Information Technology Platform "Dental laboratory"

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Abstract. This publication describes the relevance and benefits of using intelligent information systems in medicine. The purpose of the paper is analysis of the functioning of the developed intelligent information system "Dental Laboratory", the means and methods for implementing its client part. For the development of the intelligent information system a process approach was applied and a basic overview of the main processes in the dental laboratory was performed, disadvantages of similar systems were identified, series of diagrams that form the concepts and ideas for the presentation of the intellectual information system "Dental Laboratory" were created.

Keywords: Intelligent information system, Medicine, Electronic medicine, Medical information system, Dental laboratory, Process approach, Adaptive strategy.

1 Introduction

Today, it's hard to imagine the medical domain without computer technologies, which is a manifestation not only of comfort but also of necessity. The collection and storage of necessary information on paper carriers has long been in the past, because the amount of data is increasing every day, it requires new ways of processing and storing. The information system provides not only the processing and storage of data, but also the ability to quickly find the necessary facts.

Using of artificial intelligence technologies in such systems enables them to increase their capabilities, namely to process and analyze various types of data for making correct and high-quality solutions.

2 Stating the Research Problem

The most priority activity today is the formation of an information society − a society in which the processes of gathering, processing, analyzing, transmitting of information,

information and communication technologies occupy a major place in various spheres of human activity [1].

Information system (IS), according to a group of scientists led by Professor H.A. Andriashin [2] is an environment, constituent elements of which are computers, computer networks, software products, databases, people. The main purpose of the information system is the organization of storage, processing and transfer of the general information necessary for decision-making.

Intelligent information systems focus on the representation of knowledge of highly limited and specific domains of human experience, and then use this knowledge to arrive at solutions to specific problems or situations [3].

Important aspects of creating intelligent information systems are the acquisition and formalization of knowledge of the subject area in order to form a scientifically-based forecast [4].

One type of intelligence information system is the intelligent decision support system (IDSS). In general, information decision support system is an interactive computer information system that can provide assistance for decision-makers with using of facts and numbers to solve complex problems [5].

Authors of the article "Improving the management of the organization of media business using intelligent information systems" Ivan'ko A. F. and Ilcheva V. I. [6] argue that the most popular intelligent information systems are expert systems, with the help of which, based on real data, an estimate of some hypothesis is put forward and given. The article provides a number of other intelligent information systems that exist today:

- Systems of analytical calculations. They are based on the methods of research operations, statistical analysis, mathematical modeling;
- Neural networks;
- Full-text search systems. They unite with relational database management systems (DBMS) and form a new class of post-relational DBMS [6].

Artificial neural networks are also popular systems today. The first mention about artificial neural networks dates back to 1943, when in one of the publications [7] McCalloch W.S., Pitts W. H. presented the model of the neural network in an electrical circuit. The neural network is a mathematical model, and also software and hardware implementation, based on the automatic modeling of brain functions by methods of automatic classification of real situations from practice [8].

There are about 250 expert systems (ES) in the world market of medical computer products, put into operation and actively used in various institutions […].One of the online versions of Medical Information Systems (MIS) is a free English-speaking software EasyDiagnosis of MatheMEDics company, which allows only on the basis of subjective testing with a certain degree of probability to set up probable diagnosis or a detailed review of each received diagnostic category [9].

Evolutionary algorithms [10], fuzzy rule based systems [11], artificial neural networks [12] and neuro-fuzzy systems [13] and other techniques and technologies are of a popular school for investigation among scientists of this domain.

Along with single technologies hybrid approaches are developed. Hybridization of neural networks and evolutionary algorithms (EA) , fuzzy rule based systems and EA

and neural networks and fuzzy systems have resulted in substantial growth of investigation in intelligent system design domain [14].

The analysis of existing medical decision support systems over the past five years allows identify the main methods and means in these systems: intelligent data analysis, knowledge search in the database, considerations based on precedents, situational analysis and neural networks [15].

The basis of the medical information system is usually consists of the method of support vector machine (MOV), the decision trees, the method of "closer neighbor" in the space of signs, Bayesian classification, linear regression, cluster and correlation analyzes, methods of seeking associative rules, genetic algorithms, which are presented in the form of definite patterns [16].

E. Y. Vinogradova in the article "Methodology of the creation and implementation of the intellectual system" [17] offers 6 stages of the development of expert systems: identification, conceptualization, formalization, realization, testing, experienced operation and implementation.

The authors of the article "About the design of the main blocks of the intellectual information system for support decision-making by the surgeon "Atherosclerosis" Fedorov D. A. and Ostreykovsky V. A. consider [19] that the intellectual component occupies a prominent position in the structure of the IIS, because the very presence the elements of intellectual behavior makes the systems most valuable for the end user.

The authors of the article "Using the intelligent learning system for the studying information technologies by students" [18] under the direction of P. V. Nikitin described the development of a learning system that enabled to organize individual studying of students, taking into account their motivation and abilities. The system was developed using the PHP scripting language, the MySQL database.

So, the intelligent information system "Dental Laboratory" is an actual topic for research and may affect the development of similar systems.

3 Advantages of using an intelligent information system

The main reasons for using an intelligent information system:

- ensuring the completeness, relevance and truthfulness of the data;
- assistance in the effective processing and storing of data that has been formed over a long period;
- increasing of quantity of quality products, reducing quantity of defective products due to integration of the correct information model of production;
- storage of data of different structure;
- the ability to analyze information flows and predict future results in the company;
- dynamism and ability to self-development;
- representation data in the required form for the manager for making the correct decisions in the management of the laboratory.

Ensuring effective teamwork organization, modeling the relationships between technological processes is very important for the well-functioning of the dental laboratory.

This is achieved through the introduction of an intelligent information system that promotes quality and well-regulated work with minimal cost.

The introduction of the intelligent information system provides communication between employees and synchronizes all work results in one program environment.

The functionality of the information system contributes to:

- understanding every user of his duties and powers;
- prescribing rules, procedures and requirements for the work results of laboratory staff;
- a clear division of responsibility and authority among the laboratory staff;
- debug communication, technology of sending messages.

4 Disadvantages of similar systems

In the process of analysis of the work of similar information systems, the following disadvantages were identified:

- The number of users depends on the power of the company server.
- Need to install the program on your computer.
- Lack of Ukrainian interface language.
- Interface tools are designed for collaboration with clinics-customers and not with individual physical clients.
- Lack of user-friendly interface, rich functionality complicates using the interface and it creates inconvenience for inexperienced users, because they need experience to work with the program;
- Not available for small, medium-sized dental laboratories because price is too expensive for them;
- Lack of a combination of web-based management and content management;
- Interface tools do not provide for adding and sharing files.

5 Process approach to the implementation of the information system

During the implementation of the information system a process approach is used. In the process approach, the activity of the dental laboratory is considered as a chain of processes. First, it is necessary to understand what processes are used by the laboratory in order to achieve their goals. The identified processes are treated as a means to achieve these goals.

In fig. 1 visualization of the basic processes of the dental laboratory is presented.

Input data:

- data about order;
- data about the customer;
- graphical document with imprints of teeth.

Output data:

- order with status "Done";
- conclusions about the success of the laboratory (review of completed operations, number of orders, rating for done service).

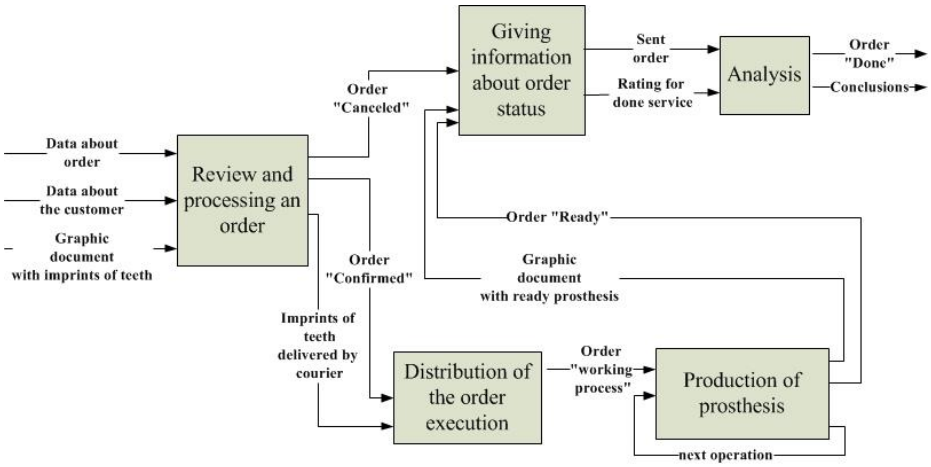

Fig. 1. Processes of the dental laboratory

This system provides 4 roles of users (fig. 2):

- The customer (a doctor or clinic) − determines the need of his patient, performs an overview of the teeth and gives imprints of the upper and lower jaws of the patient, records the order in the information system;
- Administrator − manages production processes, analyzes orders and other input information, performs the division of tasks between employees, changes the status of orders, provides control over the execution and timely sending of orders. He gives link for registration dental technicians in the system.
- Dental technician − records stage of order production in the system, records the status of the performed operation and inform when order is ready.
- Head of the laboratory − reviews the results of the dental laboratory activity, analyzes the advantages and disadvantages of the integrated process model in the system, the number of clients and the quality of work of administrators and dental technicians. He does not make any records, only reviews the current picture and makes conclusions for himself. He gives link for registration administrators and dental technicians in the system.

Any casual user will only be able to register as a customer, but without authorization he has no access to the system.

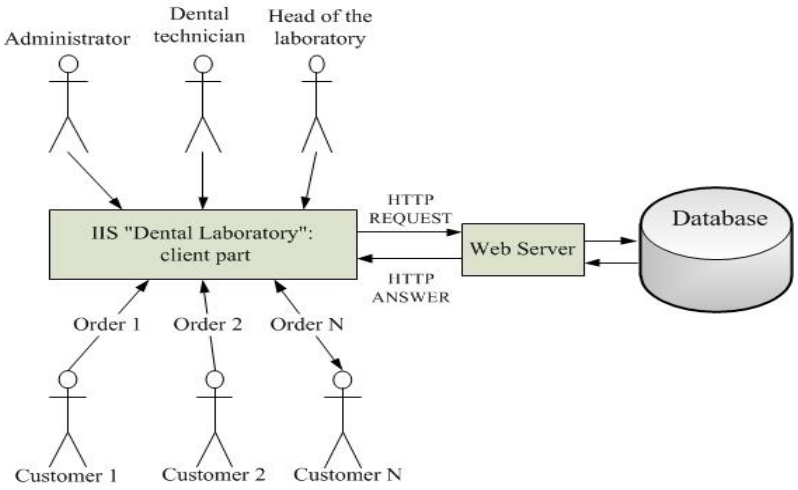

Fig. 2. Interaction of elements of IIS "Dental Laboratory"

The script customer:

- successfully enters the login and password in the system;
- indicates the type of prosthetics which it's need to produce, the material of the base, the material of artificial teeth, the color of artificial teeth, special commentaries;
- attaches a graphic file of patient teeth imprints;
- records his order;
- expects confirmation of the order by administrator;
- makes review status of his orders.

The script administrator:

- registers himself in the system after receiving the invitation from the head of laboratory;
- successful enters the login and password in the system;
- makes review of orders list;
- changes the status of the order (confirms the order);
- organizes work process, selects dental technician for executing an order;
- makes review of the working process of dental technicians;
- changes the status of the order to the "ready";
- sending an order and changing the status of the order to "done";
- gives an invitation for registration of dental technicians.

The script dental technician:

- registers himself in the system after receiving the invitation from administrator or the head of laboratory;
- successful enters the login and password in the system;
- makes review of orders list, intended for him by administrator;

- determines the nomenclature of the material from which the prostheses will be manufactured in accordance with the instructions of the administrator;
- denotes stage of the prostheses manufacture in the system;
- denotes the procedure for the prostheses manufacture of prostheses;
- makes a mark about the readiness of the prostheses.

The script head of the laboratory:

- successful enters the login and password in the system;
- makes review of orders list, the distribution of work between dental technicians, executed orders and other interest for him data in the system;
- gives an invitation for registration of administrators;
- gives an invitation for registration of dental technicians.

Unregistered user fills in the questionnaire of data about himself (surname, name, phone, address of delivery) and receives the login and password.

In fig. 3 shows a use case diagram of intellectual information system "Dental Laboratory", which depicts seven actors: head of the laboratory, administrator, dental technician, customer, unregistered user, system administrator and programmer.
In fig. 4 state diagram of the IIS.

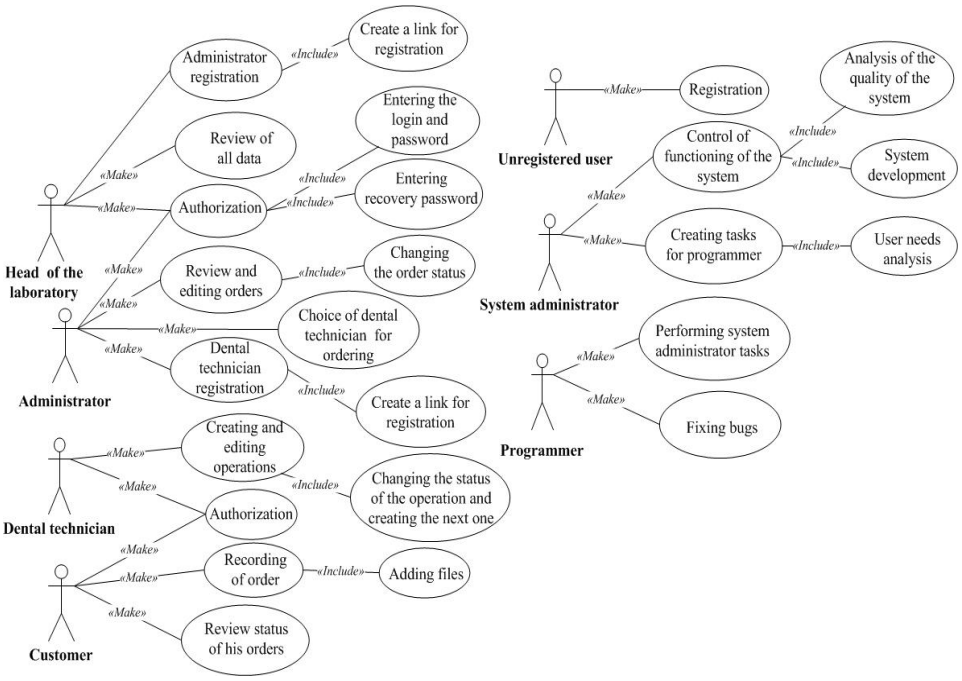

Fig. 3. Use case diagram

In the initial state the system expects data: the client registers himself or he is already registered. If client is registered, then he enters the data for authorization, in the case of entering the correct data, an interface displays for user and that allows the ability to perform actions in accordance with the rights of access. If the user performs an action, a request is sent to the server. In the case of a successful request, the action is performed and the user receives the desired result. In the case of a successful request, if necessary, information about the successful completion is displayed, in the case of unsuccessful request − the action is not executed, information about error is displayed.

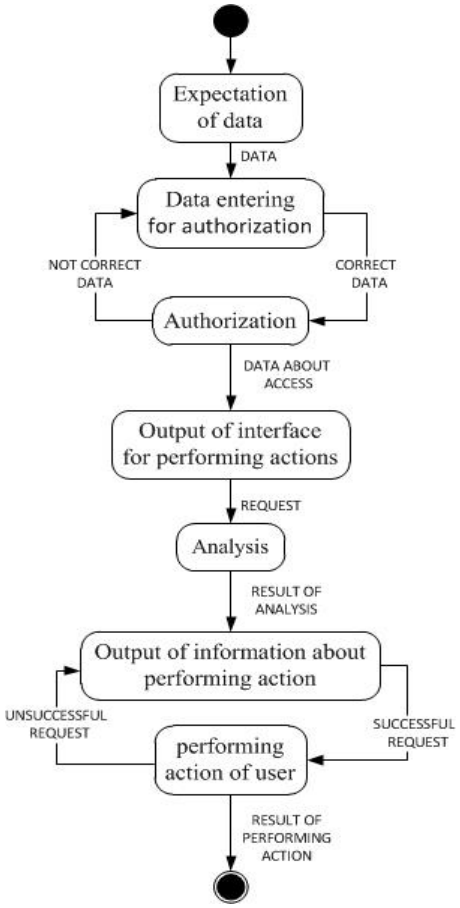

Fig. 4. The state diagram of the client part

Order statuses are important elements of the information system. State diagram of order states is shown in fig. 5. As a result of certain processes the order changes its status from "new" to "canceled" or "confirmed", "working process", "ready", "done".

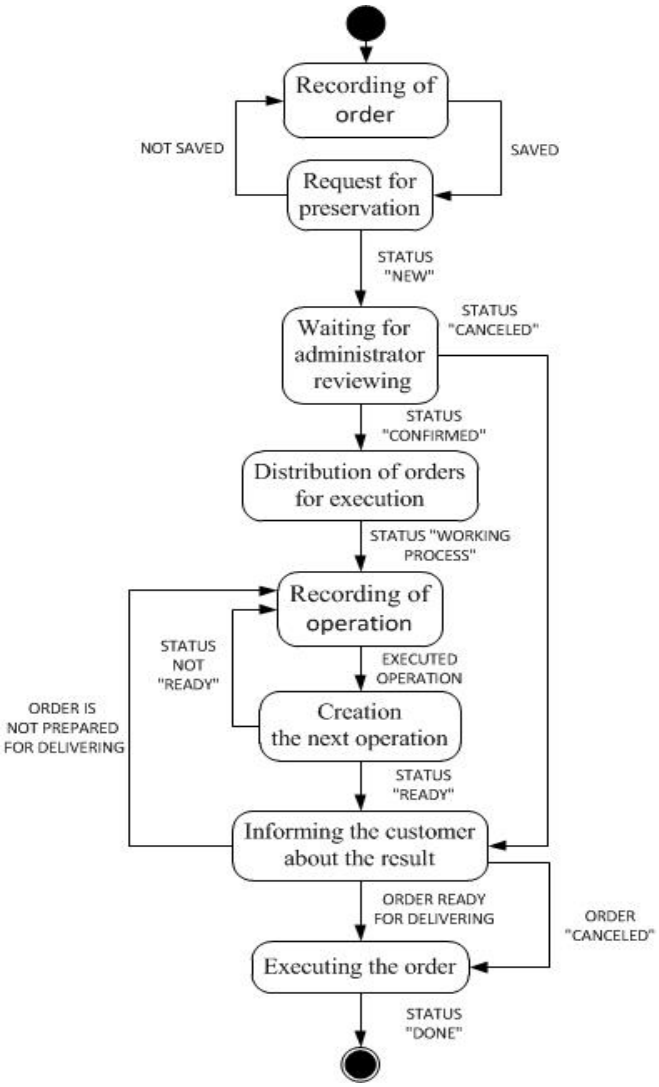

Fig. 5. State diagram of orders

6 The algorithm of working with the software product

To use the system you need to be an authorized user, have a computer or laptop with an affordable internet connection. Unlike analogues, the developed intelligent information system is implemented on a web basis, which provides access to the IIS from all devices and does not require the installation of the program on a personal computer.

A class diagram represents a static IIS, used not only to visualize, describe and document various aspects of the system, but also to build a software code.

The class diagram (fig. 6) shows the classes representing the tables in the database and their connections, which form the IIS "Dental Laboratory" and their interrelations.

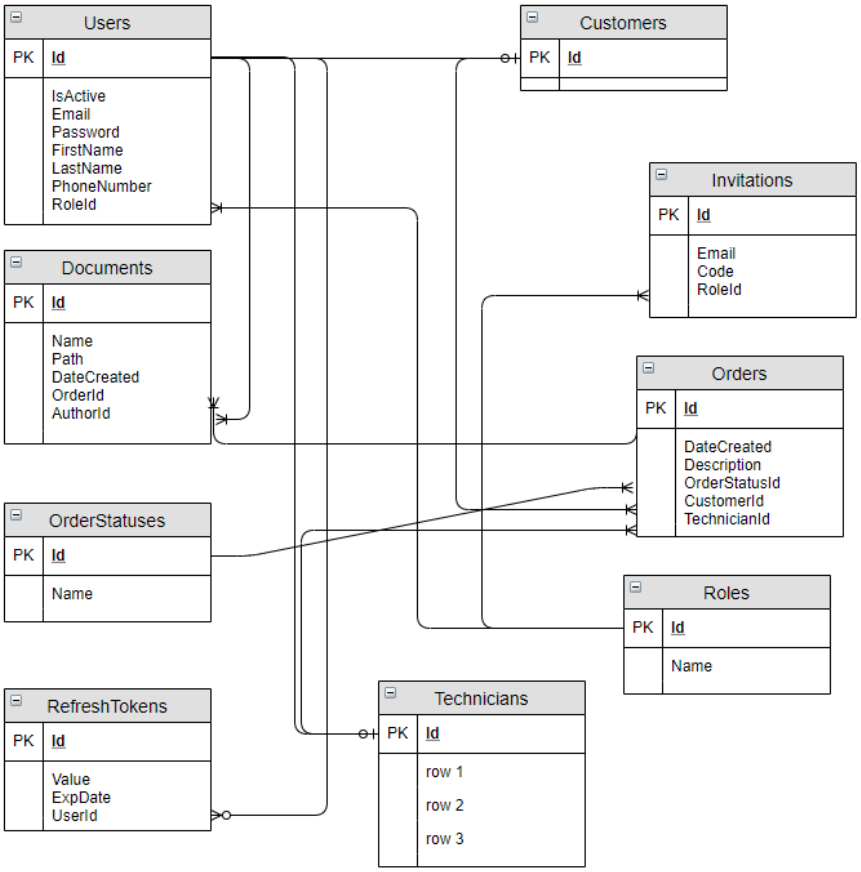

Fig. 6. Class diagram

The concept of adaptive strategy has been applied to develop the intellectual information system "Dental Laboratory". Such strategy implies that the transition to every new stage is dependent on the results of the previous one.

The task was divided into stages:

- Project evaluation.
- Search for information sources.
- Creating a technical task.
- Facility design.

The first step is to evaluate the demand of users and the necessary resources. The main task of this stage is to find out whether spending of available resources reasonable for

the expected result. In order to collect the necessary information about the needs of the user, the method of "Consumer Interview" has been applied.

A conversation with potential customers should consist of the following issues:

1. The purpose of Your purchase of such intelligent information system?
2. What factors are the main criteria for using of the intellectual information system "Dental Laboratory"?
3. If the intellectual information system ..., there is no sense to implement it in the laboratory. Fill in the pass.
4. For You, quality, cheapness or "golden mean" between two criteria is important?
5. Have you ever used similar information system, can you give any recommendation about improving it?
6. What your problems could be solved with using of this intelligent information system?

A survey should be conducted among dental laboratory staff and orthodontists.

After completing the first step, we obtain the information on the basis of which we carry out the second stage of "Searching for information sources." The main goal of this stage is to obtain the necessary data using information sources without unnecessary details. You need to understand what kind of information you look for, which sections are needed, which goals, which words to use for searching. The search of the information sources is performed according to the following criteria:

- Which system analogs are popular for solving the problem?
- Advantages and disadvantages of analogues?
- What can be improved in such systems and how?

The stages of implementation of the IIS are presented below (fig. 7).
Results expected from the future intelligent information system:

1. Productivity – the system automates the production processes thanks to integrating a certain model of product movement from order to readiness. The information system is the only environment for recording, editing, storing and exchanging the necessary information by users of one domain, provides quick access and search for the necessary data, structuring a large flow of information for optimal production process management. It allows to avoid excessive oral communication between employees, because the system contains necessary data.
2. Cost-effectiveness – the system provides an opportunity to increase the organization's profits thanks to reducing the time for manual collection, search and transfer of information and promotes rapid communication between users.
3. Technological result – influence on the development of electronic medicine and medical information systems.
4. Organizational result – the ability to automate the sequence of processes in the dental laboratory, the possibility of optimal management of processes by the administrators and the adoption of effective management decisions on the basis of relevant information.

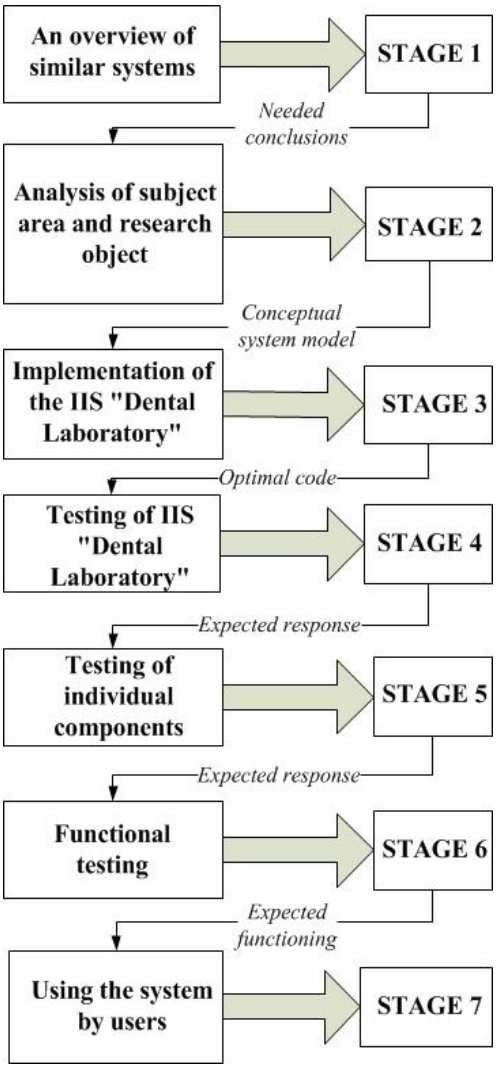

Fig. 7. The stages of implementation of the IIS

Conclusions

This publication describes the relevance and benefits of using intelligent information systems in medicine.

For the development of the intellectual information system, a process approach was applied and a basic overview of the main processes in the dental laboratory was performed, disadvantages of similar systems were identified, series of diagrams that form

the concepts and ideas for the presentation of the intellectual information system "Dental Laboratory" were created.

The main purpose of the information intelligence system "Dental Laboratory" is the recording, storage, processing, transmission of data about the implementation of processes in the dental laboratory to make the right decisions based on the analysis of processed data. This system provides 4 roles of users with different access rights: customer, administrator, dental technician and head of the laboratory. To use the implemented intellectual system "Dental Laboratory", You must be an authorized user, have a computer or laptop with an affordable internet connection. Unlike analogues, the developed system is implemented on a web basis, which provides access to the IIS from all devices and does not require the installation of the program on a personal computer.

This system will help to improve the quality and efficiency of the dental laboratory managing.

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