# **Mobile Application for Preliminary Diagnosis of Diseases**

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**Abstract.** The information system for analyzing the symptoms of a patient's disease, determining a preliminary diagnosis, and providing recommendations for contacting a doctor of a certain specialization is developed. The curent recommendation system performs the following main functions: preliminary medical diagnosis according to the selected symptoms; formation of reminder about taking medications; formation of history of taking medication.

**Keywords:** intelligent system, preliminary diagnosis, disease, recommendation system, mobile app, treatment.

### 1 Introduction

For successful treatment, the correct recognition of the disease and its causes, the determination of the characteristics of the patient's body and the course of the disease, the knowledge of the action of various drugs are needed. There are many different ways to diagnose and treat diseases, but technologies does not stand still and humanity needs ever-more convenient, faster and better solutions to problems. Finding new and improving old methods of medical diagnosis is one of the most promising directions in medicine. However, the problem of delayed diagnosis of diseases is always a crucial issue, because often patients are temporarily inactive for help to doctors, for which there are a number of reasons, such as lack of time or money, fear or distrust of doctors, hope only on own strength and many other aspects.

For example, Josef Hanus, Tomas Nosek, JiriZahora, Ales Bezrouk and Vladimir Masin [1] developed a computer-learning environment based on the interactive integration of computer-based medical diagnostic devices and medical information systems for use in preclinical medical physics. Y. BatuSalman, Hong-InCheng, Patrick E. Patterson [2] describe the development of the medical information system interface to ensure reliable interaction between users and the system in emergency situations. Choong Eun Jina, Tae Yoon Lee, Bonhan Koo, Heungsup

Sung, Sung-HanKim and Yong Shin [3] developed a system based on a bio-optical sensor for diagnosing a viral infection

Given the fact, it is relevant to create a system that would help the doctor to determine the diagnosis and find a cure. At the same time, patients, in addition to consultations in clinics, will be able to analyze the symptoms, what they are concerned about, and to which doctor it is necessary to contact to cure the disease using the application on a smartphone.

The aim of this article is to develop an information system designed to analyze the symptoms of a patient's disease, determine a preliminary diagnosis, and provide recommendations for contacting a doctor of a certain specialization, as well as a reminder about taking cure.

## 2 Analysis of known systems

Today, there are many different mobile applications that are used in the medical industry. Among the most common ones are: Diagnose, Epocrates Plus, WebMD, iTriage, Prognosis: Your Diagnosis.

"Diagnose" is an application that is designed to be used by medical professionals and trainees to diagnose patients, improve their care and improve medical education. The application allows users to include approved findings from the history of the disease, physical examination and research to calculate the probability of occurrence of the disease on the basis of certain facts. When examining a patient with a diagnosis such as stroke, doctors can now see in real time what specific data on the history, physical and laboratory examination of patients lead to a change in the probability of the disease. The program includes many diseases of different complexity, such as cancer, ectopic pregnancy, stroke, flu, pneumonia, sinusitis, injuries, headache and others.

The application has several significant disadvantages, among which are:

it is intended only for medical professionals or for people who have the necessary knowledge in the medicine area; absence of localization [4].

*Epocrates Plus* is a medical resource for healthcare professionals and students. The main idea of the application is to provide improved patient care by providing the necessary information when it is most needed.

Epocrates Plus has the following features:

- information on the use of any types and brands of remedy and all the nuances of their use;
- testing for the presence of potentially harmful influence of medicinal products, if they are taken in the same period of time;
- access to medical news and research information;
- medical calculator that calculates body mass index;
- information on diseases, alternative medicines.

Although Epocrates Plus is designed for doctors, but unlike the previous application, patients can also use it relatively easily. However, the disadvantages include the complexity of development and lack of localization.

*WebMD* is an application that provides round-the-clock access to web health information and decision support tools. The user is able to:

- choose the part of the body that worries and find out the causes of the symptoms and possible problems;
- find out about medicines, methods of treating a certain disease and other important information (instructions for medicines, side effects) provided by a large database;
- to identify prescription and non-prescription drugs, by type and form;
- access emergency medical information, no Internet connection when needed;
- find the nearest hospital or pharmacy according to current location or search for cities;
- create lists of medicines and view them at any time and anywhere;

WebMD is a leading provider of health information services that serves consumers, doctors, healthcare providers, healthcare employers via public and private Internet portals, mobile platforms and healthcare-oriented publications [5].

Despite the numerous advantages, there are several disadvantages: the presence of advertising, the complexity of development and the lack of localization.

*iTriage* is a medical application created by ambulance doctors, which is very similar to WebMD. Provides access to a medical database that allows you to search for symptoms, learn about their possible causes and find appropriate treatment. A feature of iTriage is the presence of a close relationship with the doctor, namely:

- search for the most suitable medical institution or doctor;
- finding the nearest hospital, pharmacy, emergency department, mental health clinic, public health centers, etc.;
- determine average waiting time for some emergency and emergency hospitals;
- emergency telephone numbers, online doctor consultations [6].

The disadvantages of iTriage are similar to WebMD.

*Prognosis: Your Diagnosis* is a game application that allows to test ones decision-making skills at risk, assess clinical knowledge on the go and learn more about the disease in a few minutes.

The app is a series of scenarios-clinical cases that assess the decision-making process and skills of the player. Each scenario takes a few minutes and is accompanied by a brief discussion of diagnostic consideration and key lessons that can be applied to everyday practice. All scenarios are based on real cases with patients who have been considered by a group of specialist doctors. All scenarios are based on real cases with patients who have been considered by a group of specialist doctors. The app is an embodiment of an interesting idea and is a great way for practicing physicians to develop and maintain their clinical wisdom at risk. This is also a good practice for medical students and other health professionals. However, a significant disadvantage is mandatory medical training [7].

Based on the analysis, we can conclude that most of the applications are aimed at helping doctors, healthcare professionals and students. Some are also intended for people who do not have special knowledge in medicine, but such programs have a number of disadvantages, which greatly complicate the work.

Although decision-making in diagnosis will always remain for the person, but the help provided by the technique becomes more and more significant. In view of this, the actual task is to create an information and consultation system with the help of which an ordinary person will be able to find out a possible diagnosis and receive recommendations for improving health.

# 3 The choise of the application type

As an alternative, 4 variants of information systems were chosen according to the nature of information use:

- *information retrieval system* a system in which information is searched, stored, systematized and displayed in a convenient representation;
- information analytical system a system designed for analytical processing of data using knowledge bases and expert systems;
- *information management system* a system designed to collect, classify, analyze, evaluate and disseminate relevant, timely and accurate information necessary for planning, management decision-making and control over it implementation;
- information and advisory system a system in which the information presented contains elements of decision-making and their assessment, but the final decision remains for user.

By analyzing a goal tree (Fig. 1) an information and consultation system was chosen, since such information systems are used in the medical area to diagnose the patient and determine the predictable treatment. The patient may take into account the received information, but also make another decision.

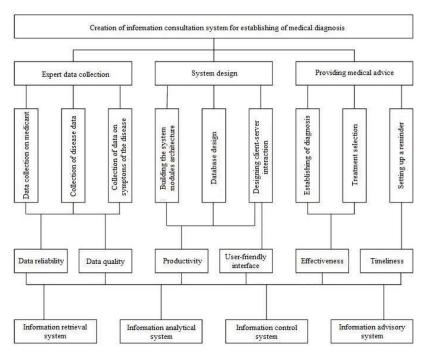


Fig. 1. Goal tree.

## 4 Building a recommendation system

When developing the draft of recommendation system, it was taken into account that it is necessary to determine the data flow scheme. The first step to build a data flow chart was creation of a context chart that reflects the main subsystems and processes with external inputs and outputs. The context diagram (Fig. 2) presents the developed system, with which two external entities interact – a patient and a doctor. The patient enters data, including the credentials and reminder settings that are transmitted to the server, processed and then sent back to the patient to obtain the result. The doctor updates the information about the treatment in case of disappearance from the sale of certain cure and the emergence of new or better ones against various diseases.

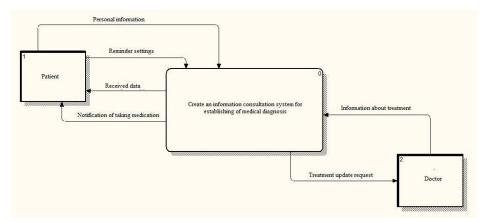


Fig. 2. Context chart.

Let's detail the context chart on the first level data flow chart (Fig. 3), which reflects the following processes:

- · sign in to account;
- diagnose;
- provide recommendations;
- · set reminders.

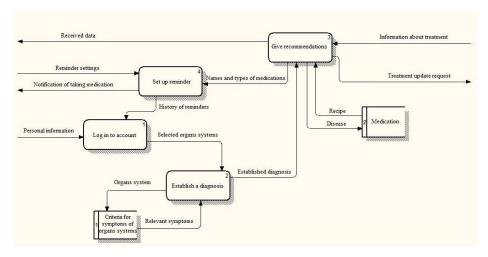


Fig. 3. Detailed (decomposition of level 1) data flow chart.

The "Log in account" process is responsible for registering and authorizing the user. After a successful authorization, the patient receives access to his or her account and has the opportunity to select the signs of the disease to further determine the medical diagnosis. The "Diagnosis" process is the determination of the patient's most possible disease according to his chosen body systems and symptoms that are

extracted from the data store called "categories of symptoms of organ systems". In "Set up reminder" process, in accordance with the entered reminder settings, an alert notification on medication intake is generated, which is recorded in the history of reminders, so that the user can review the course of treatment at any time.

The "Log in account" process (Fig. 4) is detailed into sub-processes: "User Registration" and "User Authentication", which indicate that it is impossible to log in without prior registration or with incorrect credentials.

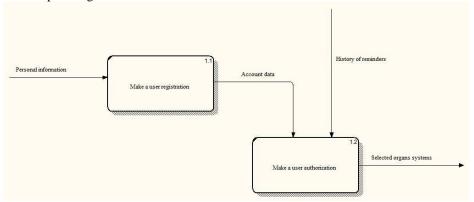


Fig. 4. Detailed (level 2 decomposition) data flow chart for the "Log in account" process.

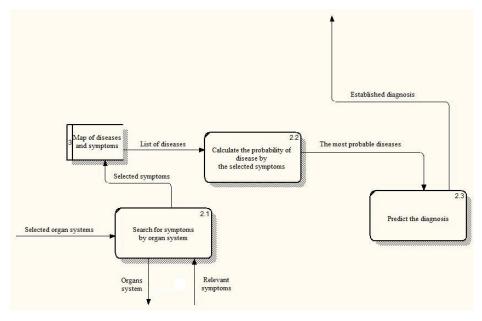


Fig. 5. Detailed (level 2 decomposition) data flow chart for the "Set diagnosis" process.

The "Diagnosis" process (Fig. 5) is detailed into three sub-processes: "Search for symptoms in the organs system" selects all symptoms to the selected organ systems

and sends a request for removal of the list of diseases according to the user selected symptoms in the data store "Map of diseases and symptoms". The subprocess "Calculate the probability of a disease for selected symptoms" determines from the list of possible diseases the most probable by means of the algorithm of the decision tree. In the subprocess "Predict diagnosis" of all possible diseases, the disease is identified with the highest probability, which is set diagnosis and the reason for seeking a doctor.

The "Set reminder" process is detailed into sub-processes: "set a course of treatment", "activate reminder s" and "generate reminder history". The "Set course of treatment" process takes the entered reminder settings and sends the next sub-process "Activate notifications" date, time, text, and dosage reminder. After the user receives a notification about taking medication, it will be recorded in the history of reminders, for which the subprocess "Create a history of reminders" is responsible.

The functional purpose of the mobile application is to provide medical advice, which includes setting of a medical diagnosis according to the selected symptoms by the user and setting reminders for timely medication. A feature is that the user can specify oneself the date and time of taking medications, which the system will remind, or follow the prescribed treatment. The restrictions on the use of the program exists in the case where there is no connection to the Internet.

The mobile application includes the following main modules:

- registration and authentication module provides the creation of an account in order to ensure the confidentiality and ease of use;
- module for interaction with server is responsible for transfering of data entered by user to server for further interaction, as well as for their receipt;
- local database interaction module interaction with a local database to store information for reminders about treatment;
- treatment history view module allows to review taken or missed user's medication;
- diagnostic module contains interaction with server part to determine the user's diagnosis;
- reminder module reminds about taking medication or performing certain procedures

Server part contains 3 modules:

- database interaction module (models);
- module for determining the diagnosis (business);
- customer interaction module (rest).

The interaction between the client and the server takes place in JSON format, using REST methods to send and receive data.

When developing the diagnosis system, classification trees were used. To construct the classification tree, an algorithm C4.5 was used, in which the number of descendants of the node is not limited. The tree is built on the basis of a training sample that contains information about the diseases and their corresponding symptoms (Fig. 6). The figure shows a simplified decision tree, by which certain

diseases of the respiratory system are diagnosed. In this system the root node is a temperature, in the role of objects there are generalized symptoms, grouped into a certain category, in the role of attributes – specified symptoms, selected according to the place of defeat or the nature of disease course. The subsets, which are not related to the desired solution of the problem, are cut off, thus approaching the leaf nodes – specific diagnoses.

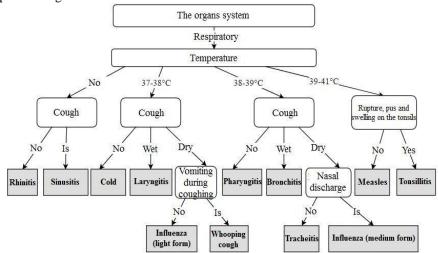


Fig. 6. An example of the decision tree.

The user selects one or more organ systems (Fig. 7). There is a short definition under each system and organs involved in it.

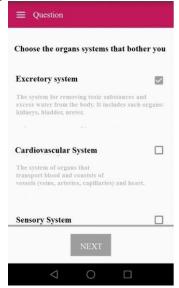


Fig. 7. Selected system of organs.

In accordance with the chosen system of organs, the user is given symptoms related to this system or systems (Fig. 8–10).

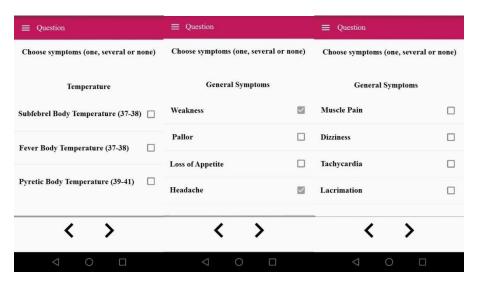


Fig. 8. The list of selected symptoms.

All symptoms of appropriate system are divided into categories according to a certain feature (for example, the category "Cough" includes all the symptoms that describe the nature of the patient's cough). In some cases, the user can select only one symptom from one category, such as temperature. You can also skip a category if none of the patient's symptoms bother you.

■ Question		■ Question		■ Question	
Choose symptoms (one, several or none)		Choose symptoms (one, several or none)		Choose symptoms (one, several or none)	
General Symptoms		Spread of Pain in a Certain Area of Body		Urine	
Muscle Cramps		Spreading of Pain in Ears		Urinary Retention	
Swelling		Spread of Pain in Hips		Opaque turbid urine	<b>V</b>
The Blue Lips		Spread of Fam in 11tps		Sand in Urine	
Bluish Discoloration of the Skin	abla	Spread of Pain in Eyes		Change Urine Color to Red	
		Spread of Pain in Neck			
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 $\textbf{Fig. 8.} \ \text{The list of selected symptoms.}$ 

After reviewing all categories of symptoms, the system displays the probable diagnosis according to those selected by user.

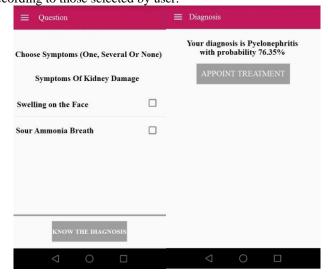


Fig. 10. The diagnosis is set.

After confirmation of the diagnosis and appointment of treatment by the doctor, reminder about taking medication is set (Fig. 11).



Fig. 11. Setting the reminder.

At the appointed time, the user receives a sound notification on the smartphone, clicking on which he can review the history of taking medication, to track which of them were taken and which were missed.

#### **Conclusions**

Thus, the recommended system designed to establish a patient's previous diagnosis and remind of the need for taking medications. The recommendation system performs the following main functions:

- a preliminary medical diagnosis according to the selected symptoms;
- formation of reminder about taking medications;
- formation of history of taking medications.

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