UDC 004.5:004.78 (045)
DOI: 10.31891/CSIT-2021-4-5

YEVHEN ARTAMONOV
National Aviation University,
IURII GOLOVACH
Company "Squad"
VITALII ZYMOVCHENKO
The Ukrainian Scientific and Research Institute of Special Equipment and Forensic Expertise of the Security Service of Ukraine

FEATURES OF CONTENT PRESENTATION IN MULTI-SCENARIO SYSTEMS

When software is developed, it is assumed that it can be used by different groups of users. The difference between these groups may be not only in the level of technical qualifications, but also in physiological and psychological differences, features of hardware, software, environment, and so on. Lead to the need of creation of the universal interface that can suit all users. Due to the fact that all users are different, this problem has no solution and in fact the interface corresponds to the property "least inconvenient" instead of "most convenient". The problem of adapting software and hardware to the conditions of use is solved by each team of developers with their own methods, but the approach to analyzing the problem and solutions is almost the same and comes down to building scenarios for the use of hardware and software. The article represent a general approach to the creation of multi-scenario systems for various purposes - electronic educational systems, hardware educational systems for the visually impaired, medical diagnostic systems. The following problems of development were solved in the article: adaptive intelligent interface, architecture and structure of adaptive intelligent interface and algorithms of functioning of adaptive system interface agents. The presented examples of hardware and software solutions, and the visualization of the model of the adaptive learning system will allow to develop own algorithms for the implementation of multi-scenario systems.

Keywords: adaptive interface, learning systems, medical diagnostic systems, multi-scenario systems

ЄВГЕН АРТАМОНОВ
Національного авіаційного університету, Київ, Україна.
ЮРІЙ ГОЛОВАЧ
Компанії "Squad", Київ, Україна.
ВІТАЛІЙ ЗИМОВЧЕНКО
Українського науково-дослідного інституту спеціального обладнання та судової експертизи
Служби безпеки України, Київ, Україна.

ОСОБЛИВОСТІ ПРЕДСТАВЛЕННЯ КОНТЕНТУ В БАГАТОСЦЕНАРНИХ СИСТЕМАХ

Коли розробляється програмне забезпечення, передбачається, що воно може використовуватися різними групами користувачів. Різниця між цими групами може полягати не лише у рівні технічної кваліфікації, але також у фізіологічних та психологічних відмінностях, особливостях апаратного та програмного забезпечення, середовища, тощо. Це призводить до необхідності створення універсального інтерфейсу, який може підійти всім користувачам. Через те, що всі користувачі різні, ця проблема не має розв'язку, і насправді інтерфейс відповідає властивості "найменш незручний" замість "найзручніший". Проблема адаптації програмного та апаратного забезпечення до умов використання вирішується кожною командою розробників своїми методами, але підхід до аналізу проблеми та рішень майже однаковий і зводиться до побудови сценаріїв використання апаратно-програмного забезпечення . Стаття представляє загальний підхід до створення багатосценарних систем різного призначення - електронних навчальних систем, апаратних навчальних систем для людей із вадами зору, медичних систем підтримки прийняття рішень. У статті вирішено такі проблеми розробки: адаптивний інтелектуальний інтерфейс, архітектура та структура адаптивного інтелектуального інтерфейсу та алгоритми функціонування агентів адаптивних системних інтерфейсів. Представлені приклади апаратних та програмних рішень, а також візуалізація моделі системи адаптивного навчання дозволять розробити власні алгоритми реалізації багатоценарних систем.

Ключові слова: адаптивний інтерфейс, навчальні системи, медичні діагностичні системи, багатосценарні системи

Introduction

Today, in the conditions of pandemic and quarantine, as never before, the question of transferring many spheres of activity to the online plane has become acute. But provided that people not only have different levels of technical training, but also differ in preferences, views, goals, and of course, technical equipment, in the development of public software systems it is necessary to provide multi-scenario presentation of information with the ability to choose user modes and automatically configure them.

In the case of mass use of a computer system, the convenience of working with the system is one of the key factors that determine the choice of this system in the software market.

Research conducted in the development of adaptive interfaces and learning systems solve a wide range of problems related to learning, however, the issues of providing a specific user with a comfortable working environment with the system are not considered enough, mainly at the level of concepts [1]. Neglect of these conditions lengthens the learning process, creates difficulties when working with the system and, in general, cannot but affect the effectiveness of the systems.

The question of finding further ways of adaptation is still open. One of the solutions to this issue is to provide the user with conditions for comfortable work with the system, i.e., on the one hand, the provision of tools for solving problems, taking into account his individual characteristics, and on the other hand, the admission to work with the system, a user with a certain level of knowledge and skills of this work, as well as the participation of the teacher / trainer in the learning process using traditional teaching tools and methods.

Related works

Research in the direction of multi-agent systems and multiscenario systems has recently become very popular. The applicability of these approaches is used in almost any field. More than 50 articles from various scientific fields were studied that describe the approach of multi-agent systems and multiscenario systems. The closest to our approach is work in the direction of education and decision support in medicine. Articles [1] and [2] consider the organization of the issues of building training courses, taking into account the needs and requests of users. Article [3] discusses a method for constructing a multi-agent training system. The possibilities of using different approaches in decision support systems in healthcare are discussed in the articles [4, 5]. Issues of informing the public are considered separately in [6].

All scientific studies confirm the extended capabilities of the proposed approaches. At this time, theoretical studies have been completed and the stage of practical implementation has begun. Practical implementation distinguishes the described approaches

Multi-scenario approach in adaptive e-learning systems

Currently, the educational centers of the world's leading countries are looking for ways, methods and techniques to improve the efficiency and quality of learning, providing for different groups of students support for their independent cognitive activity, computer learning, collective and individual modes of learning and practical tasks therefore, the term "adaptive educational system" has recently been increasingly considered in world research [7], and the term "personalization" in software engineering has moved to the sections of pedagogy, which develop a theoretical basis for distance learning.

As a result of the study of the learning process [8], the developers created a programmed learning model, which served as the basis for subsequent models. Its essence is the adaptation of the educational process to clearly defined goals, a reference result (correct answer). In accordance with the received grade, the next stage of the educational process is selected. This model can be implemented by linear and branched training schemes.

The essence of the methodology proposed by the author is to create a user model that reflects his individual characteristics, as well as means and methods that implement the functions of adapting this model in conjunction with the information system. The main provisions of the concept of creating such an interface are:

1. Adaptation of the system to the needs of the user is carried out through the settings of the system services for the user model, which is created when the user first accesses the system, and then adjusted during his subsequent logins to the system. The system services are configured by installing a help and hint subsystem, connecting to the Internet (filtering and searching), changing the intensity of information exchange for the individual characteristics of the user, as well as connecting databases, hardware for specific tasks he solves.

2. When creating a model, personal and psychophysiological (state of health) characteristics of the user, his information competence (knowledge of the capabilities of the system, computer) are taken into account. All this is revealed through special testing. Moreover, information competence is determined twice: initially during the initial testing and secondly when the user passes tests for knowledge of the computer software and hardware.

3. The user model is adjusted every time he logs on to the system, except for the first call to the system. At the same time, information competence is specified based on the analysis of the actions of this user during the last session and testing of his psychophysiological characteristics at a given moment in time.

4. The adaptation of the user to the system is carried out by teaching him to work with the system through various kinds of trainings, tips and explanations [7].

To solve the problem, we must:

- to develop and research a model of an adaptive intelligent interface for user interaction with the system;
- develop the architecture and structure of an adaptive intelligent interface;
- to develop and research the general algorithm of the adaptive intelligent interface;
- to investigate the algorithms of interaction between the user and the system when entering the information system (first mode), when re-entering the system (second mode) and when it ends;
- to develop and research algorithms for the functioning of agents of the interface system, taking into account the peculiarities of their functioning in the subsystems of coordination and control, user modeling and interaction history.

Building an adaptive learning system combines user models, e-learning system (contains a model of learning resources) and adaptation system. Each of the elements is represented by a group of parameters that must fully characterize the object to be able to model the system and predict the effectiveness of its use.

In general, the user can be represented as follows:

$$U = \{OP, SP\},$$

where $OP = \{op_1, op_2, ..., op_m\}$, $SP = \{sp_1, sp_2, ..., sp_n\}$,

where *OP* is the set of objective parameters, *SP* is the set of subjective parameters.

The process of filling the user model must have the following classification features: implicit accumulation, individuality, dynamism, longevity, descriptiveness.

The e-learning system can be reduced to two sets of parameters:

1) interface parameters (include parameters of training resources);

2) functional parameters:

$$ESE = \{IP, FP\},$$

where $IP = \{ip_1, ip_2, ..., ip_k\}$, $FP = \{fp_1, fp_2, ..., fp_l\}$,

where *IP* is the set of interface parameters, *FP* is the set of functional parameters.

In general, the process of adapting the training system is reduced to a set of rules for modifying each component of the interface of the training system for each user. To represent the processes of modification of the educational system [7], we use the following formula:

$$PA = \{pa_1, pa_2, ..., pa_o\},$$

where *pa* is the rule of modification of system parameters in accordance with user parameters:

$$o = (m+n) \cdot (k+l).$$

Graphically, this model can be represented as follows (Fig. 1).

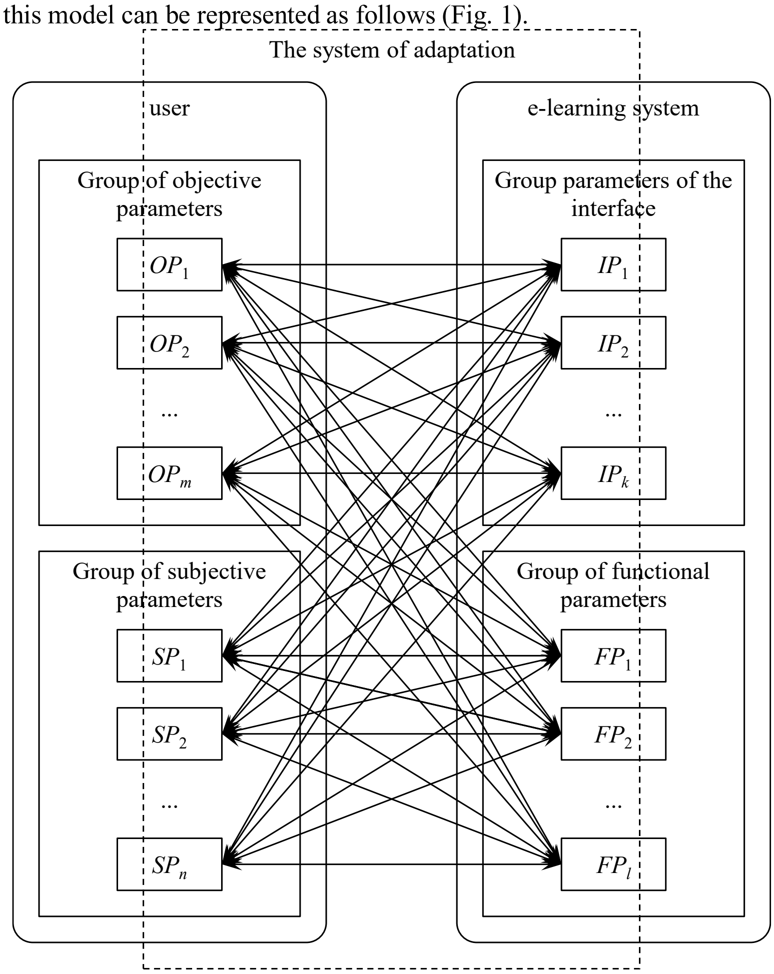

Fig. 1. Graphical representation of the model of adaptive e-learning system

Multi-scenario approach in learning systems for blind people

According to statistics, about 70,000 blind people live in Ukraine. In the absence of sight, blind people have to rely on other sources of information, such as sound and tactile sensations. Braille is one of the most common tactile fonts for reading. There are fiction and non-fiction printed in Braille in Ukraine. Even despite the cost and size of these books (for example, the geometry textbook for the eighth grade program fits in the four volumes), in Ukraine no more than 10% of visually impaired people know Braille. The high cost of such books is due to the complex process of their production and small circulations. And large editions are not needed, because there are not enough people who have the ability to read in Braille.

In this way, we get a vicious circle when there is no need to print a books in Braille, because this books has a small number of readers, but due to the lack of variety of books in Braille can not have more readers.

Instead of expensive devices called Braille displays (1000-5000 Euros depending on the configuration), a simplified system for studying Braille has been developed.

The general principle of operation of the educational complex is presented in the diagram of Figure 2. The data is sent to the device via USB (unit 1). If the control unit (unit 3) does not have a built-in implementation of the USB interface, but only the implementation of the UART interface, then the appropriate converter (unit 2) must be used to convert the signals. The data received by the controller is processed by a computer algorithm.

After data processing, the controller sends signals to the display driver (unit 4) (in this case, the driver is the electronic keys Q1-Q6). The display driver determines the state of the display according to the received signals.

The tactile display (unit 5) is an electromechanical device for outputting information. The electromechanical part of the display is made using electromagnets. Influence on the control unit is possible by means of electromechanical elements of the user interface (unit 6).

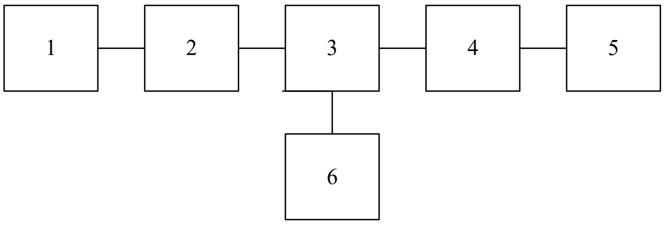

Fig. 2: Schematic representation of the hardware-software educational complex

The hardware implementation is shown in the figure 3.

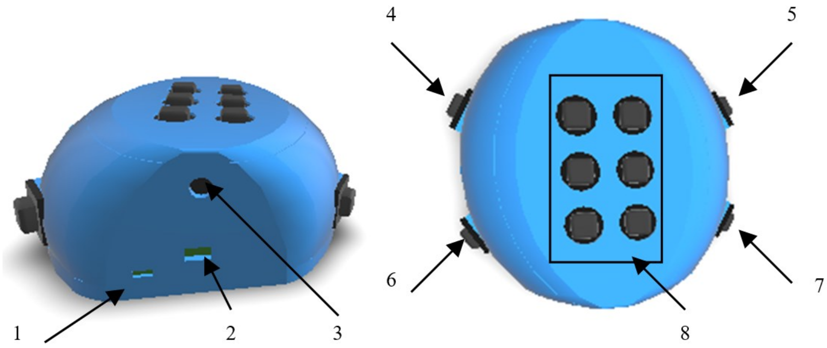

Fig. 3. Components of the hardware-software complex of learning Braille (1. Power button, 2. miniUSB connector, 3. Power connector, 4. Input button, 5. Cancel button, 6. Left navigation button, 7. Right navigation button, 8. Six dots)

The software development was based on past experience in developing systems for working with texts, in which most of the functions were brought to automatic mode [9].

The program interface is shown in Figure 4.

The developed software performs the following functions:

1) opens text files, adds service characters. There is no uppercase or lowercase letter in Braille, and a special character is added before each number;

2) allows you to use almost any font. By writing the alphabet symbols and service symbols to the file in a special way, it is possible to use the selected alphabet;

3) generates a packet of characters for transmission to the Braille display. In addition to the character codes converted to the alphabet, the number of characters in the packet is transmitted, which can vary depending on the length of the line in the display [11];

4) displays the current letters on the computer screen, both in the usual letter form and in the form of Braille dots;

5) implements automatic scrolling, which allows you to automatically move to the next character, with a specified interval;

6) receives feedback from the device to implement control.

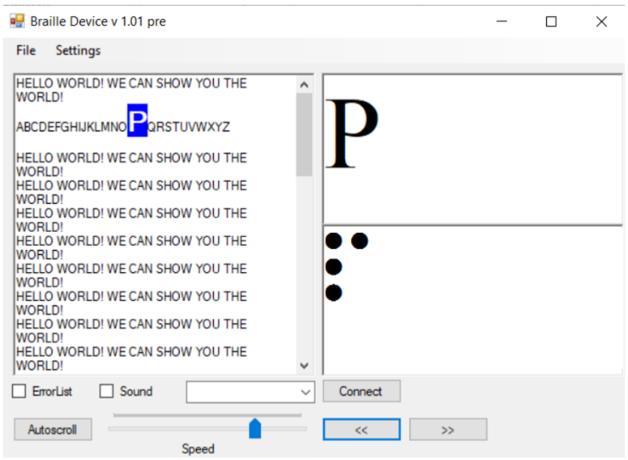

Fig. 4: Program interface of learning complex

Additional description of the software and hardware are presented in the in the patent documentation (Patent of Ukraine 105395 MPK (2016.01) G09B 5/00 G09B 21/00. Modul pidiomnoho mekhanizmu prystroiu taktylnoi indykatsii).

Multi-scenario approach in medical diagnostic systems

Of great diagnostic value are pathognomonic symptoms, the detection of which is sufficient to establish a reliable diagnosis. But the number of pathognomonic symptoms is strictly limited, they do not always manifest themselves in the relevant diseases and not at all stages of the disease, forms and variants of its course, and therefore the diagnosis is mainly focused on non-specific and specific symptoms, especially in their combination. The combination of related symptoms is a syndrome [11].

In the case of lung cancer, almost complete descriptions of syndromes and treatments are defined in pre-designed and prescribed protocols from leading cancer treatment associations, such as the NCCN (National Comprehensive Cancer Network) [12] or Cancer Research UK [13, 14].

When examining a patient, the doctor essentially recognizes the visual, sound, temperature and other images on the basis of which he makes the diagnosis. But in a difficult epidemiological situation, it is necessary to limit direct contact between patients and doctors, if possible. It is the use of widely used computer diagnostic systems that makes this possible.

The main purpose of such systems is to reduce the waiting time for intermediate results in collecting the data needed by the doctor to make a final decision. In developing such a system, which is currently undergoing experimental operation [15], it was first necessary to conduct research to determine sufficient information space of the parameters that are necessary for the formation of the diagnosis.

When forming the parameters that will be processed by the system, the developers have the following problems [16]:

1) implementation of analysis of biosignals and medical images;

2) assessment of the informativeness of diagnostic signs;

3) synthesis of decisive rules on the basis of which the decision on the diagnosis is made.

But the implementation of such systems is possible only if there is a complete description of the procedure of medical examinations and storage in a single place of the results of these examinations, because it is impossible to collect insufficient signs and it is unacceptable to force patients to conduct optional examinations. very expensive).

At inspection of the primary patient it is necessary to pay attention to detection of "cancer signals":

- symptom of "unsuccessful treatment" (peptic ulcer, gastritis, laryngitis, pneumonia, cystitis, hemorrhoids);
- symptom "plus tissue", ie the growth of volume formation;
- syndrome of "small symptoms" (increased fatigue, decreased efficiency, loss of interest in others, discomfort, loss of appetite); - pathological secretions (bloody, mucous);
- persistent dysfunction of the body;
- paraneoplastic syndromes.

The basic (pathogenetic) symptoms of cancer are

And - the fact of the presence of tumor formation;

II - local symptoms:

- dysfunction of the body,
- pain,
- pathological discharge;

III - general symptoms:

- intoxication,
- paraneoplasia;

IV - symptoms of complications and metastasis.

Moreover, at each k-th level of interaction between the internal and external environment, each i-th subsystem of the organism R_i (cardiovascular, respiration, nervous, immune, etc.) is in a certain j-th state s_{ij}^k of the multitude

$$S_i = \{s_{ij}^k\}; \quad k = \overline{0,14}; \ i = \overline{1,n_k}; \ j = \overline{1,n_i}$$

where n_k is the number of body subsystems at the k-th level of interaction with the environment;

n_i is the number of possible states of the i-th subsystem at the k-th level.

The set of states S_i is conventionally divided into subsets: S_{in} – norm, S_{ig} – borderline state and S_{ip} – pathology, that is:

$$S_i = S_{in} \cup S_{ig} \cup S_{ip}$$

The set of states of the whole organism S is determined by the set of states of all its subsystems

$$S = \{S_i\}, \ i = \overline{1,n_r}$$

where $n_r = \max\limits_k n_k$.

With the development of medicine, the set of diagnoses expands by detailing some diagnoses and taking into account both lower levels of interaction (cellular, biomolecular, and below), and higher (level of the subtle etheric body and above). In this formulation, the problem of diagnostics using a computer medical diagnostic system is reduced to the problem of determining whether the current state of the organism or its individual subsystem belongs to one of the formalized states from the set of diagnoses $\{D_i\}$.

Among the set of problems solved in the development of diagnostic medicine systems are two relevant tasks of optimization are allocated: selection of informative signs and optimization of decisive rules. If the optimization of the decisive rules to some extent finds a satisfactory solution, due to the presence of a well-developed theory of testing statistical hypotheses, the problem of the actual analysis of different survey methods is poorly covered. The system of initial diagnostic signs must meet the following requirements:

1) completeness of the description. The system of initial features should cover all selected aspects of the measured concept;

2) minimization of the description. The most common mistake of many researchers is an attempt to analyze an extremely large number of features, which, according to researchers, should help increase the informativeness of the sample [14]. However, for the synthesis of computer diagnosis (as for the solution of any classification problem) should be used useful information for this task, which does not carry "noise" and irrelevant information (not related to the purpose of the study), so when developing a system of features should avoid excessive amount of source information;

3) the structure of the system of signs. Signs should be grouped, relatively evenly describing all aspects of the measured phenomenon;

4) quantitative certainty of diagnostic signs. This certainty is provided by the formalization of the description of the features, which is discussed above.

These studies include:

- computed tomography (CT);
- bronchoscopy;
- biopsy;
- histology;
- immunohistochemistry (IHC);
- positron emission tomography (PET).

The procedure for conducting surveys is presented in Figure 5. This procedure provides for the sequence of examinations, in which PET is performed only if necessary, which was determined by biopsy.

These requirements are not exhaustive. In the case of obtaining data using questionnaires, much attention should be paid to techniques to reduce the possibility of falsification of answers and reduce the systematic error of testing. In some cases, the selection of useful information for substantive reasons is performed by the researcher himself (perhaps not quite successfully), otherwise the fight against redundancy is carried out by formal methods by assessing the informativeness of the space of diagnostic features.

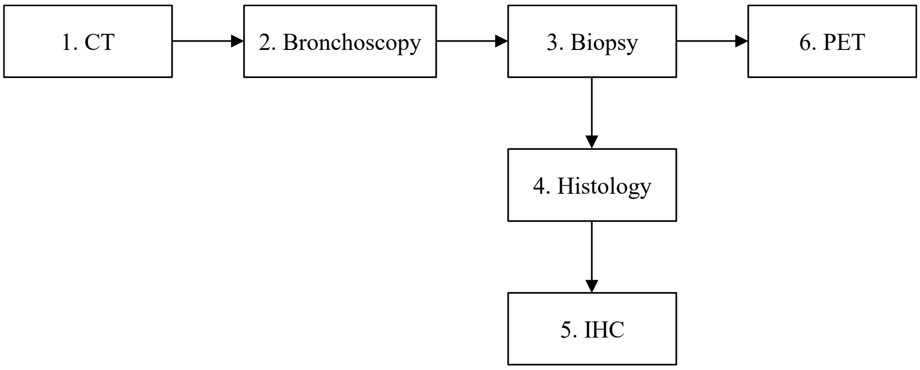

Fig. 5: Software interface hardware and software training complex

The program realization of output tree presented on Figure 6 [17].

As a result of solving the tasks set in the appropriateness of the chosen path in the organization of the work of the program support system for decision-making in the treatment of lungs' cancer was shown. On the basis of the presented data it is envisaged to obtain a set of new scientific results that will allow to consistently substantiate the methods of determining the necessary diagnosis in patients' examination and effective treatment.

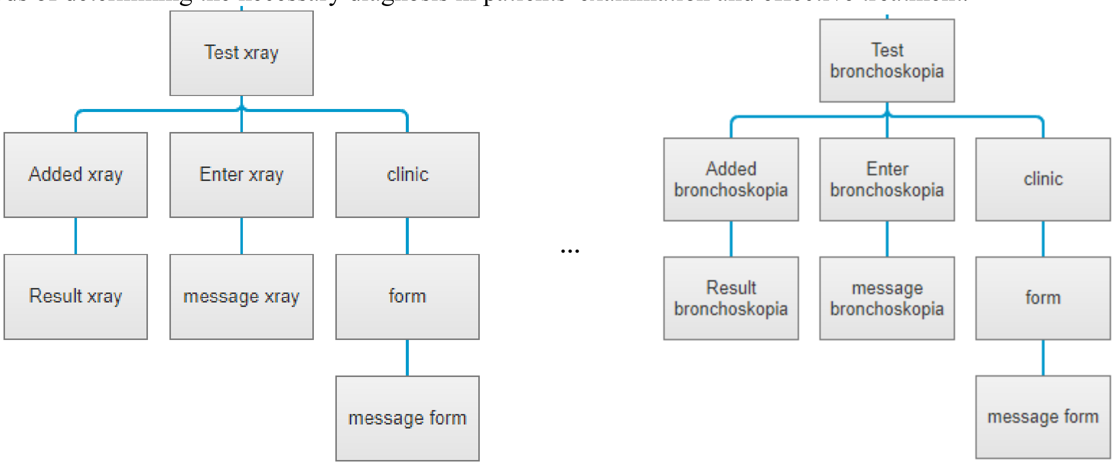

Fig. 6: Some forms of application that display the necessary diagnostic procedures and regulate data entry to the system

Experiment

The proposed approach was used to build three described systems: e-learning system for studying MS SQL (100 participants for 13 days – 2 scenarios (Table 1)), hardware-software complex of learning Braille (50 participants for 15 lessons – 3 scenarios (Table 2)) and Lung Cancer Treatment Decision Support Program (500 participants for 30 days – 2 scenarios (Table 3)).

Students took the training course remotely for an average of 3 hours a day. Due to the peculiarity of teaching Braille, children usually did not study in classes and at the same time. On average, the lessons lasted 40 minutes a day. In the Lung Cancer Treatment Decision Support Program users worked 25-30 minutes a day.

The tables contain information about the scenarios that users worked on at the beginning of the day / lesson and the number of users who changed the scenario at the end of the day/lesson.

Table 1

Scenario usage in the system e-learning system for studying MS SQL

Day	Scenario 1 at the beginning of the day	Change of scenario at the end of the day	Scenario 2 at the beginning of the day	Change of scenario at the end of the day
1	85	9	15	5
2	81	8	19	4
3	77	5	23	3
4	75	8	25	2
5	69	7	31	3
6	65	4	35	1
7	62	3	38	1
8	60	7	40	1
9	54	8	46	1
10	47	7	53	2
11	42	6	58	1
12	37	5	63	0
13	32	4	68	0
Result	28		72	

Table 2

Scenario usage in the hardware-software complex of learning Braille

Lesson	Scenario 1 at the beginning of the lesson	Change of scenario at the end of the day		Scenario 2 at the beginning of the lesson	Change of scenario at the end of the day		Scenario 3 at the beginning of the lesson	Change of scenario at the end of the day	
		1->2	1->3		2->1	2->3		3->1	3->2
1	35	5	1	10	3	1	5	0	2
2	32	3	2	13	2	1	5	1	1
3	30	2	1	14	4	1	6	0	2
4	31	2	2	13	2	2	6	1	1
5	30	3	1	12	2	1	8	0	0
6	28	4	1	12	1	2	10	1	0
7	25	5	2	13	2	1	12	1	0
8	21	2	1	15	1	3	14	0	1
9	19	2	0	14	2	2	17	1	1
10	20	3	1	13	1	1	17	0	2
11	17	4	0	16	0	3	17	1	1
12	14	2	1	18	1	2	18	0	1
13	12	5	0	18	0	1	20	1	1
14	8	3	1	23	1	2	19	0	1
15	5	2	1	24	1	2	21	0	1
Result	3			24			23		

Table 3

Scenario usage in the Lung Cancer Treatment Decision Support Program

Day	Scenario 1 at the beginning of the day	Change of scenario at the end of the day	Scenario 2 at the beginning of the day	Change of scenario at the end of the day
1	424	15	76	3
2	412	9	88	2
3	405	8	95	2
4	399	8	101	1
5	392	9	108	1
6	384	10	116	2
7	376	12	124	2
8	366	13	134	2
9	355	5	145	3
10	353	6	147	2
11	349	4	151	4
12	349	4	151	2
13	347	4	153	1
14	344	3	156	1
15	342	7	158	2
16	337	8	163	3
17	332	4	168	2
18	330	4	170	2
19	328	3	172	0
20	325	8	175	1
21	318	7	182	0
22	311	5	189	1
23	307	8	193	0
24	299	8	201	2
25	293	5	207	0
26	288	4	212	1
27	285	5	215	1
28	281	8	219	0
29	273	6	227	0
30	267	3	233	1
31	265	5	235	0
Result	260		240	

In each of the systems, there is a gradual transition to scenarios of higher complexity. There is an almost complete rejection of simple scenarios in Learning Systems.

Conclusions

As a result of solving the tasks that were set in the study the relevance of the chosen path in the organization of software in the implementation of multi-scenario methods of information presentation was shown. On the basis of the presented data it is supposed to receive set of new scientific results which will allow to substantiate consistently universal methods of formation of scenarios of behavior of system.

Based on the analysis of existing approaches to the creation of electronic educational complexes for the blind, the lack of experience for teaching visually impaired children was revealed., which required to develop a scenario of the system for this category of users. The world uses standard Braille displays with 40 or 80 letters per line for learning. All other projects have remained at the stage of describing the idea or conceptual scheme - they include the advertised touch smartphones and tablets with Braille, and educational electronic devices are not even considered as a concept.

Software testing has shown that despite the large amount of work that must be done before the implementation of hardware and software in the educational process, the use of the program individually is already possible.

And based on the review of existing software solutions to support decision-making in the diagnosis of lung cancer, it was proved the feasibility of implementing a new software system that will use modern approaches to work with all groups of system users. The construction of this system is impossible without the development of a mathematical model that will describe the relationship of treatment methods and the necessary diagnostic procedures with the parameters of the patient. The difficulty of obtaining a mathematical model is due to its dimension, multicriteria and uncertainty of a number of conditions, and today is solved through the use of expert opinion or a priori protocols for diagnosis and treatment.

The multi-scenario approach allows to realize the results of diagnosis by the method of logical inference, taking into account the available data and the level of qualification of the system user. The use of fuzzy logic makes it possible to build evaluation systems based on natural language expert statements about causal relationships.

And the application of a multi-scenario approach to the automatic change of settings in video surveillance systems allows to adapt the system to external parameters of the environment without operator intervention, which is especially useful in cases where devices are in hard to reach places.

The presented solutions prove the power of the mechanism of information systems with a multi-scenario ideology of functional implementation.

REFERENCES

1. Chatzopoulou D.I., Economides A.A. Adaptive assessment of student's knowledge in programming courses. Journal of Computer Assisted Learning. 2010. Vol. 26, № 4. P. 258-269. URL: doi:10.1111/j.1365-2729.2010.00363.x

2. Melesko J, Kurilovas E. Personalised intelligent multi-agent learning system for engineering courses. 2016 IEEE 4th Workshop on Advances in Information, Electronic and Electrical Engineering (AIEEE). 2016. DOI: 10.1109/AIEEE.2016.7821821

3. Kristensen T, Dyngeland M. Design and Development of a Multi-Agent E-Learning System. International Journal of Agent Technologies and Systems 7(2):19-74. 2015. DOI: 10.4018/IJATS.2015040102

4. Schaumann D, Breslav S, Goldstein R, Khan A, Kalay Y.E. Simulating use scenarios in hospitals using multi-agent narratives. Journal of Building Performance Simulation. 10(2):1-17. DOI: 10.1080/19401493.2017.1332687

5. Diamond IR, Grant RC, Feldman B.M., Pencharz PB, Ling SC, Moore AM, Wales PW. Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. J Clin Epidemiol. 2014;67(4):401–409. doi: 10.1016/j.jclinepi.2013.12.002

6. Yost J, Dobbins M, Traynor R, DeCorby K, Workentine S, Greco L. Tools to support evidence-informed public health decision making. BMC Public Health. 2014;14:728. doi: 10.1186/1471-2458-14-728.

7. Artamonov E.B, Zholdakov O.O. Concept of creating a software environment for automated text manipulation. Scientific journal “Proceedings of the National Aviation University”. 2010. Vol. 3 (44). pp. 111-115.

8. Artamonov Y.B. Rozrobka pidxodu do formuvannja adaptyvnyx navčal′nyx resursiv. Bulletin of the Engineering Academy of Ukraine. 2017. № 1. P. 239-243. (in Ukranian)

9. Jimaa S. The impact of assessment on students learning. Procedia-Social and Behavioral Sciences. 2011. Vol. 28. pp. 718-721.

10. Abid Masood Khan, Hifsa Batool, Saleha Ashraf A comparative study to evaluate assessment facilities at government special education schools. Pakistan Journal of Humanities and Social Sciences Research. 2020. # 02(01). URL: https://www.researchgate.net/publication/344287807.

11. Sandra V B. Jardim The Electronic Health Record and its Contribution to Healthcare. Procedia Technology. 2013. #9. pp. 940 – 948.

12. Bulletin of National Cancer Registry of Ukraine 2018. URL: http://www.ncru.inf.ua/ publications/BULL_19/index_e.htm (Access: 11.03.2021).

13. Cancer Research UK survival data. 2010. URL: http://info.cancerresearchuk.org/cancerstats/ types/ lung/survival/index.htm#source14 (Access: 15.03.2021).

14. Cancer Research UK. Cancer Stats. 2010. 2010. URL: http://info.cancerresearchuk.org/ cancerstats/types/lung/index.htm?script=true#mortality (Access: 16.03.2021).

15. Tosun A.B., Kandemir M., Sokmensuer C., Gunduz-Demir C. Object-oriented texture analysis for the unsupervised segmentation of biopsy images for cancer detection. Pattern Recognition. 2009. Volume 42 Issue 6. pp. 1104-1112. URL: https://doi.org/10.1016/j.patcog.2008.07.007 (Access: 27.03.2021).

16. Parry D.T., Parry E.C. Computerised Decision Support for Women's Health Informatics. In Medical Informatics in Obstetrics and Gynecology.Medical Information Science Reference: Hershey. 2008. pp. 302-314.

17. Artamonov Y.B., Golovach Y.Y. Pidhodi do organizacії roboti programnogo kompleksu pidtrimki priinyattya rishen' pri likuvanni raku legeniv. Bulletin of the Engineering Academy of Ukraine. 2018. # 1. pp. 128-134. (in Ukranian).

Yevhen Artamonov **Євген Артамонов**	PhD, Associate Professor of Computerized Control System Department, National Aviation University, Kyiv, Ukraine. e-mail: eart@ukr.net orcid.org/0000-0001-9872-8144, ResearcherID: C-2506-2019 https://scholar.google.com/citations?user=zyeRqjYAAAAJ&hl	кандидат технічних наук, доцент кафедри комп’ютеризованих систем управління Національного авіаційного університету, Київ, Україна.
Iurii Golovach **Юрій Головач**	Director of Delivery at company “Squad”, Kyiv, Ukraine. e-mail: iurii.golovach@gmail.com orcid.org/0000-0001-9872-8144	директор з постачання компанії “Squad”, Київ, Україна.

Vitalii Zymovchenko **Віталій Зимовченко**	Senior Engineer of the Ukrainian Scientific and Research Institute of Special Equipment and Forensic Expertise of the Security Service of Ukraine, Kyiv, Ukraine. e-mail: 777235@ukr.net orcid.org/0000-0001-9834-8547	провідний інженер Українського науково-дослідного інституту спеціального обладнання та судової експертизи Служби безпеки України, Київ, Україна.