Designing a mobile medical expert system using the Yandex.Alice voice assistant

E M Markushin, K E Ognegin\(^1\), P S Polskaya, A Shinkaruk and S P Yakimov

Reshetnev Siberian State University of Science and Technology, 31 Krasnoyarsky rabochny avenue, Krasnoyarsk, Russia

\(^1\)E-mail: ogneginkirill@gmail.com

Abstract. Solving the problem of making a primary diagnosis in the absence or shortage of qualified doctors. The main task is to reduce the risk of incorrect assessment of the health status of people who do not have the opportunity to receive prompt qualified medical advice and assistance. We offer a project solution – Alice’s skill (voice assistant from Yandex) “Pocket Doctor” with a voice interface, which is a diagnostic expert system containing rules for logical inference based on symptoms, the assessment of which does not require special laboratory tests and can be performed by people who do not have a medical education. Based on the collected information from the user, the primary diagnosis and recommendations for emergency medical care are determined.

1. Introduction

If a person feels sick, it is necessary to go to a doctor. Unfortunately, this is not always possible – there are lots of reasons for this, which can be both objective and subjective. How to be a hunter in the taiga, a tourist on a long hike, a shift worker, a sailor on a fishing seiner? Even in the city, it is often quite difficult to get primary medical care even in the city because of long queues in local clinics, which do not disappear despite the best efforts of medical staff.

It would seem that the Internet at least partially solves this problem, but in practice, the availability of poorly structured information often leads to sad consequences. People at the first signs of illness, try to independently diagnose themselves and self-medicate, without having medical education and often the consequences of such actions can lead to serious consequences, as well as fatal outcomes.

A striking example was the global problem with the COVID-19 coronavirus infection. People who falsely assume that they have experienced a common cold do not receive the medical care they need, which leads to serious consequences, as well as fatal outcomes. On the other hand, the workload of medical staff forces doctors to recommend that patients limit their visits to medical institutions as much as possible in order to reduce the risk of infection.

Thus, it becomes urgent and necessary to create an expert system that is constantly in the zone of accessibility and allows you to make a primary diagnosis and give recommendations for providing first aid to the patient, and reduce the risks that arise. The technical side of the issue is not fundamentally complicated. The life of a modern person is closely connected with mobile devices. Today, people can’t imagine their life without a smartphone that allows them to make online purchases, make an appointment with doctors, and search for the necessary information in a matter of minutes.
The complexity of the task is due to the need to process a large amount of information using logical output and the organization of an intuitive data input interface. To solve this problem, it seems appropriate to use the achievements in the field of creating a voice interface [1].

Voice interfaces have become commonplace, there are General-purpose voice assistants (Alexa, Siri, Cortana, Google Assistant, Alice), as well as specialized software solutions for narrow specialists or certain areas of business and social sphere.

The voice interface is convenient in cases when the usual ways of interacting with the information system may be difficult due to the user's type of activity, or when the user has reduced mobility or other physical disorders.

The main goal of the project is to create the Alice skill using the voice interface to determine the initial diagnosis and assign the appropriate specialist (Created on the “Yandex platform.Dialogs”).

2. Methods
An important criterion for a good voice interface is its naturalness, that is, interaction with such an interface should create a sense of communication with a real person. Such a voice interface should work correctly, have a huge vocabulary, conduct a "dialogue" with the user, ask leading questions and give useful hints.

The most popular voice assistant in our country is Yandex Alice. Alice is a voice assistant that can recognize and synthesize speech in Russian, give answers to user questions, and solve applied tasks using programmed skills. Alice is based on a neural network that allows you to maintain conversations with the user without pre-defined scenarios.

For third-party developers, Yandex has launched the “Yandex platform.Dialogs” is intended for publishing various automated skills or chats with operators, followed by connecting to Alice [2].

Alice's skill is a specialized voice assistant mode that allows the user to call automated processes of a certain kind and get the necessary information. The skill is placed in Alice's public skill catalog. This means that It is available to a wide range of users who can call this skill by keywords or its name.

Advantages of creating a skill for Alice:

- Ability to access more than 35 million users.
- The skill appears in Yandex apps, as well as on various devices, such as phones, watches, smart speakers, and others.
- No need to install a third-party app.
- Reliability and accuracy of voice recognition provided by Alice.
- Continuous improvement of Alice’s functions.

The functionality of the designed information system assumes two user roles:

- Administrator responsible for its operation and the correct operation of individual components (figure 1).
- User who needs to be diagnosed (figure 2).

The administrator can maintain a dictionary of keywords and nodes in the inference tree (add, edit, and delete). When editing the corresponding directories, the same interface solutions should be used for adding and changing entries. The logical output tree in the designed information system is binary and, accordingly, has two types of nodes:

- Symptom - is a branch of the tree that has a logical connection with subsequent nodes: the "Yes" link-confirmation of the presence of the symptom and the "No" link, which determines the conclusion if it is absent.
- Diagnosis - has no logical continuation and is a diagnosis and recommendations for further actions.
The user’s application must have access to the corresponding database on the server via the Internet in order to function. The user is consistently given questions about the presence of a particular symptom from the output tree until the node corresponding to the diagnosis is reached. The answer is selected using the Alice voice interface.

Scenario of interaction of the voice interface with the user:

- A greeting, and a quick hint on how to use the skill.
- Getting symptoms from the user (as a set of replicas).
- Answer in the form of clarifying questions and go to step 2, otherwise-issue a list of possible diagnoses, if the information received from the user is sufficient.
To develop the functional model of the application, the unified modeling language UML was used in the Rational Rose design environment [3], which provides users with the ability to create, analyze, modify, and manage models using a single object-oriented approach and a single modeling language.

In order for the developed application to be user-friendly and have the most complete functionality, it is necessary to perform an important stage of the software lifecycle – design, according to the ISO/IEC/IEEE 12207:2017 standard [4].

Database design is an important stage in the development of an information system (IS). Data storage and processing is one of the main tasks of any information system. According to GOST 20886-85, a database is a collection of data organized according to certain rules that provide for General principles of data description, storage, and manipulation [5].

The developed IS will include a large amount of information: text, graphics, links, and other types. The database structure is implemented in a classical way using a relational model, which is represented as two-dimensional tables [6]. The database is designed using MySQL Workbench 8.0.19.

The administration application will be implemented using the classic client-server architecture. The server part will be written in C# using the framework ASP.NET, the client part will be written using one of the popular JavaScript frameworks: Angular, React, or Vue. HTTP entry point (webhook) for interaction with the “Yandex platform.Dialogs” will also be implemented on ASP.NET.

3. Results
Created based on UML use case diagrams, the entity-relationship diagram contains tables (figure 3):

- Symptoms (this table stores questions indicating the presence of the symptom, and foreign keys to go to either the next symptoms or the diagnosis).
- Diagnoses (this table stores the names of diagnoses and their descriptions).
- Node (this table is the link between the symptoms and diagnoses tables).
- Node type (this table contains information about the node type).

![Figure 3. entity-relationship diagram.](image-url)
The interface part of the application for the administrator requires a lot of attention. In order for the app to be user-friendly, when designing the interface, you must take into account:

- Intuitive layout of controls for faster operation.
- Tips, informational messages to reduce the number of human errors.
- Adjust the color scheme to reduce eye fatigue when working long hours.

Based on these conditions, an application was developed for database administration and setting up links and branches between issues.

Before using the program, the administrator must log in to their account. After that, the main menu window of the program will open, where the user can search for existing symptoms or diagnoses, add a new symptom or diagnosis, create a new branch, and test the operation of the primary diagnosis, as shown in figure 4.

![Main menu window of the admin application](image)

**Figure 4.** Main menu window of the admin application.

4. **Discussion**

The procedures for making a diagnosis are currently well studied and formalized, and there are descriptions of them adapted for use in everyday conditions by people who do not have special medical education [7].

Currently, there are a large number of online services for medical diagnostics that meet the subject area:

- Symptomate - medical diagnostics service with voice control via voice assistants: Amazon Alexa, Microsoft Cortana. The advantages of this service are that after diagnosis, the service offers to make an appointment with a doctor, and the disadvantages of the system are that voice assistants do not support the Russian language [8].
- WebMD - a website for making an initial diagnosis, including a list of symptoms, information about medications and diseases. The website lacks a voice interface and support for the Russian language [9].
• Therapist - a mobile app that allows you to make a primary diagnosis. The complexity of the app is that the user can't start diagnostics until they select a body part and a disease, which in turn can't always make a correct diagnosis. Also, there is no voice interface [10].

Advantages of the Alice skill being developed include the following:

• The presence of a voice interface.
• Usability.
• Integration into the Yandex ecosystem.
• The ability to use the app anywhere in the world if you have Internet access.

5. Conclusion

Thus, work was done on the development of an information system for database administration and on the design of Alice's skill.

Currently, the expert system is being actively tested under the supervision of qualified doctors in the city of Krasnoyarsk, and work is underway to accumulate a database that will make the application the most useful and provide information to the user in full.

In the future, it is planned to improve Alice's skill, which will allow you to offer an appointment to the appropriate specialist after determining the initial diagnosis. This design solution will reduce the risk of incorrect initial diagnosis and avoid various complications, which will undoubtedly have a positive impact on people's health.

References
[1] Voice interfaces: how a computer recognizes speech and learns to speak. Retrieved from: http://te-st.ru/2017/11/08/voice-interface/
[2] Yandex. Dialogues. Retrieved from: https://dialogs.yandex.ru/
[3] Leonenkov A V 2006 Object-oriented analysis and design using UML and IBM Rational Rose (Moscow: Binomial. Knowledge lab)
[4] ISO/IEC/IEEE 12207:2017 Systems and software engineering – software life cycle processes. Retrieved from: https://www.iso.org/ru/standard/63712.html
[5] GOST 20886-85 data Organization in data processing systems. Retrieved from: https://internet-law.ru/gosts/gost/12548/
[6] Markov A S and Lisovskiy K Yu 2006 Database. Introduction to theory and methodology (Moscow: Finance and statistics) p 51-77
[7] Vorobiev A I and Shklovskiy N E 1992 Your family doctor. Home adviser (Moscow: World)
[8] Symptomate. Retrieved from: https://symptomate.com
[9] WebMD. Retrieved from: https://webmd.com
[10] Therapist. Retrieved from: https://clck.ru/N4nWM