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Tasks of data refreshment in information systems

Abstract

In this work is resolved task of monitoring of databases, functioning for a long period of time and serving the end users. Data of such databases are characterized by a number of parameters one of which is their actuality. For example, collection of outdated data leads to overload of databases. So, such data need to be removed from the databases. In this work is resolved the task of detection of various parameters of data nd conditions, determining necessity of their removal from the databases. Due to this, during the long term use of the databases, the last ones will be automatically cleaned up from outdated data preventing the database from overload.

Keywords: refreshment, information systems, social tasks, information image, utilization parameter, interpretational descriptions, refreshment measure.

1. Introduction

Widespread usage of distributed information systems, oriented on solving social tasks (SIS), allows to substantially raise effectiveness of functioning of the social environment. An example of these SIS can be systems of social insurance, related to medical services, pension system services and other kinds of services [1]. Basic features of such systems are as follows:

- service life of these systems is rather long,
- information containing in different SIS can have common fragments,
- full replacement of a system with another one due to obsolescence is not desirable,
- changes in social information systems have to reflect the corresponding changes in the social environment,
- the possibility to transfer of information fragments from active state to passive state is a natural functioning process of random social systems.

Because an information fragment by itself is an abstraction to a degree, we will discuss not the information fragments but the fragments of information images or the information images as a whole (Io_i). Let us review the definition of an information image.

Definition 1. An information image is a set of data that has an individual interpretation in the corresponding subject area, which is formally described by the following relation:

$$Io_i(D) = j(x_{i1}, \dots, x_{in}),$$

where D are data that make up Io_i and x_{ij} is an element of the interpretational description of Io_i.

In most cases x_{ij} can be a single word or a phrase in the native language of a SIS user. Information images Io_i can have their own structure. This structure describes the interconnection between components $io_i \in Io_i(D)$. Description of these interconnections can look like certain functions or another form of description of interconnections between $io_i(d_i)$ and $io_j(d_j)$. This structure corresponds to the description structure of the interpretation $j(x_{i1}, \dots, x_{in})$ of the information image $Io_i(D_i)$. A socially oriented base has to be filled with information images because these images describe different people or single groups from the social environment. Thus, certain data are interconnected corresponding to the description of interpretational extensions $j(x_{i1}, \dots, x_{in})$. Features of an information description are mostly determined by specifics of perception of the corresponding image by the users. This perception is met by a hierarchic structure of the corresponding image. A hierarchic structure is formally described by the following relation:

$$Io_i(D_i) = \{(io_{i1}(d_{i1}) \to io_{i2}(d_{i2}) \to \dots \to io_{ik}(d_{ik})) \vee (io_{i2}(d_{i2}) \to io_{i23}(d_{i23}) \to io_{i24}(d_{i24}) \to \dots \to io_{i2k}(d_{i2k})) \vee \dots \vee (io_{im}(d_{im}) \to \dots \to io_{irg}(d_{irg}))\}, \quad (1)$$

where the indexes $(i, m, k, \dots, n)$ define the placement of a fragment $io_{i,m,k,\dots,n}(d_{i,m,k,\dots,n}) \in Io_i(D_i)$ in the hierarchic structure $S[Io_i(D_i)]$.

2. Basic concepts

To choose information fragments for their exclusion from the active part of SIS or for utilization of non-active $Io_i(D_i)$, the corresponding choice parameters are used, which will be called utilization parameters (P_u^i). These parameters are formed within the system (SUD) that processes the utilization $Io_i(D_i)$. Defining of these parameters is based on using the following conditions and data:

- maximum time period when the chosen $Io_i(D_i)$ is non-active, (P_u^t),
- if the data received by user corresponding with his request do not meet his expectations, (P_u^M),
- the data which, when used within the scope of tasks being solved, lead to occurrence of structural anomalies in this system, (P_u^S),
- the data which are no more relevant, which can happen in the social environment due to changes occurring in it, (P_u^A).

The mentioned conditions can be extended by others, that reflect certain features or specifics of each single system [2, 3]. On the basis of these conditions the SUD system forms a system of utilization parameters. Thus, the main task that needs to be solved, is to define the utilization parameters, used to define data characterized the above-mentioned conditions and thus require utilization. As a whole, the process of defining utilization parameters and removing the corresponding $Io_i(D_i)$ or their replacement with the corresponding up-to-date $Io_i(D_i)$ is called refreshment of SIS.

Utilization of $Io_i(D_i)$ in the system consists of the following transformations, conducted by SUD in the SIS system:

- certain $Io_i(D_i)$ or their fragments are transferred from the SIS into the data archiving system (SAD),
- a necessary modification of $Io_i(D_i)$ is conducted, the original of the modified image is transferred from the SIS into the data archiving system (SAD),
- in the SIS, one information image $Io_i(D_i)$ is replaced with another information image $Io_i^*(D_i)$, however, the original of the replaced image is transferred from the SIS into the data archiving system (SAD),
- additional $Io_{ij}(D_{ij})$, absent in the SIS before, is introduced into the SIS,
- additional authentication of $Io_i(D_i)$ is performed, because SUD has detected absence in the $Io_i(D_i)$ the necessary fragments of interpretation description of $Io_i(D_i)$ in the subject area of interpretation of SIS.

The SUD system cooperates with SIS in the following ways [4]:

- by performing control of all $Io_i(D_i)$ corresponding to the formed strategy of data check of the SIS system,
- by performing analysis of a dialog implemented between the SIS and the user or the system that uses SIS,
- by implementing analysis of SIS functioning, performed on the basis of data regarding the requirements of the owner of SIS.

3. Solving the main task

Interpretation of different types of utilization parameters P_u^i and information images $Io_i(D_i)$ describes why the corresponding information image is not suitable or not necessary for solving tasks (Zd_i) that SIS is oriented to, which will be called regular tasks (Zd_i^S). This means that different types of parameters P_u^i are quite closely related to the different tasks like Zd_i^S. For instance, the task of long-term storage of $Io_i(D_i)$ is typical for information systems like archives and is not a regular task Zd_i^S for systems like SIS [5, 6].

One of the utilization parameters is defined by the time interval Δt_i, during which a certain $Io_i(D_i)$ is not used or is not active. The corresponding utilization parameter will be written as $P_u^t(\Delta t)$, where Δt is a parameter argument that defines the value of time interval after which the corresponding $Io_i(D_i)$ can be considered non-active, which can be described by the following relation:

$$\{\{P_u^t(\Delta t) > \Delta T_i[Io_i(D_i)]\}\&(Zd_i^h \notin Zd_i^S)\} \rightarrow \{P_u^t(Io_i(D_i)) \rightarrow \rightarrow (SIS \backslash Io_i(D_i))\}, \quad (2)$$

where ΔT_i is a time interval during which $Io_i(D_i)$ has to be activated, Zd_i^h is the task of storing $Io_i(D_i)$ during the time interval of undefined value at the moment of using SUD system, $P_u^i(SIS)$ is a set of utilization parameters of the SIS system. The value of Δt for each single $Io_i(D_i)$ can be individual. Thus, within the scope of the work of SUD system the value of ΔT_i can be chosen as the maximum of all ΔT_i values of different $Io_i(D_i) \in SIS$.

Utilization parameters P_u^i, as well as the SIS system itself, are closely related to the subject area of interpretation of information images of the system, which will be written as $W_i(SIS_i)$.

A condition that defines the next P_u^i parameter describes the situation when the user or another system, while using $Io_i(D_i)$ from the SIS_i, could not solve the task because of inconsistency of the received image with the expected data. All tasks that can use $Io_i(D_i)$ from the SIS_i are basically tasks related to $Zd_i^S \in SIS_i$. The description of Zd_i^S present in the SIS_i contains the description of all requirements to $Io_i(D_i)$. In this case, the following situations are possible:

- the user of $Io_i(D_i)$ misuses $Io_i(D_i)$,
- the Zd_{ij}^K task description used by the user does not comply with the Zd_i^S task description from the SIS_i.

In the first case $J(Io_{ij})[Zd_{ij}^K] \neq J(Io_{ij})[Zd_{ij}^S]$, and the system refuses to service the user. In the second case $J(Io_{ij})[Zd_{ij}^K] \not\Leftrightarrow J(Io_{ij})[Zd_{ij}^S]$, which means the $J(Io_{ij})$ contains inconsistency with $J[W_i(SIS_i)]$. The SUD system performs analysis of the mentioned inequality in order to determine whether Zd_{ij}^K is not correct or $Zd_{ij}^S \not\Leftrightarrow W_i(SIS_i)$, which corresponds to the situation when $J(Io_{ij})[Zd_{ij}^S] \not\Leftrightarrow W_i(SIS_i)$. This means that there were changes in $W_i(SIS_i)$ which did not have any representation in $J(Io_{ij})[Zd_{ij}^S]$ and in the SIS_i in general. In this case the parameter $P_u^i \rightarrow P_u^M$, which corresponds to the situation when SIS_i is not utilized, but refreshed.

Let us examine the statement:

Statement 1. If $J(Io_{ij})[Zd_{ij}^K] \not\Leftrightarrow J(Io_{ij})[Zd_{ij}^S]$, then there is such a modification $J(Io_{ij})[Zd_{ij}^S]$, which will lead to

$$J(Io_{ij})[Zd_{ij}^K] = J^*(Io_{ij})[Zd_{ij}^S].$$

Interpretational descriptions $J(Io_{ij})$=$j(x_{i1}^O * ... * x_{im}^O)$ and $J(W_i) = j(x_{i1}^W * ... * x_{in}^W)$ are normalized texts on the native language of the user, and their fragments are written as tm_i. According to [7], there is a full output system for these texts, that consists of the rules of replacement, exclusion, inclusion and transpositions, that, correspondingly, are described by the relations:

$(tm_{i1} * ... * tm_{ij} * ... * tm_{in})/(tm_{ij} \rightarrow tm_{ik}) \Rightarrow (tm_{i1} * ... * tm_{ij-1} * tm_{ik} * tm_{ij+1} * ... * tm_{in})$,$(tm_{i1} * ... * tm_{ij} * ... * tm_{in})/(tm_{ij} \rightarrow 0) \Rightarrow (tm_{i1} * ... * tm_{i(j-1)} * tm_{i(j+1)} * ... * tm_{in})$,$(tm_{i1} * ... * tm_{ij} * ... * tm_{in})/(tm_{ij}(+)tm_{ir}) \Rightarrow (tm_{i1} * ... * tm_{ij} * tm_{ir} * tm_{ij+1} * ... * tm_{in})$,$tm_{i1} * ... * tm_{ij} * ... * tm_{in})/(tm_{ij} \rightarrow tm_{ij-1}) \Rightarrow (tm_{i1} * ... tm_{ij-2} * tm_{ij} * tm_{i(j-1)} * tm_{ij+1} * ... * tm_{in})$.

Because the given system is full, it is possible to perform a random transformation $J(Io_i) \rightarrow J^*(Io_i)$ on its basis, using the following:

$$J(Io_{ij})\text{=}j(x_{i1}^O * ... * x_{im}^O) \text{ and } J(W_i) = j(x_{i1}^W * ... * x_{in}^W).$$

The condition that defines the parameter P_u^M is formally described by the relation:

$$\{[h^K(Io_i(SIS_i)) \rightarrow (SIS_i \rightarrow h^K(Io_i))]\&(Io_i^* \not\approx Io_i)\} \rightarrow \{P_u^M[Io_i\&W_i(SIS_i)] \rightarrow h^K(Io_i^*)\} \quad (3)$$

The next parameter of the class P_u^i corresponds to the case when within the SIS_i such situations occur when certain Io_i are no longer relevant to $W_i(SIS_i)$. This happens because in the W_i, which is a certain fragment of the social environment, there are natural changes that may miss the SIS_i. It is obvious that such a situation can be detected in case when user addresses the SIS_i and the received Io_i does not allow him to solve his task. Naturally, such situations should be avoided. Because of that, within the SIS_i, among all the tasks $Zd_{ij}^S \subset SIS_i$ those are preferred which check and replace or modify the Io_i with the purpose of ensuring their relevance to W_i. The parameter which corresponds to this case will be called relevance parameter and written as P_u^A.

Unlike P_u^M, the P_u^A parameter is oriented towards the part of tasks from the task set Zd_i^S, that are not activated by users addressing the SIS_i. This part of tasks will be written as Zd_i^{SV} or the inner regular tasks of the SIS_i. A possible example of Zd_i^{SV} is a task of the system audit [8, 9]. Any SIS_i contains not only data from the subject area of interpretation $W_i(SIS_i)$, but also the housekeeping data, that basically, too, are information images that will be written as Is_i. These Is_i are in fact characteristics of Io_i classes. Possible examples of Is_i are:

- number of addressing a certain class Io_i by users,
- duration of Io_i inactivity,
- sizes of different Io_i classes and so on.

These characteristics are defined by the specifics of $W_i(SIS_i)$. Housekeeping data are parameters used to solve tasks like Zd_i^{SV}. Activation of tasks of Zd_i^{SV} type is based on the set of criteria related to the housekeeping characteristics. Possible examples of these criteria are:

- intensity of using a certain Io_i type,
- sizes of Io_i of different types,
- number of denials of service by various Io_i types,
- violations of conditions of providing services by the system and so on.

Tasks Zd_i^S are activated corresponding to the requirements for technical maintenance of the SIS_i. However, situations can occur when, while the system is servicing the users, anomalies appear. These anomalies, as stated before, are identified by the parameter P_u^A and are connected with changes in the $W_i(SIS_i)$. Any changes in the W_i performed by workers of the corresponding departments have to be recorded in the corresponding SIS_i. Because there is no physical connection between the documents, produced in the institutions, and $Io_i \in SIS_i$, it is necessary to define certain parameters of Io_i image from the document and image $Io_i \in SIS_i$, which, regardless of the text semantics, would allow to identify the version of the Io_i text contained in the SIS_i. Let us assume the following propositions:

Proposition 1. Each producer of a new version of an element Io_i^* has to represent it in such a way that Io_i^* could be distinguished from Io_i on the basis of different values of technical parameters.

Proposition 2. A relevant image of Io_i^* is an image, formed on the basis of the document created after the occurrence of $Io_i \in SIS_i$.

According to this proposition, if $Io_i^*(p_{i1}^*, \dots, p_{ik}^*) \neq Io_i(p_{i1}, \dots, p_{i1})$, a replacement is made: $Io_i(p_{i1}, \dots, p_{ik}) \to Io_i^*(p_{i1}^*, \dots, p_{ik}^*)$. Utilization parameters are used to detect Io_i that needs to be replaced. Thus, P_u^A characterizes the difference between p_{ij} and ip_{ij}^*, which is described by the relation:

$$\{\forall(p_{ij} \in Io_i)\forall(p_{ij} \in Io_i^*)\exists p_{ik}[p_{ik}^* \neq p_{ij}]\} \to P_u^A[(Io_i^*(p_{ik}^*) \to Io_i(p_{ik})]. \quad (4)$$

Possible examples of p_{ij} parameters of Io_i image are image sizes, image structure, coordinates of Io_i placement in the SIS_i and others, formed on the basis of Io_i interpretation in the W_i.

The utilization parameter, used in the case when anomalies in the SIS_i appear on the structural level, is written as P_u^S. This parameter concerns the consistency measure $\mu(Io_i, Io_j)$ between certain Io_i and Io_j in the SIS_i. If the user chooses Io_i and Io_j within a single request, then the number of requests of various users, who choose images Io_i and Io_j within a single addressing, defines their consistency measure. Obviously, $\mu(Io_i, Io_j)$ depends on the structure $S(SIS_i)$ because the latter considers interconnections between the corresponding Io_i and Io_j. However, $S(SIS_i)$ is formed during the design of SIS_i, and after a certain amount of time the corresponding, structurally close, images can become weakly dependent, which leads to decrease of $\mu(Io_i, Io_j)$. This is defined by the external factors, which are user requests for data in the SIS_i, and it can be changed during the process of SIS_i functioning. Change in consistency measure during the SIS_i functioning between single Io_i, Io_j must not exceed the given value. If $\delta\mu(Io_i, Io_j) > \Delta\mu(SIS_i)$, the system requires structural refreshment. In practice, this could mean that SUD performs transpositions in the $S(SIS_i)$ of those images Io_i that, corresponding to the structure, became inconsistent with the adjacent images Io_j by the value exceeding $\Delta\mu(SIS_i)$. This parameter is formally described by the following relation:

$$\{[\mu t_k(Io_{ij}, Io_{i(j+1)}) = \alpha\mu]\&[\mu t_{k+1}(Io_{ij}, Io_{i(j+1)}) = \beta\mu]\& \&[(|\alpha\mu - \beta\mu|) > \Delta\mu]\&\exists Io_{ir}[\mu t_{k+1}(Io_{ij}, Io_{ir}) < \Delta\mu]\& (Io_{ij} \to Io_{ir})\} \to P_u^S[(Io_{i(j+1)} \to Io_{ir})\&(Io_{ir} \to Io_{i(j+1)})] \quad (5)$$

When using the introduced utilization parameters, a task arises of defining the fullness of these parameters. This means that it is necessary to determine if these parameters are sufficient to perform the given measure of refreshment of the system SIS_i [10]. To solve this task it is necessary to prove that the parameter system $\{P_u^t, P_u^M, P_u^S, P_u^A\}$ is full. Thus, let us define the concept of refreshment measure η of the system SIS_i. We will introduce the definition:

Definition 2. A given refreshment measure η of the system SIS_i is determined by a certain value of deviation of an integral parameter, that characterizes accordance of the SIS_i functioning process to the technical requirements, from the real value of this parameter, that characterizes current abilities of SIS_i.

The mentioned definition of η is in fact similar to the classical definition of reliability of a technical system [11]. Unlike reliability, refreshability defines by which utilization parameters P_u^i and to what extent we need to perform the system refreshment. Reliability, in its classical sense, means the measure of probability of a system malfunction, because in most cases, to define reliability, data regarding probability of failure of various system elements are used.

Let us assume that an integral parameter $\mathcal{P}$ is a certain function of single parameters, that, in a sense, can be called technological, which is written in this way: $\mathcal{P} = F(P_u^t, P_u^M, P_u^S, P_u^A)$. Then the refreshability measure will be written as: $\eta = \mathcal{P}_p - \mathcal{P}_i$, where $\mathcal{P}_P$, $\mathcal{P}_i$ are the value of the integral parameter after finishing all stages of SIS_i design and its current value. As an approximation of explicit form of the F function, the following linear polynomial will be assumed:

$$\mathcal{P} = a_1^u P_u^t + a_2^u P_u^M + a_3^u P_u^S + a_4^u P_u^A.$$

Thanks to using the data utilization parameters, it is possible to discuss detected deviations of these parameters from the given values and the influence measure of each parameter on the value of system refreshability. In this case it is not necessary to wait for manifestation of change of even one utilization parameter, which in fact represents the system state relatively to this parameter, because SUD system checks their values corresponding to the refreshing strategy of SIS_i [12].

Interpretation of situations that correspond to presence of certain values of utilization parameters, is as follows:

- irrelevance of necessary data means that the user receives data and discovers their irrelevance after an attempt to use them by a third party, which in most cases is another information system,
- necessary data do not meet the user expectations, which is discovered by the user, so it is known where the discrepancy is,
- some data, received by user as a set after a single request, are not sufficiently related to each other, which means that they are not placed properly in the SIS_i structure relatively to their actual importance,
- data are not used during a set time interval, so they are defined as irrelevant for the user.

In this case, the users are divided into the following categories:

- users that address SIS_i to obtain information from the system, (h^K)
- users that enter data into the system corresponding to their authority,(h^V)
- users that maintain the functioning process of the system (h^S).

Let us examine the following statement:

Statement 2. The system of utilization parameters is full.

This statement means that the system $\mathcal{P}(SIS_i)$ is full when a random possible user successfully performs requests, that meet the technical requirements, to the system SIS_i, provided that the values of the utilization parameters are within acceptable range.

Let us assume that h^K addresses SIS_i, or $h^K \to SIS_i$. As a result, SIS_i gives an information image $Io_i(D)$, which can be written as the following relation: $h^K \to SIS_i \to Io_i(D) \to h^K$. In this case, the following negative situations can take place:

1. $Io_i(D)$ does not correspond to $h^K(Io_i^*(D))$, where $Io_i^*(D)$ is an image expected by h^K, or $h^K \to SIS_i \to \neg(Io_i^*(D))$.
2. Using $Io_i(D)$ has led to a conflict between h^K and St_i, or $h^K(Io_i(D)) \to \neg(St_i, Io_i)$.
3. Received images $(Io_i, Io_j) \to \neg(Io_i \nsim Io_j)$.
4. A received image $Io_i(D) \to \neg(Io_i(D)\&W_i(SIS_i))$.

If the system SIS_i is addressed by the user h^V, the following negative situations can take place:

1. The user h^V enters an information image into the SIS_i, which is described by the relation:

$$[h^V(Io_i(D)) \to (SIS_i)] \to \{[Io_i(D) \notin W_i(SIS_i)]\&[Io_i(D) \cup SIS_i]\}.$$

2. The user h^V extracts an information image from the SIS_i, which is described by the relation:

$$[h^V(Io_i(D)) \to (SIS_i)\backslash Io_i(D)] \to \{[Io_i(D) \notin (SIS_i)] \vee \neg Io_i(D)\}.$$

The result of h^V user actions corresponding to point 1 can lead to the change of P_u^A value, because $Io_i(D)$ is incompatible with $W_i(SIS_i)$. The result of h^V user actions corresponding to point 2 can lead to the change of P_u^M value, because $Io_i(D)$ is compatible with $W_i(SIS_i)$ but excessive for SIS_i and thus is excluded from SIS_i, however, it can be extracted from W_i and SIS_i.

The first case that concerns the h^K user corresponds to solving within the SIS_i one of Zd_i^S tasks and is described by the relation (3).

This means that the following takes place:

$$\{h^K \to SIS_i \to \urcorner(Io_i^*(D))\} \to \{(SIS_i \to Io_i)\&(Io_i^* \not\approx Io_i)\}.$$

The relation $[W_i(SIS_i) \to (SIS_i \cup Io_i)]$ takes place and there is a request $h^K(Io_i^*(D))$. This means that we can write $SIS_i\&W_i \to \Delta W_i$, because W_i is a full description of the subject area of interpretation. So we have $h^K(Io_i^*(D)) \to (SIS_i\&\Delta W_i) \to Io_i^*$. In the last case the following relation can be written:

$$P_u^{\mathrm{M}}[(W_i(SIS_i)\&Io_i)] \to [(\Delta W_i\&SIS_i) \to Io_i^*].$$

The second case that concerns the h^K user corresponds to solving within the SIS_i one of Zd_i^S tasks and is described by the relation (4). Let us assume that St_i represents a certain SIS_j. Then the following relation takes place: $h^K(Io_i(D)) \to \urcorner(SIS_j\&Io_i(D)$. However, SIS_i and SIS_j are oriented towards common users $H^K = \{h_1^K, \dots, h_1^K\}$. Thus, the relation $[W_i(SIS_i) \cap W_j(SIS_j)] \neq 0$ takes place. Because $S_i(SIS_i)\&S_j(SIS_j)$ are structures of the type described in (1), there are common elements in $S_i(SIS_i)\&S_j(SIS_j)$ connected by implications in SIS_i and SIS_j. Fragments:

$$[(Io_{i1}^S, \dots, Io_{im}^S) \in SIS_i]\&[(Io_{j1}^S, \dots, Io_{jk}^S) \in SIS_j]$$

will be called transitions $PR(SIS_i, SIS_j) = PR_{ij}$ between SIS_i and SIS_j. Thus, it can be written that:

$$[W_i(SIS_i)\&W_j(SIS_j)\&PR_{ij}\&(h^K(Io_i(D) \in SIS_i)] \to Io_i^*],$$

which corresponds to implementation of P_u^A from (4).

The third case can be described by the following relation between images: $(Io_i \nrightarrow Io_j) = [\urcorner(Io_i \to Io_j)\&\urcorner(Io_j \to Io_i)]$. The following relation can be written:

$$\{[(Io_i\&Io_j) \in W_i(SIS_i)] \to \exists Io_k[(Io_i \to Io_k \to Io_j)]\} \to \{[(Io_i \to Io_j) \to Io_k] \vee [(Io_j \to Io_i) \to Io_k]\}.$$

The given relation can be extended on any number of $Io_i \in W_i$ on the basis of the statement (1). This extension allows to write the following relation:

$$[(Io_{i1}, \dots, Io_{in})\&W_i(SIS_i)\&(\forall Io_{ij} \in W_i)] \to \{(Io_{i1}, \dots, Io_{in}) \to \to [(Io_i \to Io_j) \vee (Io_j \to Io_i)]\}.$$

The last conjunct corresponds to the description of the operator action P_u^S from the relation (5).

When $h^K(Io_i(D)) \to \urcorner[Io_i(D)\&W_i(SIS_i)]$ takes place, it means that $\forall(SIS_i)\exists(SIS_k)[Io_i(D) \in SIS_k]$ takes place, because if $h^K(Io_i(D))$ is incorrect, the access system SD will deny the access and $SD[h^K(Io_i(D))] \to \urcorner(Io_i(D))$.

If $\forall(SIS_i)\urcorner\exists(SIS_k)[Io_i(D) \in SIS_k]$, then according to the rule (2) for h^V, a Zd_i^S is initiated like: $h^V(Io_i(D)) \to (Io_i(D) \cup SIS_k)$.

The above-given proof shows that the system $\mathcal{P}(SIS)$ ensures the implementation of all $Zd_i^S \in SIS$, where $SIS = \{SIS_1, \dots, SIS_n\}$.

4. Summary

The paper reviewed the task of refreshing SIS, that consists of regular data actualization, removing from the SIS the data which are no longer relevant and modifying the data, that represents processes of changes occurring in the environment serviced by the SIS. The introduced utilization parameters allows to detect and then to eliminate anomalies that occur in the SIS for various reasons and can lead to failure of solving the necessary tasks by using the SIS.

The possibility of data refreshment ensures the possibility of using a system of SIS type regardless of the basic tools used to create each of the single SIS, because SIS refreshing functions are implemented by a separate SUD system that interacts with the SIS through its user interfaces. Thanks to this, regardless of the natural aging of the SIS system, it can be effectively used when solving social tasks.

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