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Synthesis of cognitive-constructive process management in human-technical-natural systems

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Abstract. The paper deals with the problems of synthesizing emotionally oriented management of cognitive-constructive processes in human-technical-natural systems with respect to the influence of heterogeneous illusions and misconceptions. The general problem statement is examined, logical models that reflect the task are proposed. The basic foundations of the synthesis of various factors for solving problems are identified. Emotions, illusions, and misconceptions are considered among such factors. This is done to overcome emerging contradictions and address the problems with due regard for the positive and negative aspects of the listed factors. Another goal of this is the formation of an adequate environment and means of cognitive and constructive activity in terms of complex system specifics, including humans, technology, and natural objects. The foundations for a new systematization of factors and adequate means of cognitive-constructive activity are being created. These basics take into account the influence of emotions, illusions and misconceptions. Individual and collective characteristics of intellectual and information resources are analyzed along with the features of objective and subjective aspects of control synthesis. New abstract and specific models are being designed that improve cognitive and constructive activity, the development and use of knowledge for the problems being solved.

Keywords: emotionally oriented management, synthesis, human-technical-natural system, cognitive-constructive process, emotions, illusions, misconceptions.

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Синтез управления когнитивно-конструктивными процессами в человеко-технико-природных системах

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Резюме. В статье рассматриваются проблемы синтеза эмоционально-ориентированного управления когнитивно-конструктивными процессами в человеко-техническо-природных системах с учетом влияния разнородных иллюзий и заблуждений. Представлена общая постановка задачи, предложены логические модели, отражающие поставленную задачу. Для решения задач выявлен фундаментальный базис синтеза различных факторов, к которым относятся эмоции, иллюзии и заблуждения. Это делается для преодоления возникающих противоречий, решения проблем с учетом положительных и отрицательных сторон перечисленных факторов, а также формирования адекватной среды и средств познавательной и конструктивной деятельности с учетом специфики сложных систем, включающих человека, технику и природные объекты. Создаются основы для новой систематизации факторов и адекватных средств познавательно-конструктивной деятельности, которые учитывают влияние эмоций, иллюзий и заблуждений. Рассматриваются индивидуальные и коллективные характеристики интеллектуальных и информационных ресурсов, особенности объективной и субъективной сторон синтеза управления. Создаются новые абстрактные и конкретные модели, совершенствующие познавательную и конструктивную деятельность, формирование и использование знаний для решаемых задач.

Ключевые слова: эмоционально-ориентированное управление, синтез, человеко-техническо-природная система, когнитивно-конструктивный процесс, эмоции, иллюзии, заблуждения.

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Introduction

Highly dynamic and competitive development of technologies, their complication and increasing application are often accompanied by unjustified losses of resources, emotional burnout of developers, loss of motivation and subsequent illusions and misconceptions that lead away from the useful results of cognitive-constructive activity obtained by a person.

All this leads to the need to identify the fundamentals of the synthesis of various factors (emotions, illusions, misconceptions) to overcome arising contradictions and solve problems with due regard for the positive and negative aspects of the listed factors as well as to form an adequate environment and means of cognitive-constructive activity, taking into account human technical and natural specifics.

In this article, an attempt is made to comprehend and create a new systematization of factors and adequate means of cognitive-constructive activity with due regard for the influence of emotions [1-3], illusions and misconceptions. In addition, the individual and collective characteristics of intellectual and information resources, objective and subjective aspects of control synthesis are taken into account. New abstract and specific models are being created that significantly improve cognitive-constructive activity, the formation and use of adequate knowledge for the problems being solved.

Current situation of scientific and technical development

Modern scientific and technological development gives rise to a number of problems:

– an increase in the volume of practically unstructured information that people do not have time to process and comprehend;

– a sharp reduction in the time for analysis and decision-making;

– inadequacy of purely technical solutions (solutions require active human participation, the use of natural elements, that is, a transition to the “man-technology-nature” system [4,5], to nature-like technologies; ergatic and cyber-physical systems are required [6, 7]);

– high intensity of element interaction in such systems;

– increasing responsibility for the decisions made and their implementation, which may be accompanied by emotional burnout and destruction of the habitat (a conscious or unconscious action);

– the need for platform independent and easily scalable solutions;

– an urgent need for solutions that take into account the human factor, including emotions, illusions and misconceptions;

– the need to form alternative solutions for some tasks that increase the reliability and safety of the systems being created (functional controlled redundancy) under the influence of negative illusions, emotions, misconceptions, and design errors;

– the need to develop models of emotional resources and models of the perception adequacy and methods of their assessment (to prevent “emotional-illusionary” chaos and use emotions and illusions in a positive sense, for emotional assessments of proximity and achievability of goals);

– the need for evolutionary assessments of solutions to problems of creating complex systems under the influence of emotions, illusions, and misconceptions;

– the problem of conflict in cognitive and constructive processes;

– growth of automatic generation of disinformation that provokes misconceptions;

– the problem of achieving an understanding of the ongoing processes.

Such systems require continuous technology to transform the ideal into the material and vice versa.

When solving such problems, a basis is possible for creating smart materials and structures that harmonize the emotional state of the individual and the team.

Examples include the task of creating flexible exoskeleton and illusion clothing (as opposed to clothing illusion).

It is possible to create a basis for ensuring not just the quality of life, but the achievement of happiness, wealth, and healthy longevity in the sense of sustainable development systems [4].

The novelty of these studies lies in the comprehension and creation of a new systematization of factors and adequate means of cognitive-constructive activity, which take into account the influence of emotions, illusions, disinformation and misconceptions and are aimed at increasing the productivity of constructive activity.

In addition, the individual and collective characteristics of intellectual and information resources, objective and subjective aspects of control synthesis are taken into account. Mechanisms of alternative solutions are being formed that provide not just opposing competitive solutions, but controlled redundancy that supports increased reliability and security. It should be noted that the cognitive-constructive process itself is based not only on synthesis processes, but also on the processes of learning, self-organization and creative thinking.

New abstract and specific models are being created that significantly improve cognitive-constructive activity, the formation and use of adequate knowledge for the problems being solved. We are talking about models for the implementation of solutions to cognitive-constructive tasks through systems consisting of a person, technical means, and natural elements. The construction of such implementations (inference and synthesis of solutions) is carried out by the methods of folding and expanding the problem statements and transitions between the levels of the problem statements.

Statement and solution of the problem

This research is intended to solve the problem of integration or fusion (diffusion) of natural science and humanitarian knowledge in the field of cognitive-constructive activity, ensuring the continuity of technological and humanitarian processes of processing knowledge and material objects with a controlled limitation of their complexity. It is proposed to address the issue by identifying and constructing technical, linguistic and imaginative means of describing human-machine natural technical systems and methods of their programming, synthesis, self-organization, learning, creative thinking, analysis and evaluation. It is possible to consider new forms of computing (quantum, chemical, biological, etc.).

Difference from other previous studies

Previously performed studies by other authors are more limited and affect only the objectified parts of the problem (alienated knowledge) [4-9]. The simple question of what needs to be done with a computer so that working with it evokes the desired emotions and results goes beyond both purely technical and humanitarian research [10-16]. There are some partial solutions in mechatronics, in ergatic and cyber-physical systems, but purely technical and managerial solutions prevail there. The proposed research is intended to elucidate the human nature without interrupting the technical side of the tasks being solved, on the basis of complementing the computing environment and a human. It is suggested to consider the unity of human mental and motor activity in the technical-natural environment, the unity of the management of emotions, intellect, technology that is humanitarian-technical-natural synergy.

The purpose of the research is to increase the productivity of cognitive-constructive activity with the creation of conditions for satisfaction with both individual and collective activities based on a reasonable distribution of functions in a constructive environment.

The tasks of this research include:

– system-logical analysis of the current situation in the creation of complex systems (not just technical systems, interfaces, but viability, reliability, safety and sustainable development of life-forming systems);

– synthesis of systems capable of achieving vital goals with the reasonable use of heterogeneous resources;

– identification of structural elements of complex systems at the levels of material and ideal objects and transitions between them;

– creating concepts of new materials for solving these problems;

– creating tools for an adequate perception of the living environment (real and virtual) and organizing thinking, taking into account emotions and illusions (and other figurative structures) as well as their logical interconnections;

– forming a picture of the living environment based on the degrees of freedom (“libernetic”) in order to implement effective thinking and cognitive-constructive activity and to control the degrees of freedom;

– identifying and integrating sensory spaces for human-technical-natural systems as projections of the living environment;

– identifying patterns and creating models for the organization of collective-individual thinking and cognitive-constructive activity.

For constructing conceptual models, it is proposed to use the methods of constructive ontologies, the theory of graphs and networks, the concept of interfaces using new channels of information exchange.

As a means for achieving the goal and objectives of this paper, we propose to develop system-logical models based on constructive logic, dimensional technologies that will make it possible to specify the qualitative and quantitative characteristics of processes and objects (power, complexity, volumes of information, characteristics of constructive implementations, scalability, intensity of using knowledge for solving specific problems, etc.). For the systems under consideration, the constructive implementation turns into a human-machine-natural system equipped with a special activation for solving the problem.

The study of activations of human-machine-natural systems is associated with a number of difficulties. Activating a computer to solve some information problem is a relatively simple software and information object. In a slightly more complex case, activating, for example, a robot to solve some material problem is not just a software-information object, but an object equipped with material resources. In the most general case, it is essential to equip the activation with components of impact on a person (both informational and emotional) and on natural components. The “human” components must also take into account possible illusions and misconceptions. One of the objectives of this study is to establish the structures and functions of such activations and to model them. In particular, analysis and models of complexity and other resource constraints are required. It is also necessary to identify synergistic effects that can be used here.

It is also necessary to create mechanisms of conclusions and constructions of such activations as generalizations of the concepts of inference and inference machines. The operation of such generalizations of inference systems requires the involvement of humans and, in general, human-machine-natural systems at the next level. For a person's work, it is important not only to use a purely verbal logical apparatus, but also visual geometric images and other non-verbal means.

Influence of emotions and illusions on constructive activities and its results

When studying the influence of emotions and illusions on constructive activity and its results, many problems arise. Some of them are listed below:

– recognizing, constructing and using illusions and emotions;

– constructing techno-neural recognition models in emotions and illusions;

– development of mathematical methods for recognizing emotions and illusions;

– design and use of illusions and emotions based on evolutionary modelling;

– the use of emotions and illusions in the life processes of human-technical-natural systems;

– the use of emotions and illusions to increase productivity, speed, adequacy and rationality of resource consumption while developing a variety of life processes;

– analysis of emotions and illusions in a scientific and technical text (for example, the interpretation of Gödel's theorems and other negative results like causing scientific and technical illusions);

– problems of the illusory nature of mathematics itself (for example, for practical differentiation, transitions to the limits are not needed, the derivative can be determined by the equality):

$$|(f (x+d) – f (x))/d – f '(x)| < Rd.$$

– problems of self-generated programs possibility;

– problems of recognition system inferiority. Recognition is often performed without justification, without building a model. An illustration is the pattern recognition by networks of technical neurons. In fact, this is just a fit to the answer, which leads to the vulnerability of such recognition systems. This is an illusion of the intellectuality of modern systems for techno-neural network recognition. It is required to supplement a recognition with model building, with an explanation. An example of an alternative is purposeful mechanics and libernetics, using models of control over the degrees of freedom [17-19].

Problems of the objective nature of the manifestation of emotions include the following:

– neurophysiological (physical and chemical measurements);

– behavior: non-verbal (speech), verbal (mechanical), vegetative reactions;

– problems of the subjective nature of the manifestation of emotions-subjective assessments (for example, the imitation of emotions by an actor);

– problems of individual and collective manifestation of emotions and illusions;

– problems of emotion manifestation in human-machine-natural systems;

– problems of using intelligence in processing emotional and illusory information (information illusions and information about illusions);

– problems of knowledge about emotions and illusions as well as illusions and emotions in knowledge. Conative, constructive and cognitive projections of emotions and illusions. Overwhelming and irresistible emotions. Managing emotions and illusions, both your own and external. Individual and collective emotions and illusions. Emotions and illusions that help and hinder problem solving.

The following roles of emotions can be used in systems management:

1. intra-subject roles:

– implementation of feedbacks for any actions (the number of emotion types depends on the number of activity types, a cybernetic classification of emotions is required),

– management of goal priorities, actions, dominance of emotions.

2. intersubjective roles:

– managing the assistance and counteraction of different subjects (people, animals and artificial systems that imitate emotions);

– bionic role, imitation of a nature-like function in an artificial system.

The structure of emotional factor interaction in an emotionally susceptible system (examples are related to the structure of factor transfer in living organisms) as well as intersystem interaction.

The roles of illusions used also include:

1. intentional roles:

– creation of augmented reality,

– generating the required emotions,

– overcoming the lack of time,

– introduction of another subject into a different state.

2. unintended roles:

– misleading,

– sudden insight, a hint in solving a problem.

Logic of emotions, illusions, and misconceptions

This section proposes a formalization of some aspects when taking into account the human factor in solving design problems in human-machine-natural systems.

To describe problems containing information about emotions, illusions and misconceptions in the statements, it is proposed to use special modalities in a constructively interpreted language of predicate logic. General view of recording sentences, some of these modalities is

$$\mathrm{d}R\mathrm{b}B,$$

where db are “modal brackets” choosing the type of such modalities, *R* is a modal relation, *B* is a sentence. We will use pairs as db: [] (necessity), <> (opportunity) and {} (“sufficiency”). The formal interpretation of these pairs is given below.

Let us consider substantively, first of all, the following types of modalities:

– the emotional modality Sen, reflecting the emotional attitude of a certain subject to what is reflected by some judgment:

$$[\mathrm{Sen}(e,s)]\ B.$$

It is a sentence reflecting the fact that the subject *s* experiences emotion *e* in relation to the fact expressed by sentence *B*, where e is a term of a special type Emotion (in the simplest case, a constant from a predetermined list of emotions), *s* is a term of the Person type (in the simplest cases a variable or constant, for example, *s* = I, *s* = you, *s* = John), *B* is a logical formula;

– the modality “thinks that”:

$$[\mathrm{Thi}(s)]B$$

It is a sentence reflecting that subject *s* believes that sentence *B* has been fulfilled.

The interpretation of *Sen* link is further carried out using Kripke's models (models of possible worlds or possible states of the world, interconnected by modality relations, see below). For some subjects, *Thi* connective can also be interpreted by such models. We will call such subjects logical. For non-logical subjects, reasoning with *Thi* is carried out by modeling the reasoning of such an illogical subject with sentences describing his reasoning already in logical language. For these cases, so that there is no confusion, it is more advisable to use a different approach that better reflects the misconceptions, which is done below.

In such a language, you can use more traditional modalities, for example, temporal:

[Past] *B* – “there was always *B*”,

<Past> *B* – “there used to be *B*”,

[Future] *B* – “there will always be *B*”,

<Future> *B* – “someday there will be *B*”,

here time is not necessarily linear, one can take into account the uncertainties (indeterminacy, unpredictability) of both the future and the past.

You can also use aletic (“truth”) modalities:

[*O*] *B* – “must be *B*”,

<*O*> *B* – “maybe *B*”,

which traditionally are also meaningfully interpreted by Kripke's models with the relation of “true” (objective) possibility *O*.

Deontic (normative) modalities can also be considered, for example,

[*C*] *B* – “must be *B*”,

<*C*> *B* – “allowed *B*”,

where *C* is the relation of the (legal) rule. The statement *tCu* means that the state *u* corresponds to the norm *C* from the point of view of the state *t*.

When interpreting the mentioned modalities by Kripke models, the following general approach is used:

Let the statement *t* |= *B* mean that in the state of the world t the statement *B* holds, and *R* is the notation of modality. Then *R* is interpreted as a binary relation on the set of states of the world (set of worlds). At the same time, some states of the world are considered as real, others are imaginary. Then the statement *t* |= [*R*] *B* is traditionally interpreted as

A*u*((*tRu*) => (*u* |= *B*)) – “In all worlds accessible from *t* by *R*, *B* is fulfilled”, hereinafter we write the application of binary relations in infix form,

the statement *t* |= [*R*] *B* is traditionally interpreted as

E*u*((*tRu*) & (*u* |= *B*)) – “In some *R*-accessible worlds, *B* is fulfilled”.

To describe emotions, it seems reasonable to use a modality of the form {*R*} *B* – the statement *t* |= {*R*} *B* is interpreted as

A*u*((*u* |= *B*) => (*tRu*)), that is,

for example, the statement *t* |= {Sen (*e*, *s*)}*B* is interpreted as

A*u*((*u* |= *B*) => (*t* Sen(*e*,*s*) *u*))

In other words, the fact that the subject experiences in this sense a certain emotion *e* in relation to statement *B* means that this subject in a given state of the world experiences this emotion to all states of the world in which statement *B*. is fulfilled. For example, if *s* = “desire”, then the statement

$$t \models \{\text{Sen}\ (e, s)\}\ B$$

means that all states in which Proposition *B* is fulfilled are “desirable” in this sense from the state *t*. Note that for an impossible desire this set is empty.

Non-modal logical connectives are interpreted by operand, for example,

$$t \models (B \Rightarrow C) \Leftrightarrow ((t \models B) \Rightarrow (t \models C)).$$

We see that Sen and Thi are functions that generate relationships between (real and imagined) states of the world. The relationships generated by the Sen function define the states of the world to which these subjects experience certain emotions while in other states of the world. The relations defined by the Thi function define the states of the world that these subjects consider possible when they are in other states.

Another important type of modalities in solving the problems under consideration is “computing” or “dynamic” modalities. Here the modality relation is set by some action. Often this action is determined by some program code. For example, [*p*] *B* means that after the execution of the program *p* statement *B* must be executed. This modality is often used in combination with the implication: (*B* => [*p*] *C*) – the action *p*, when executed in condition *B*, leads to the fulfillment of condition *C*.

Citation is used to interpret the knowledge and judgments of illogical subjects.

Instead of the sentence [Thi (*s*)] *B*, we write the sentence See (*s*, that (*B*)) – “to the subject *s* it seems that sentence *B* has been fulfilled”. That is a linguistic metafunction (“macrofunction”) that transforms a logical sentence *B* into a special term intended for further processing to take into account the specific quasi-logic of such subjects. Of course, such a quasi-logic can vary for different subjects, which should be described by special formulas for different classes of such subjects.

The “that” function can also be used to shorten and better understand formulas.

To solve constructive problems formulated in the given language, a constructive (implementation) interpretation of logical connectives is used. For example, statements of the types [*R*] *B* and {*R*} *B* are implemented by computer programs or some activations of human-machine-natural systems. Sentences from a language with modalities can be translated into an ordinary logical predicate language in accordance with the descriptions given here. After that, to solve the assigned tasks, you can employ the means of constructive inference. Then, from the constructed evidence, it is possible to algorithmically extract computer programs, program objects or objects of human-machine-natural system activation.

Conclusion

A promising result of further continuation of the research is a system for creating constructive ontologies in the form of a complex of models, calculus and algorithms using the new systematization mentioned above. It is possible to build calculi in a form suitable for reading and understanding by both humans and machines, algorithms for the interpretation of these calculi on publicly available programming systems.

The significance of the research lies in the fact that methods of constructing models, constructive ontologies of specific controlled processes and objects, taking into account the emotions of illusions and misconceptions, are proposed.

As the expected results of the implementation of the work, one can specify:

– in the field of worldview – the construction of system-logical models of activation-motivation of living, lifelike and life-containing components;

– in the field of theory – new complexity parameters – the complexity of activation as opposed to the relatively simple input of the program into the computer.

Further work is related to the construction of models. Some of them are listed below:

– logical and mathematical (Logic of emotions. Logic of illusions and logical illusions. Logic of misconceptions. Paraconsistent and quasi-consistent logics. Paradoxes and quasidoxes. Illusions from the point of view of logic.) [20, 21];

– geometric (Geometry of emotions. Geometry of illusions and geometric illusions. Geometries of spaces of emotions and illusions. Euclidean and non-Euclidean geometries of emotions and illusions. Illusions of Euclidean and non-Euclidean geometries.);

– chronogeometric (Chronogeometry of emotions. Chronogeometry of illusions and chronogeometric illusions (twin paradox). LT (space-time) interpretation of illusions and emotions.);

– algebraic (Algebra of emotions. Algebra of illusions. Algebraic illusions. Dynamic algebra to simulate emotions and illusions.);

– automata-theoretic (Emotional automaton. Illusion automaton. Automaton illusions.);

– physical (Illusions of physics (for example, the illusion of wave function reality);

– physics of illusions and emotions.

The mechanisms of generating emotions should also be investigated:

– natural mechanisms of generating emotions,

– developed mechanisms of generating emotions,

– the basis for the formation of acquired mechanisms.

Continuing the list of models, let us add some particular ones:

– “Emotional Intelligent Artificial Fabric”.

– “Computer with emotional control” (positivity, negativity – motion control – striving, avoidance).

– “Wave Model of Emotions”.

– Humoral-field control models.

– Binding functional elements to spatial arrangement.

– The graph of discrete interaction and the graph of humoral-field connections (circulation, injection, consumption) features of the connection of the instrumental and control components.

– Similar electronic systems: power supply, information transfer, heat exchange. Emotions here can be simulated by changing general characteristics (voltages, currents, frequencies, etc.). Emotional Neural Network: General Threshold/Weight Management. So far, there is only one implemented and widely used analogue: the back propagation of an error when teaching technoneural networks with a teacher. There are only two emotions here: good (“it worked out”) and bad (“it didn't work out”).

– Economic interpretation – profit/loss in the monetary system. This is in clear disagreement with living systems.

It is required to conduct machine learning experiments with emotion-like stimulation. Emotional and associative training of people.

There is a question: is it possible to organize the work (and training) of technical neural networks with general humoral-field control? Generally speaking, the activation function can be made dependent not only on the integral input action, but also on global humoral-field factors. In particular, technoneurons with controlled thresholds can be considered.

It is required to take into account the dependence of emotional characteristics on age. An adequate computing environment is also required for observing and setting up an experiment.

The following can also be attributed to the applications of this research.

Study and use of illusions arising from systems of “artificial intelligence”, more precisely, from technical neural networks (or machine learning systems) – illusions leading to errors in image recognition. For example, such errors occur in the presence of competing images, when the recognition is performed by convolutional neural networks (sometimes the application of unusual images to the recognized object makes it “invisible” to trained convolutional networks). This can be used to mask recognizable objects and to combat such masking.

The use of emotions in programming languages was implicitly proposed long ago by N.N. Nepeivoda when he talked about the means of handling “pleasant” and “unpleasant” surprises. Here “surprises” are events that change the course of the main program. “Pleasant” surprises bring the solution of the problem closer, “unpleasant” ones – postpone it. The constructive logic of their processing is clearly described. In essence, the “illusion of a pleasant surprise” was also described that arises when programs are extracted from the natural constructive logical conclusions of some constructively not generally valid formulas, for example, when trying to program the solution of the “Peirce problem” corresponding to the formula:

$$((X \Rightarrow Y) \Rightarrow X) \Rightarrow X.$$

You can attribute other emotions to events (objects, processes) and provide reactions to them.

For example, “terrible” events threaten to destroy the system, achieving a solution to a problem leads to “satisfaction”. Objects that are more suitable for use in solving a problem may be more “liked” than others. Untested program code should create a sense of “danger”, etc.

Thus, it is possible to obtain not only the language of emotionally illusionary programming, but also the corresponding languages for setting problems and constructive inference of programs from these algorithms. The inference machine itself may also be subject to emotions and illusions that need to be studied.

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