THE CRITERIA'S SET WITH INVARIANT DESIGN BUILDING ELEMENTS ON THE BASE OF THREE IMPUTATIONS: "CONVENIENCE", "SAFETY" AND "ENERGY-EFFICIENCY"

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Abstract. The paper deals with the formalization of the criteria for constructing building management systems. We consider three criteria - "convenience", "safety" and "energy-efficiency". For each objective proposed method of calculation.

Imputation "Convenience"

«Convenience» - the imputation, characterizing the value degree of conformity to the proposed terms conditions optimal low-rise residential building comfort. The optimality criteria is a complex criteria, containing the characteristics' set . The imputation «Convenience» value depends on the values of comfort characteristics. The comfort characteristics are conditionally abstract objects' parameters, that have a direct or correlation with subjective comfort feeling. The investigated object can contain n comfort points. After that the value of "Convenience" value (K) may be defined as

$$K = \sum_{i=1}^{n} \left(1 - \frac{\left| a_i^{opt} - a_i \right|}{a_i^{opt} + a_i} \right) \qquad (1)$$

a_i - the convenience characteristic of investigated object (is measured in actual size);

a_i^{opt} - the optimal investigated object value the convenience characteristic (is measured in actual size);

It is clear, that the convenience concept is subjective and depends on human physiological makers, his/her being in this living quarters. Comfortable conditions for one person could be quite uncomfortable for another one.

Man, being in the room, is exposed by many factors. Consequently, solving the creating problem of a comfortable indoor climate, it is necessary to elaborate such control engineering systems' algorithm, that will take place into account the regulated microclimate parameters' perceptions. In this case the first step is analyzing the effects of individual microclimate parameters and their combinations for person comfort.

Temperature is the most significant indoor climate factor. Aside an obvious effect on the room air temperature, there is a radiant radiation influence. It rises from other room items and from the sun (through the window openings). Thus, it is important to maintain an optimal ratio between the mean radiant and the room air temperatures. Air humidity has a significant impact on most of the processes that may occur in the indoor climate: bacteria, viruses, and dust mites, education fungi infections of the respiratory tract and allergies, intensification of issue of construction materials, peeling dust.

Imputation "Safety"

"Safety" – the imputation based in there components:

- The reliability characteristic of an artificial intelligence system of investigated object S_r
- The engineering security artificial intelligence system characteristic S_e
- Description of the artificial intelligence system protection module S_s

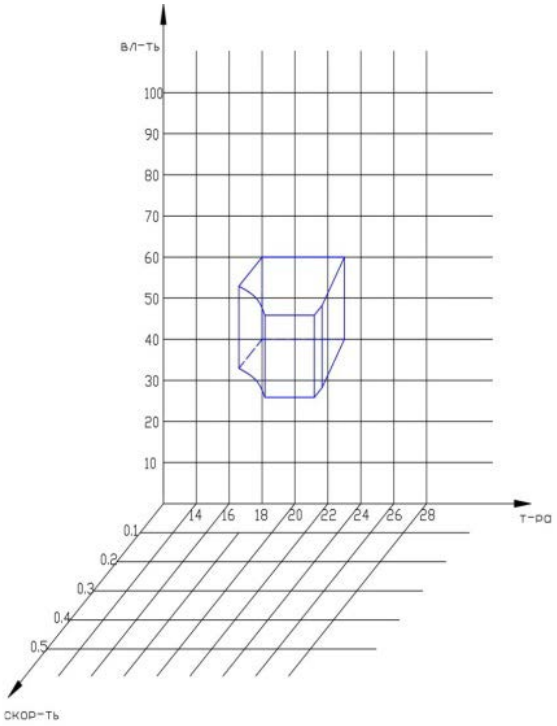

Fig. 1. The optimal comfort conditions space

Thus, the criteria imputation "Safety" is an additive characteristic based on these three components:

$$S = S_r + S_e + S_S \tag{2}$$

Characteristic of artificial intelligence system reliability is analyzed as:

$$S_r = 1 - \frac{\left| N^{opt} - N \right|}{N^{opt} + N} \tag{3}$$

N -the abstract investigated object reliability characteristic;

N^{opt} - the optimal value of the abstract investigated object reliability characteristic, defined by the following algorithm.

It is rather easy to determine the reliability of control systems organized on different kind structures. Classic feature of system reliability is the probability of not failure (P). It is calculated as formula (4)

$$P = \frac{N_K}{N_H} \tag{4},$$

where N_H - initial elements' number of the system that is being tested,

N_K - the finite elements' number of the system, remaining be able to work.

For example, the formula for determining the probability of failure-free operation with a decentralized structure will be like (5)

$$P(t) = 1 - \prod_{i=1}^{m} (1 - P_i) \tag{5}$$

Thus, you can determine the likelihood of a control system with any of the given structures. However, the considered characteristics of reliability not be acceptable for a final decision making on the choice of the particular structure of the control system, because it does not include the criticality of various engineering systems.

To account such heterogeneity influence of various engineering systems on the building possible viability by introducing an abstract characterization of the automatic control systems reliability (N), when it is calculating the probability of non-failure operation of control systems of various engineering systems (P) will be multiplied by the weighting coefficients corresponding criticality of engineering systems.

$$N = 1 - \prod_{i=1}^{m} (1 - k_i \cdot P_i) \tag{6}$$

Defining the building engineering systems' "weight" seems reasonable to distinguish three characteristics engineering systems: volume of thermal energy consumption (H, GCal), the

volume of electric energy consumption (E, kW) and the number of people (M), whose comfort and effectiveness directly depends on the correctness of the considered systems engineering.

So, abstract weighting criticality factor of engineering systems for offices could be defined by the (7).

$$N = 1 - \prod_{i=1}^{m} (1 - k_i \cdot P_i) \tag{7}$$

Thus, formalized an abstract characterization of the automatic control systems' reliability and abstract criticality of engineering systems weighting factor. Basing on proposed feature it is possible to determine the optimal look of the automatic building control system structure from the meet the needs of critical engineering systems point of view.

The second characteristic of "Security" is characteristic of engineering security artificial intelligence systems (S_e). That could be defined as:

$$S_e = 1 - \frac{d - d'}{d + d'} \tag{8},$$

d - the unprotected systems risk (cu);

d' - the degree of system risk (cu).

Consider the following description of security systems - a security modules' assessment of the artificial intelligence systems. It is defined as

$$S_S = \sum_{i=1}^{m} \left(1 - \frac{s_i^{\max} - s_i}{s_i^{\max} + s_i} \right) \tag{9}$$

$s_i^{\max}$ - the largest possible protected sites number of investigated object's consideration module;

s_i - the accepted protected sites number of investigated object's consideration module.

In the system of automation and dispatching of low-rise residential building it is a complex subsystem security that could be divided into subsystems that implement separate functions. Usually there are the following four subsystems in the residential building security system:

• security alarm system;

• fire alarm system;

• access control;

• CCTV.

To save funds of the investor company developing the automation system project it is often provided a consolidated subsystem, for example, security and fire control panels.

Fire alarm system and automatic equipment ensure continuous automatic the system efficiency monitoring by logging events, alarm and their elimination, the determination of the exact address of the fire source and output this information to a display, receiving information about the fire extinguishing system work in the heard of fire.

The most high-tech and science-intensive measure in comprehensive security implementation is monitoring a continuous process of collecting and analyzing information on the value of the object state diagnostic parameters.

Imputation "Energy-efficiency"

Imputation "Energy-efficiency" characterizes the fuel-energy resources and drinking water amount within the low-rise buildings investigation.

$$E = \sum_{i=1}^{l} \left(1 - \frac{\left| e_i^{'} - e_i \right|}{e_i^{'} + e_i} \right) \qquad (10)$$

$e_i^{'}$ - the saving volume of the i-th type of the resource (the item of fuel and energy resources and drinking water), implemented by the action of artificial intelligence systems studied buildings, (ton of reference fuel);

e_i - the total consumption volume of the i-th investigated building resource type (the item of fuel and energy resources and water), (ton of reference fuel)..

Under the overall consumption understanding the total volume of savings and volume of total consumption.

The aim of the engineering systems is the required microclimate parameters' maintenance, containing temperature and relative humidity.

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