruction $S_3(t)$, generates and transmits information about the execution of the instruction $S_3(t)$ and the function $S_2(t)$ to the AO, and the CO makes response executing function $Y(t)$.
7. The AO analyzes the function $Y(t)$ and makes decision on the implementation of the following functions of interaction between it and the EO, for example, the identified states of the CO: “norm”, “accident development” and “accident”.

The 4-th multifunctional principle of interactivity is formalized on the basis of codes and functions $S(t)$ created by the AO, and which involve parallel or sequential algorithmic execution of a certain set of functions $S(t)$ specified by the family:

$$S(t) \Rightarrow F\left[S_1(t), S_2(t) ... S_i(t) ... S_n(t)\right], \qquad (2)$$

In addition, this most general principle of interactivity determines the interactive response of the EO as a certain family of functions $Y(t)$:

$$Y(t) \Rightarrow F\left[Y_1(t), Y_2(t)...Y_j(t)...Y_k(t)\right], \qquad (3)$$

the number of which does not necessarily have to be equal to the number of functions $S(t)$, that is $n \neq k$.

The examples of the implementation of this principle of interactivity are given in [5] when the criteria of interactivity are determined and classified.

These classified principles of informativity can be efficiently applied to social interactive systems of information interaction between the subjects of law on the basis of the information neuro-model of the subject of law, proposed in [6].

The structure implementing the information neuromodel of the subject of law is shown in Fig. 13.

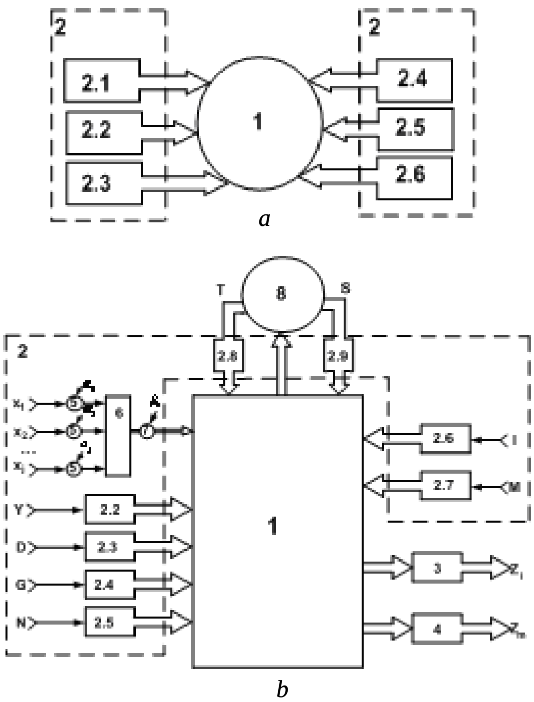

Fig. 13. The structure of the information neuromodel of the subject of law: a – non-interactive model, b – interactive model

In Fig. 13, the block meanings are as follows: 1 is the intellectual attribute of the subject of law; 2 consists of ($2_1 \div 2_9$): external input information and material flows, correspondingly; 3, 4 – corresponding external output information and material flows; 5 – multipliers; 6 – adder; 7 – creator of a sign function of logical unit; 8 is memory environment; $\left(a_1, a_2, ..., a_j\right)$ are significance coefficients of input communication interactions; $b_x, b_y, b_a, b_i, b_m, b_g, b_s, b_t, b_n$ – the threshold values of the total weighted impact of the external interactions according to the coefficients a_j which the intellectual attribute of the subject of law responds to, correspondingly; j – the arbitrary number of factors of each external interaction of the subject of law, in accordance with, for example, the following types of interactions: 2 (external input interactions) includes: 2.1 – $\left(x_1, x_2, ..., x_j\right)$ – existing random chaotic interactions; 2.2 – $\left(y_1, y_2, ..., y_j\right)$ – administrative, legislative interactions; 2.3 – $\left(d_1, d_2, ..., d_j\right)$ – reasonable economic interactions; 2.4 – $\left(g_1, g_2, ..., g_j\right)$ – factors of survival; 2.5 – $\left(n_1, n_2, ..., n_j\right)$ – unpredictable, inactive or predicted but unidentified flows of external interactions; 2.6 – $\left(i_1, i_2, ..., i_j\right)$ – information interactions; 2.7 – $\left(m_1, m_2, ..., m_j\right)$ – material interactions; 2.8 – $\left(s_1, s_2, ..., s_j\right)$ – fear function and assessment of the response to external information and material interactions; 2.9 – $\left(t_1, t_2, ..., t_j\right)$ – secret information data that is not displayed consciously or purposefully in the output information and material interaction flows; 3.4 – corresponding output information and material external flows.

In this case, the functions of the intellectual attribute in a device can be executed by a human operator or a cybernetic device with artificial intelligence.

3. Conclusions

Characteristics of the principle of non-interactive information relationship between objects are systemized. The conceptual characteristics of four principles of interactivity are highlighted as the example of interaction between the AO and the EO. The developed conceptual foundations of the principles of interactivity can be used as a basis for system design and analysis.

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ПРИНЦИПИ ІНТЕРАКТИВНОСТІ ТА ІНТЕРАКТИВНОЇ ІНФОРМАЦІЙНОЇ ВЗАЄМОДІЇ

Ігор Пітух, Любов Николайчук

Визначено основні принципи інтерактивної взаємодії між об'єктом активізації та об'єктом виконання. Розроблено підходи інтерактивності враховуються під час проектування та аналізу систем. Проведено формалізацію, систематизацію та класифікацію базових принципів інтерактивності. Показано впливи на об'єкти активізації та виконання з визначеними умовами. Структурно представлено принципи інтерактивної взаємодії. Розглянуто принцип інтерактивності який базується на характеристиці об'єкта виконання, що має пам'ять і здатний адаптуватися, удосконалюватися, реорганізовуватися структурно чи функціонально у часі. Приведено приклад алгоритму що реалізує мультифункціональний принцип інтерактивної взаємодії.

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Research interests are simulation of data traffic in interactive computer systems.

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Areas of interest: problems of informatization in jurisprudence environment.