Brief information about the project

Name of the project	AP13068289 «Application of machine learning methods for early diagnosis of pathologies of the cardiovascular system»
Relevance	Cardiovascular diseases (CVD) remain as one of the leading causes of death worldwide. In most of the developed European countries, this indicator reaches 40% of all deaths, and in Kazakhstan - more than 50% [1-3]. According to the latest data, in Kazakhstan, most people die from diseases of the circulatory system - 24.44% of all deaths, in second place - respiratory diseases - 12.89%, third place - from neoplasms - 12% [4-5]. The main part of this paper is the study of digital monitoring methods and the development of a hardware-software complex for early detection of CVD using machine learning algorithms, thereby making a significant contribution to reducing mortality from CVD. The high sensitivity of electronic stethoscopes, compared to a conventional stethoscope, allows us to use them for screening obstructive coronary artery disease. Conventional stethoscopes lack auscultation ability to detect intracoronary murmur of turbulent blood flow arising from hemodynamically significant coronary artery disease. According to our research, the sensitivity of electronic stethoscopes has grown significantly. At this moment, an electronic stethoscope has a higher sensitivity than an acoustic stethoscope, both for a cardiologist and for a patient in the analysis. The introduction of mathematical methods of data analysis has significantly expanded the capabilities of phonocardiography (PCG) and electrocardiography (ECG). Such advantages as non-invasiveness, safety, the absence of contraindications, relatively inexpensive equipment, create the prerequisites for the use of PCG and ECG in telemedicine. Machine learning will play an integral role in this, as a tool that allows us to find samples in the data generated by diagnostic tests for cardiovascular diseases.
Purpose	**The aim of the project is to develop a fully functional prototype of a software and hardware platform for diagnosing pathologies of the cardiovascular system based on the analysis of electrocardiograms using machine learning methods and algorithms.**
Objectives	To achieve this goal, it is necessary to solve the following tasks: 1 To analyze the literature on existing methods of automated processing of signals emanating from the heart, including electrocardiograms (ECG), in the context

	of the application of Machine learning (ML) in the tasks of medical functional diagnostics. 2 Based on the analysis of the literature on existing approaches and methods of signal processing and recognition, taking into account the specifics of the received input data and the possibilities of using ML in the task of recognizing pathological deviations in these signals, to form a set of basic parameters and characteristics of the ML model. 3 To form a large-scale volume of training and test ECG data for normal and most pathological conditions, as well as the structure of the ECG database. 4 Develop algorithms for creating training images, algorithms for training and test ECG databases with the maximum possible set of heart pathologies. 5 To develop specialized algorithms for automating experimental studies of the ML model in order to make a reasonable choice of the ML model structure option as the basis for artificial neural network blocks, as well as to determine the optimal number of neurons of the hidden layers of the model for the selected model structures, taking into account the specifics of medical data. 6 To conduct experimental studies of the developed ML-model of ECG processing and analysis and evaluate, on the basis of the methodology adapted to the study, the effectiveness of its functioning in the task of express diagnostics of heart function. 7 To develop a hardware platform with the capabilities of a listening signal, automation of the recording process, synchronization with ECG, remote transmission and analysis on a cloud computing platform using machine learning methods. 8 Integrate the hardware platform into the developed ML model and evaluate the effectiveness of the analysis results by comparing them with diagnostics from doctors. 9 Develop a mobile application that works in conjunction with a hardware platform to provide users with recommendations regarding diagnostics, saves and processes records, displays measurement results.
Expected and achieved results	Within the framework of the project, it is planned to publish 12 publications and obtain 4 security documents, namely: -1 article in a peer-reviewed scientific publication on the scientific direction of the project, included in the 1st

	(first) quartile of the impact factor in the Web of Science database -1 article in peer-reviewed scientific publications on the scientific direction of the project is indexed in Science Citation Index Expanded Web of Science database and having a percentile in the Scopus database at least 75 (seventy five) -2 articles in peer-reviewed scientific publications on the scientific direction of the project indexed in Science Citation Index Expanded Web of Science database and having a percentile in the Scopus database at least 50 (fifty) -2 articles in international or republican conferences; -3 articles of the conference of the far abroad; -1 book in Kazakhstan publishing houses; -2 monographs; -1 patent for the invention of results in the Kazakhstan patent office; -3 copyright certificates. It is planned to be published in journals and book series such as "Artificial Intelligence in Medicine", "Journal of Clinical Medicine", "IEEE Computational Intelligence Journal", "IEEE Intelligent Systems", "IEEE Access", "Computers, Materials & Continua", "Sensors", "Lecture Notes on Computer Science", "Lecture Notes on Artificial Intelligence". The scientific effect is the introduction of artificial neural networks into medicine, using information technologies in the field of healthcare. This will give a big leap in the development of information technology and improving the effectiveness of medicine. The expected socio-economic effect is that our invention is able to detect diseases of the cardiovascular system and lungs at an early stage, diagnostics will help reduce potential errors of doctors when making a diagnosis and will significantly facilitate the work of the doctor himself. The annual material damage of cardiovascular diseases in Kazakhstan averages about 89 billion tenge, experts of the Ministry of Health of the Republic of Kazakhstan note [19]. The results of this project, in turn, will reduce the number of complications of diseases and mortality from them in the most able-bodied segment of the population, reducing the material damage caused to the state.

	The above-mentioned product can be applied in the field of healthcare, and the invention will also be commercialized in three directions. 1. Business to Business 2. Business to Customer 3. Business to Government Commercialization will increase the efficiency of examination rooms in medical institutions, identify pathological abnormalities at home, which will save time and resources for ordinary consumers.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	Омаров Батырхан Султанович Айдаров Канат Алхожаевич Альмухамедова Айжан Болатовна Турсынова Ажар Тойлыбайкызы Сұлтан Данияр Байкувеков Мейіржан
List of publications with links to them	1. Omarov, B., Baikuvekov, M., Momynkulov, Z., Kassenkhan, A., Nuralykyzy, S., & Iglikova, M. (2023). Convolutional LSTM Network for Heart Disease Diagnosis on Electrocardiograms. Computers, Materials & Continua, 76(3). 2. Omarov, B., Tuimebayev, A., Abdrakhmanov, R., Yeskarayeva, B., Sultan, D., & Aidarov, K. (2023). Digital stethoscope for early detection of heart disease on phonocardiography data. International Journal of Advanced Computer Science and Applications, 14(9). 3. Omarov, B., Momynkulov, Z., & Mukhametkaliyev, A. (2023, September). 1D Convolutional Long-Short-Term Memory Network for Heart Diseases Detection on Electrocardiograms. In 2023 IEEE 12th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS) (Vol. 1, pp. 696-702). IEEE. 4. Mukhametkaly, A., Momynkulov, Z., Kurmanbekkyzy, N., & Omarov, B. (2023). Deep Conv-LSTM Network for Arrhythmia Detection using ECG Data. International Journal of Advanced Computer Science and Applications, 14(9).
Patents	-
!!! Along with the completed form, please attach to email relevant photographs and video materials that can be used to visualize and present the project on the web page.	