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## REMOTE NEUROREHABILITATION PORTAL FUNCTIONALITY

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### Abstract

The paper presents a portal developed for remote rehabilitation of patients with various neurological pathologies. The distinctive features of the developed system as compared with the existing ones are: the possibility of patient communication with the attending doctor, timely updating of the patient's individual trajectory of rehabilitation, control of the rehabilitation results through online monitoring of the patient's health condition by the video recording function integrated into the system, rehabilitation opportunities for patients in outlying areas of the Krasnoyarsk Territory. The software implementation of rehabilitation is based on proprietary medical methodologies developed at the Department of Nervous Diseases with a course of medical rehabilitation for postgraduate education at Krasnoyarsk State Medical University named after V.F. Voyno-Yasenetsky (Scientific Supervisor is MD, Professor S.V. Prokopenko). The paper pays special attention to the functionality of the remote rehabilitation system for the users with the roles: "Doctor", "Patient" and "Administrator". Screenshots of the portal are presented. The system is a classic Web application built on free software. The presented work can be useful to neurorehabilitation specialists of the Krasnoyarsk Territory and to specialists throughout Russia. The proposed information system can be also used for patients' rehabilitation exercise training of doctors and nurses.

### Keywords

remote rehabilitation, neurorehabilitation, information system, information system functions, database, home rehabilitation, information and communication technologies

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## ФУНКЦИОНАЛЬНЫЕ ВОЗМОЖНОСТИ ПОРТАЛА ДИСТАНЦИОННОЙ НЕЙРОРЕАБИЛИТАЦИИ

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### Аннотация

Разработан портал дистанционной реабилитации пациентов с различными неврологическими патологиями. Отличительными особенностями разработанной системы перед существующими является: возможность коммуникации пациента с лечащим врачом, своевременная корректировка индивидуальной траектории реабилитации пациента, контроль

результатов реабилитации путем онлайн-мониторинга состояния здоровья пациента с помощью встроенной в систему функции записи видео, создание возможности реабилитации для пациентов в отдаленных точках Красноярского края. Программная реализация реабилитации базируется на авторских медицинских методиках, разработанных на кафедре нервных болезней с курсом медицинской реабилитации последипломного образования Красноярского государственного медицинского университета им. профессора В.Ф. Войно-Ясенецкого (научный руководитель д.м.н., профессор С.В. Прокопенко). Показаны функциональные возможности работы системы дистанционной реабилитации пользователей с ролями «Врач», «Пациент» и «Администратор». Представлены скриншоты портала. Система представляет собой классическое веб-приложение, построенное на свободном программном обеспечении. Представленная работа может быть полезна нейрореабилитологам Красноярского края и специалистам по всей России. Предложенную информационную систему можно использовать также для обучения врачей и медсестер различным упражнениям для реабилитации пациентов.

#### **Ключевые слова**

дистанционная реабилитация, нейрореабилитация, информационная система, функции информационной системы, база данных, домашняя реабилитация, информационно-коммуникационные технологии

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## **Introduction**

Every year, the introduction of information and communication technologies improves the efficiency and quality of work in the health sector. The developed systems are used in the field of laboratory service automation, advisory computational diagnostics and the choice of treatment tactics, monitoring of a patient's condition, scientific research, in the educational process and the other areas [1].

In order to achieve high-quality recovery from diseases or injuries of the nervous system functions, it is necessary to carry out rehabilitation measures prescribed by a doctor for a long time. These prescriptions often do not fit into the inpatient treatment.

Existing information systems for remote rehabilitation either lean towards the use of equipment, or do not have support in the Russian Federation, or do not cover the whole range of the functionality presented below.

The information system considered in the article belongs to a new field of research – telemedicine, and is the first software development of the proprietary medical methodology (S.V. Prokopenko et al., Russian Patent 2013). The system, implemented as a web portal, contains a set of remotely prescribed rehabilitation video exercises by a doctor, provides for feedback from patients, accumulating statistical information on patients, etc. This functionality will be presented in more detail below and has not been previously implemented in the other similar information systems [2].

The operation of any information system consists of such steps as data-in, processing input information and presenting it in a convenient form, data-out for presenting to the consumer, providing feedback. So we list the following project tasks:

1. Combine, into a single methodology, proprietary and well-known rehabilitation methods aimed at motor function recovery, intellectual activity, fine motor skills, balance and walking for patients with neurological and orthopedic pathology.
2. Develop an adaptive design of the NeuroDom Internet portal [3].
3. Design and develop a database that will provide secure storage of personal data. All stages of patient rehabilitation will be stored in this database, also as medical scales; the handbook of the International Classification of Diseases will be connected to it [4].
4. Create a video-series of exercises describing the anatomy of the joints and muscles, the operating technique, the functional component of each exercise.
5. Develop algorithms that implement the technology of information collecting, storing, processing and presenting.
6. Code and program the portal to place the site files on the servers.
7. Fill the portal with information: text, graphics, video, photos, etc.
8. Perform testing of the “NeuroDom” portal on real data.

The work performers of the project are Reshetnev Siberian State University of Science and Technology (SibSU named after M.F. Reshetnev) and Krasnoyarsk State Medical University named after V.F. Voyno-Yasenetsky (hereafter – KrasSMU).

## **Description of the patients' rehabilitation process using the “NeuroDom” information system**

After the patient has undergone the initial period of rehabilitation in the hospital, the doctor can assess his health condition using medical functional scales [5, 6], with the application of the information system functionality. Next, the doctor prescribes the rehabilitation complex of exercises on the “NeuroDom” portal. Exercises are presented in the form of video clips and are based on the copyrighted medical methodologies, which are developed

at the Department of Nervous Diseases with a medical rehabilitation course of postgraduate education at KrasSMU named after V.F. Voyno-Yasenetsky (Scientific Supervisor is MD, Prof. S.V. Prokopenko) [7].

Fig. 1 presents a diagram of use cases that describes the relations and dependencies between users (patient, doctor, technical support) involved in the rehabilitation process [8].

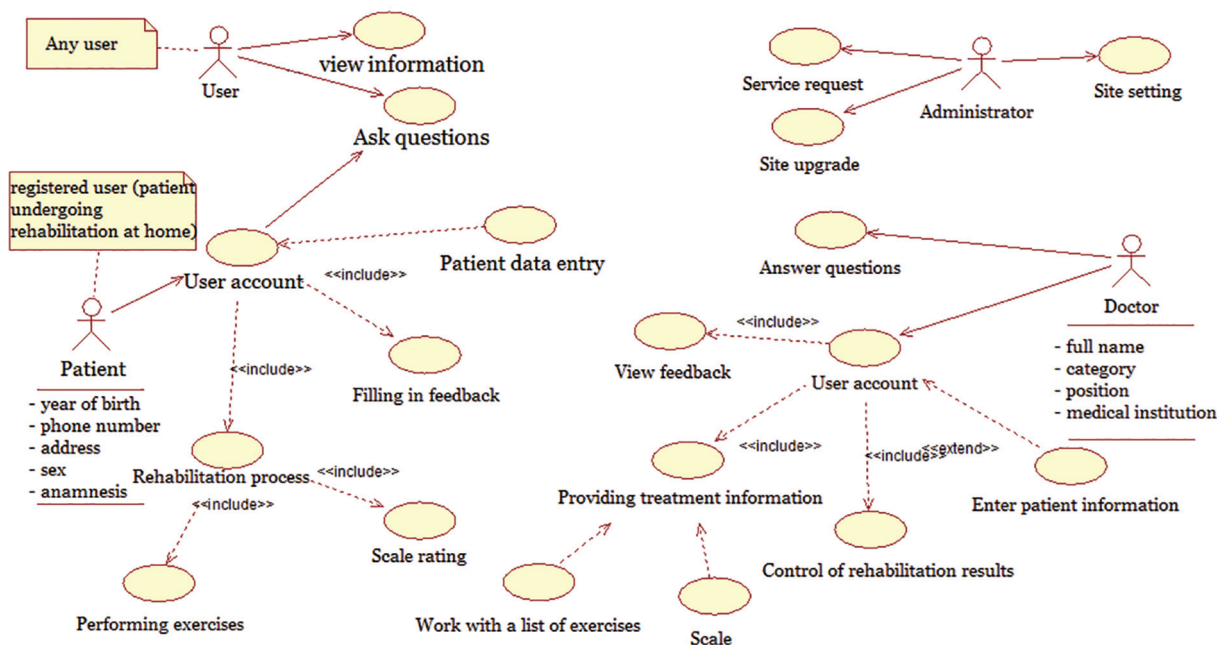


Fig. 1. General use case diagram

The database is implemented in such a way that it would be possible to ensure the security of personal data storage. Two servers are used for the system. One server is used for storing personal data within the network and the main server is aimed for storing data and using the system on the Internet.

The system activity is carried out using browsers such as Mozilla Firefox, Google Chrome, etc.

The system has a mechanism for registering and authenticating users, based on entering the correct combination of username and password. Thus, the separation of functionality according to access rights is achieved for:

1. Doctor;
2. Patient;
3. Administrator.

The user’s functionality with the role of a “Doctor” allows accessing the exercise management interface: viewed, added new, modified, deleted, grouped exercises into categories (Fig. 2).

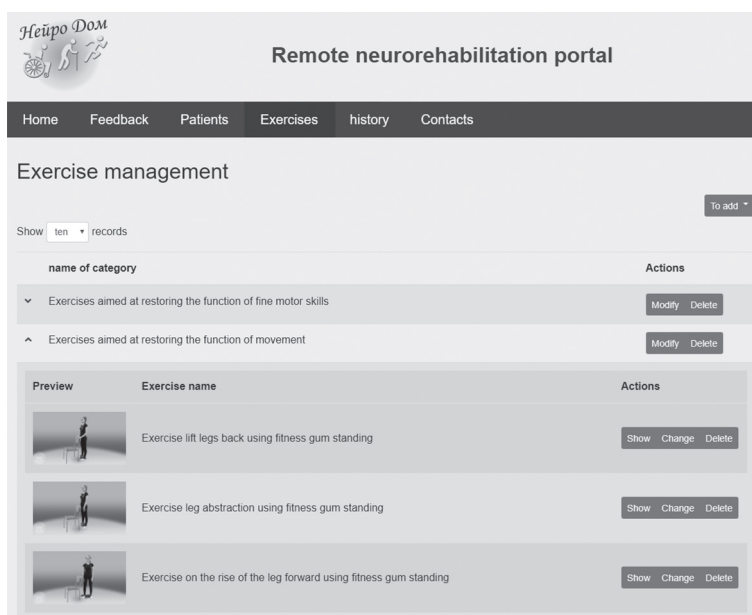


Fig. 2. The exercise list

The doctor has an access to view a list of all patients. Each patient is attached to his own attending doctor, who has the right to change his personal data, unlike the other doctors.

The doctor indicates the number of days and the time for the complex of exercises, in the process of prescribing a course of exercises (Fig. 3). A graph is plotted based on the completed and unfulfilled exercises with relation to a predetermined period of time.

The menu item “Feedback” displays a list of conversations with patients and the number of unread messages. This functionality is designed for communication between a doctor and a patient with text messages and attachments, such as pictures and recorded videos. The function of video recording and sending is added in the presented system.

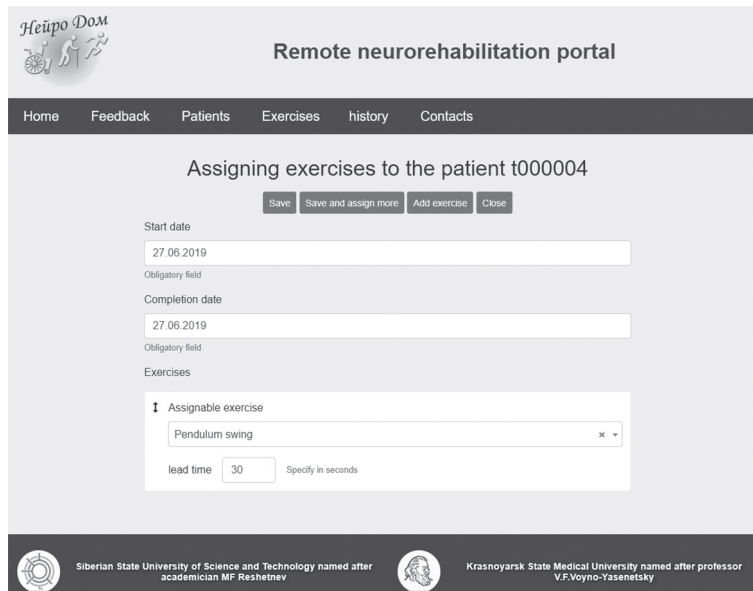


Fig. 3. Prescription of the exercise set

The menu item “History of actions” displays a list of all patients’ actions that can be filtered by date, patient, action categories (Fig. 4).

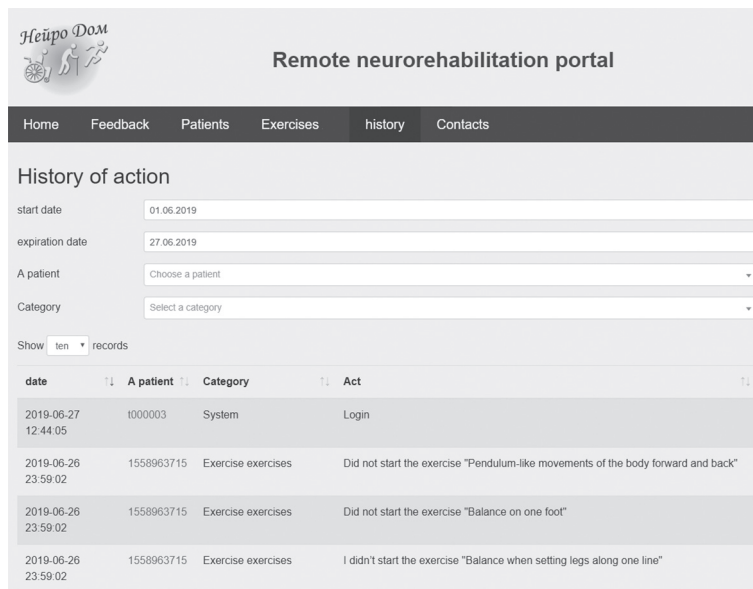


Fig. 4. History of actions

The user’s functionality with the role of a “Patient” allows accessing to a personal account where the personal information can be edited, photos can be added, as well as the history and schedule of exercises is shown.

When the patient enters the menu item “Exercises”, he sees the list of exercises for today with a description and a video instruction how to do it (Fig. 5).

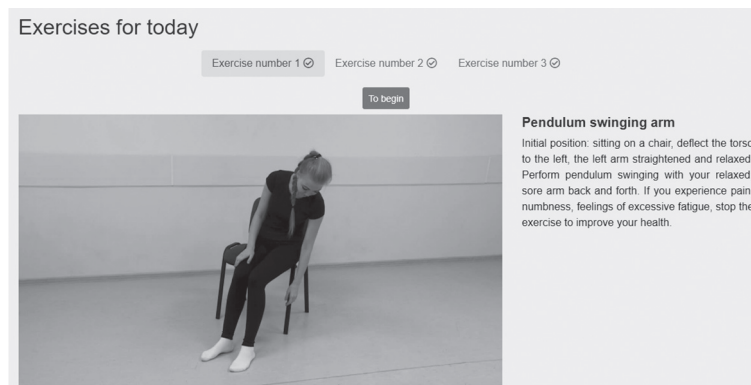


Fig. 5. Performing an exercise

Before starting the exercise, you should enter the blood pressure and pulse. After entering the data, the video will start, and the patient can perform the exercise. After finishing the exercise, the patient can click on the “Completed” button and the exercise will be reckoned as completed or “Could not be completed” and then a window will open in which you need to enter a comment about the problem with the exercise, which will be sent to the doctor.

The user’s functionality with the role of an “Administrator” allows accessing to:

- the content management of the portal that gives the possibility to edit the pages of the site, register and edit users with the roles of a “Doctor” and a “Patient”;
- management of security and access rights;
- management of scales and neurological status with the possibility to add new and edit existing scales.

The information system is designed in such a way that new scales can be connected to it without changing the source codes and database structure.

Automated data collection of users’ actions is realized, and then can be processed and retrieve statistical data.

Linux CentOS 7 is used as a server operating system and PostgreSQL – as a database. The system is implemented in PHP7, using the Symfony 3 framework [9]. On the front-end of the application, the Twitter Bootstrap [10–12] framework is used in conjunction with the jQuery library [13, 14], using HTML5 and CSS3 [15, 16].

## Conclusion

The authors presented the functions of the “NeuroDom” information system by describing the users’ options with the roles: Doctor, Patient and Administrator.

The information system is designed to create continuous rehabilitation at home with the implementation of feedback from the doctor; also it gives the possibility to create and carry out online monitoring of the individual rehabilitation trajectory of patients living in outlying areas of the Krasnoyarsk Territory, which will reduce the level of disability.

The following tasks were implemented in the course of this work: the design of the portal was developed; the database was designed and developed; a video-series of exercises with the description of the joints and muscles anatomy was created, the technique of execution was designed; code and programming of the portal was finished; content was filled; site files are hosted on KrasSMU servers.

The information system is designed in such a way that new scales can be connected to it without changing the source codes and database structure.

Automated data collection of user actions has been implemented. This data can be processed to get statistics.

The portal has been implemented and is at the stage of testing and preparation for the adoption into the Prof. Clinic of Krasnoyarsk State Medical University named after V.F. Voyno-Yasenetsky.

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