Brief information about the project

Title	AP23488521 Development of an automated seismic biomonitoring system using entropy analysis and machine learning methods for short-term earthquake forecasting in Almaty
Relevance	The city of Almaty is located in a highly seismic region of Kazakhstan, as evidenced by the devastating earthquakes of past centuries. Strong earthquakes pose a threat of irrevocable losses to the population and infrastructure of the country. The constant threat of catastrophic earthquakes and their consequences makes the problems of ensuring seismic safety of the population and earthquake prediction one of the most pressing. The project plans to use information-entropy analysis and artificial intelligence to solve the problems of short-term forecasting of strong earthquakes. The use of modern machine learning methods for analyzing seismograms and biological harbingers will increase the efficiency of early detection of signs of seismic activity during the period of earthquake preparation.
Goal	The goal of the project is to develop an automated system for recording and analyzing seismic biomonitoring data in order to identify harbingers anomalies using artificial intelligence and machine learning methods, as well as entropy analysis of seismograms to solve the problems of complex short-term earthquake forecasting in Almaty.
Tasks	1. Collection and preparation of archival data on the sound activity of biological objects (birds) and seismic activity (seismograms) in the city of Almaty for further use in classification and identification in order to identify signs of earthquake preparation as part of a short-term earthquake forecast. 2. Development, testing and patenting of a device for recording the sound activity of biological objects: registration of sound signals of birds and the formation of a database necessary for further analysis of biological harbingers of earthquakes. 3. Data analysis to extract audio signal features using various processing methods: spectral, cepstral, information entropy and wavelet analysis: proper feature extraction is one step towards realizing a model with the least prediction error. In this step, a list of features will be defined based on various audio signal analyzes to train machine learning models. 4. Preparation and implementation of models for earthquake prediction using machine learning algorithms: the following machine learning algorithms will be used: artificial neural network (ANN), support vector machine (SVM), K-nearest neighbors (KNN), naive Bayes (NB)) and random forest algorithms. The role of this task is to determine the best algorithm. 5. Training and testing machine learning models using GPU-based parallel computing: training will be implemented on parallel computing. This will help reduce training and testing time. 6. Analysis of the performance of trained models in terms of calculation time to determine the optimal characteristics of the computing device: using various CPU and GPU devices, the performance of the devices will be analyzed. Based on the result, the optimal resource of the device will be selected in terms of price-quality ratio. 7.

	Preparation of guidelines for the use of a trained model to identify precursors of strong earthquakes in the city of Almaty: demonstration of a working solution with processing of sound signals of biological objects and digital seismograms based on machine learning to identify biological harbingers and increase seismic activity during the preparation of earthquakes.
Expected and Achieved Results	As a result of the research work, a system for recording and analyzing seismograms and audio signals of biological objects will be developed using methods of entropy analysis and machine learning as part of a short-term forecast of earthquakes in the city of Almaty.
Names and Surnames of Research Group Members with Their Identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and Links to Corresponding Profiles	Ибраимов Маргулан Касенович (https://www.scopus.com/authid/detail.uri?authorId=57189617696, https://orcid.org/0000-0002-8049-3911) Жексебай Даурен Мурзатулы (https://www.scopus.com/authid/detail.uri?authorId=57204696440, https://orcid.org/0009-0008-1884-4662) Хохлов Серик Анатольевич (https://www.scopus.com/authid/detail.uri?authorId=57193160477, https://orcid.org/0000-0001-5163-508X) Агишев Алдияр Талгатович (https://www.scopus.com/authid/detail.uri?authorId=57201661110, https://orcid.org/0000-0001-9788-7485) Сқабылов Әлішер Әлиұлы (https://www.scopus.com/authid/detail.uri?authorId=57218876415, https://orcid.org/0000-0002-5196-8252) Хохлов Азамат Анатольевич (https://www.scopus.com/authid/detail.uri?authorId=57945306100, https://orcid.org/0000-0001-6987-9058) Суровцева Наталия Владимировна Арифулова Ирина Исмаиловна (https://www.scopus.com/authid/detail.uri?authorId=18435997000, https://orcid.org/0000-0002-5303-5640)
Publications list with links to them	Zhexebay D., Skabylov A., Ibraimov M., Khokhlov S., Agishev A., Kudaibergenova G., Orazakova A., Agishev A. Deep Learning for Early Earthquake Detection: Application of Convolutional Neural Networks for P-Wave Detection //Applied Sciences (Switzerland) – 2025, 15(7), 3864. DOI: 10.3390/app15073864. https://doi.org/10.3390/app15073864.

Patent information	A patent application has been applied in the framework of the project. An application for a patent for an invention has been filed. Application No. 366316 - Patent for an invention. Incoming No. 2025-25681, dated 04/28/2025. Barcode No. 3519388. Application Reg. No. 2025/0401.1, dated 04/28/2025. Based on the results of the study, a copyright certificate was received for the program called "Intelligent system for monitoring the sound activity of biological objects" dated November 05, 2024, number: 51101