VIEW CONTROL SYSTEM ON

BASICS OF THE METHOD

ELECTROOCULOGRAPHY

UDENTGRNAUKOVIYKERIVNIK:D. .DK-11MNKOTUBAYLOAROBOTUVIKONAV:S . IN .

T . N ., PROF.LISENCOO.M .

CONSULTANT:K . T . N.,DOCENTPOPOVA.ABOUT

TOPICALITY

DEVICES FOR THE DISABLED

COMPUTER

The system has great potential for applications in various fields, including medicine, robotics, virtual reality, and information technology for controlling various devices with a glance. It enables people with disabilities. At the same time, the effectiveness of these systems is determined, first of all, by the reliability indicator of the classification of EOG signals and the presence of a universal interface in them, which expands its scope of use. Therefore, the further development of existing approaches and technical solutions aimed at increasing the reliability and universality of gaze control systems is currently an important and urgent task

CONNECTION OF WORK WITH SCIENTIFIC PROGRAMS, PLANS, TOPICS

Dissertation studies were conducted at the Department of Design of Electronic Computing Equipment (KEOA) of the FEL of KPI named after Ihor Sikorsky in accordance with the subject of scientific research of this institution, the scientific directions of activity of the KEOA department, as well as the priority direction of the development of science and technology of Ukraine "Information and communication technologies".

THE GOAL OF THE WORK

The aim of the dissertation is to increase the reliability and universality of gaze control systems based on the EOG method by further developing existing approaches to their construction, including methods of classifying EOG signals, improving their structural and functional organization, developing algorithmic and software solutions for its implementation, and creating a layout of the gaze control system for based on them.

WORK TASKS

To achieve the goal, the following **tasks were solved:**

- The EOG method and means of recording electrooculograms were analyzed, the analysis of modern gaze control systems was performed, including the results of a patent search, and the statement of the research task was formulated.
- An analysis of modern methods of electrooculogram classification was carried out and an improved structural and functional organization of the gaze control system was proposed.

WORK TASKS

- Simulation modeling of the system classifier using known classification methods was carried out and the choice of the basic method of EOG signal classification for use in the developed system was substantiated.
- The gaze control system was modeled, its software package was developed, and its experimental studies were carried out, including the gaze control of a mini-robot and a PC mouse.

OBJECT AND SUBJECT OF RESEARCH

The object of research is the process of registration, processing and classification of EOG signals in eye control systems.

The subject of the research is methods of classification of EOG signals and algorithmic and software solutions of the gaze control system.

RESEARCH METHODS

The following methods were used to solve the tasks set in the work :

1

EOG

2

Machine learning

for signal classification

- logistic regression;
- decision tree;
- random forest;
- algorithm of support vectors, K-
- nearest neighbors,
- AdaBoost
- XGBoost
- Naïve Bayes
- neural network EEGNet, EEGNet_SSVEP, DeepConvolutional Network, Shallow Convolutional Network

3

Method

experimental studies

SCIENTIFIC NOVELTY

- The structural and functional organization of the gaze control system is proposed, the distinguishing feature of which is the presence of 2 radio modem components between the path of registration, processing and classification of EOG signals and the microcomputer, depending on the application, depending on the application.

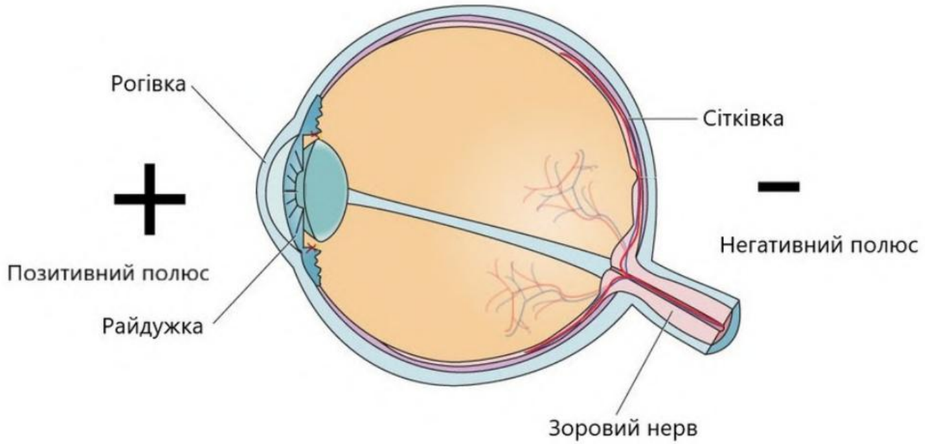
SCIENTIFIC NOVELTY

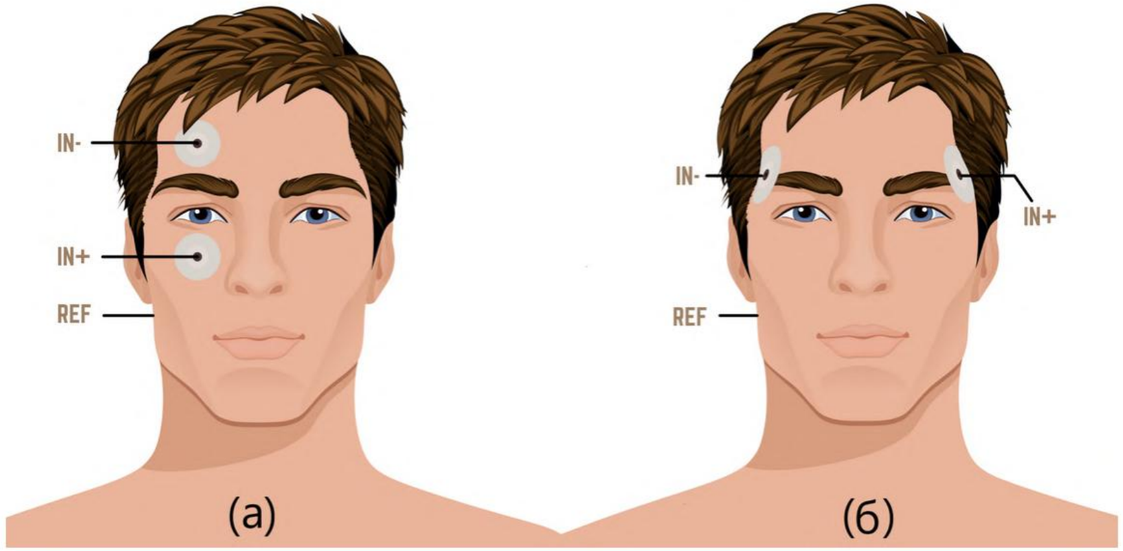
- The selection of the "Sample Forest" machine learning method as the basic one for use in the gaze control system was justified by testing and comparing the effectiveness (according to the reliability criterion) of 12 methods of classifying EOG signals, which made it possible to achieve the reliability of the classification by the selected method during its testing to the level of 91% .

PRACTICAL MEANING

The practical value of the obtained results is determined by the developed algorithmic and software solutions for the implementation of the proposed structural-functional organization of the gaze control system and its created layout.

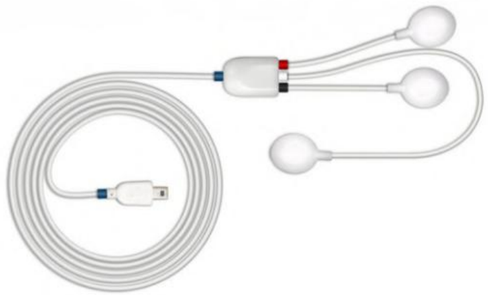
TECHNIQUE TE METHODOLOGY OF EOG REGISTRATION





TECHNIQUE TE METHODOLOGY OF EOG REGISTRATION

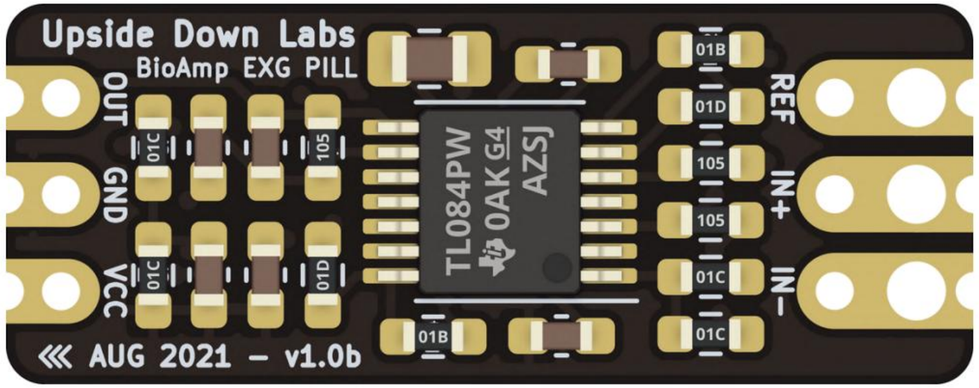
ELECTROOCULOGRAM REGISTRATION SYSTEMS



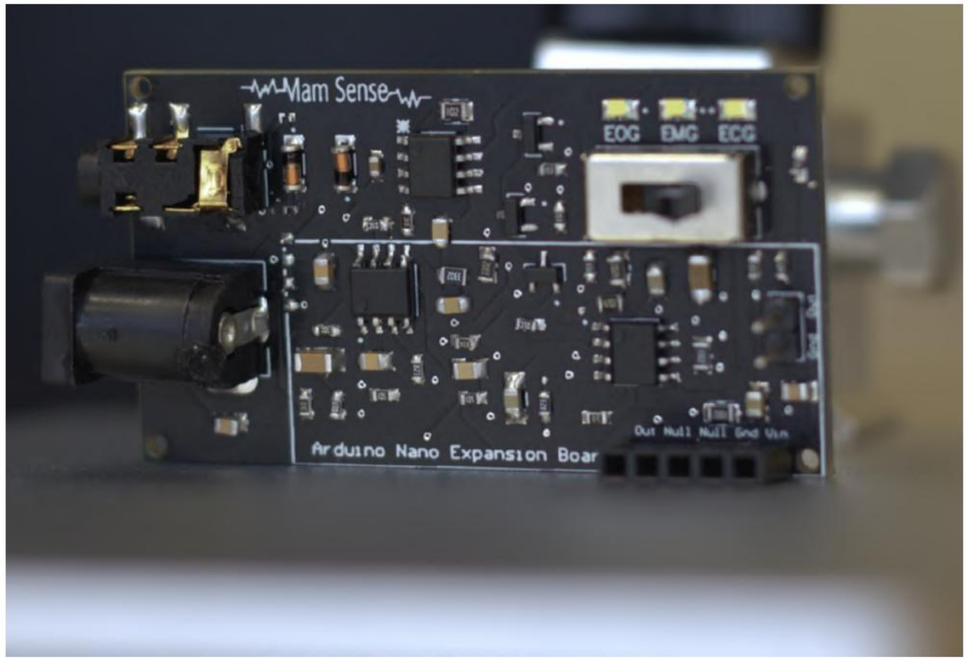
Biosignalsplux
EOG sensor

B-Alert X10

ELECTROOCULOGRAM REGISTRATION SYSTEMS

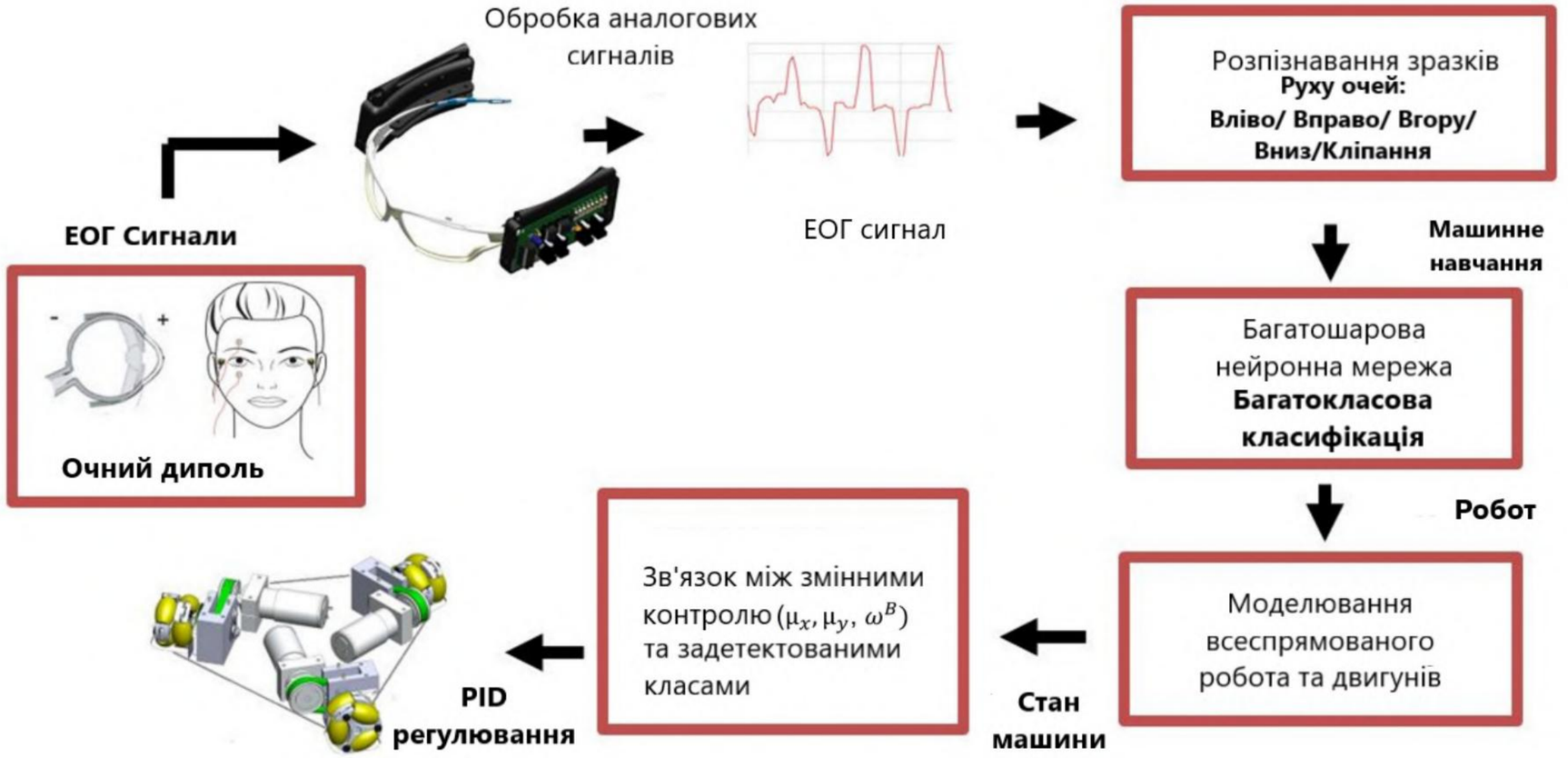


BioAmp EXG Pill



MaM Sense

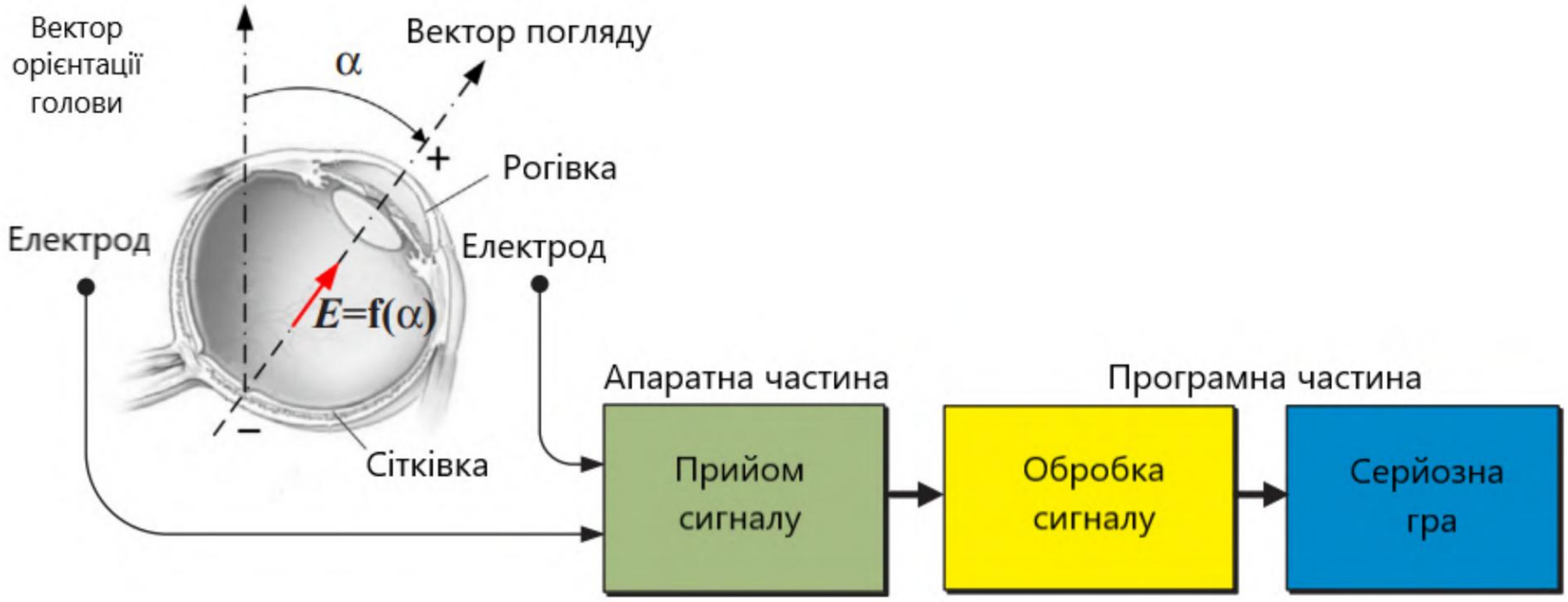
MODERN SYSTEMS VIEW CONTROL



1

Human–Machine Interface: Multiclass Classification by Machine Learning on 1D EOG Signals for the Control of an Omnidirectional Robot

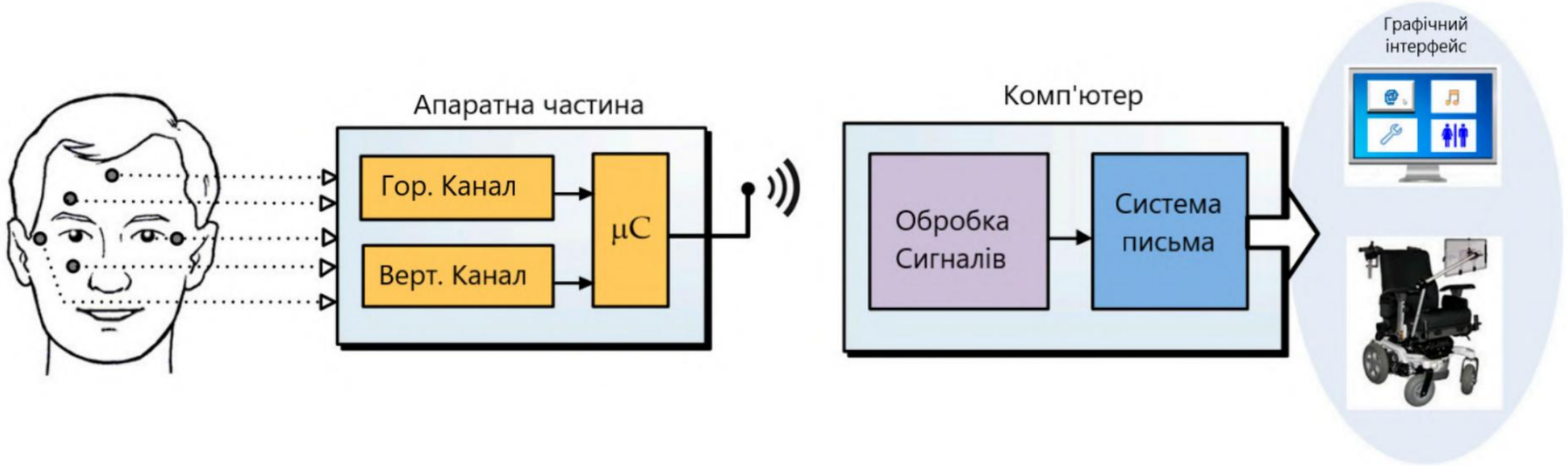
MODERN VIEW CONTROL SYSTEMS



2

Development of an EOG-based system to control a serious game

MODERN VIEW CONTROL SYSTEMS



3

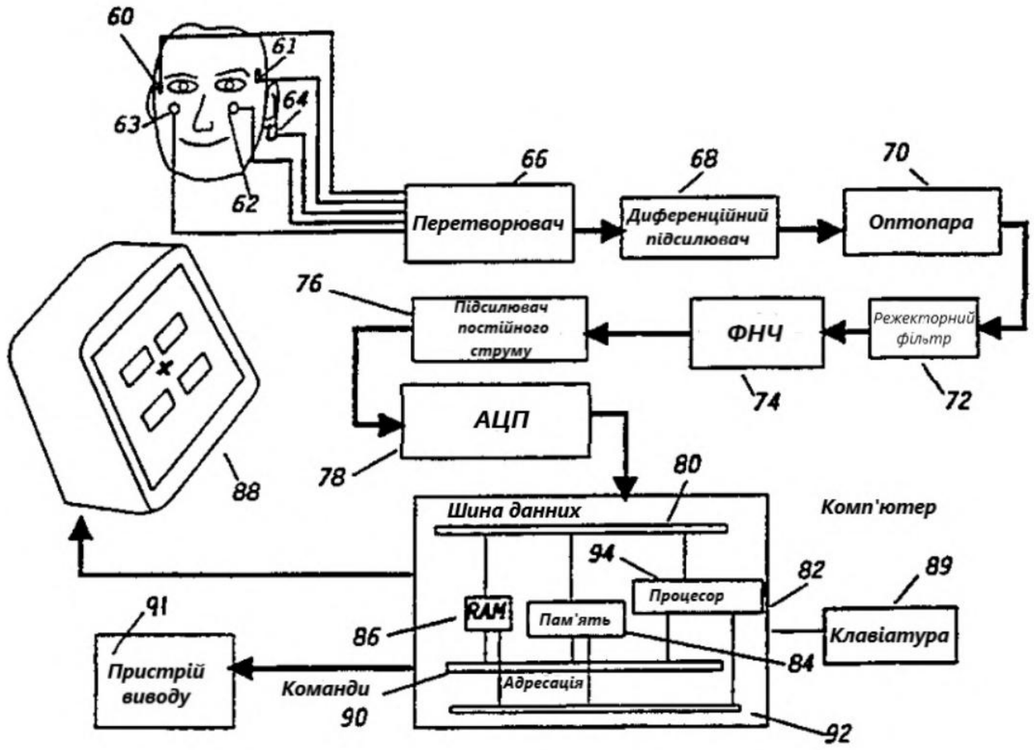
Development of a Computer Writing System Based on EOG

MODERN VIEW CONTROL SYSTEMS

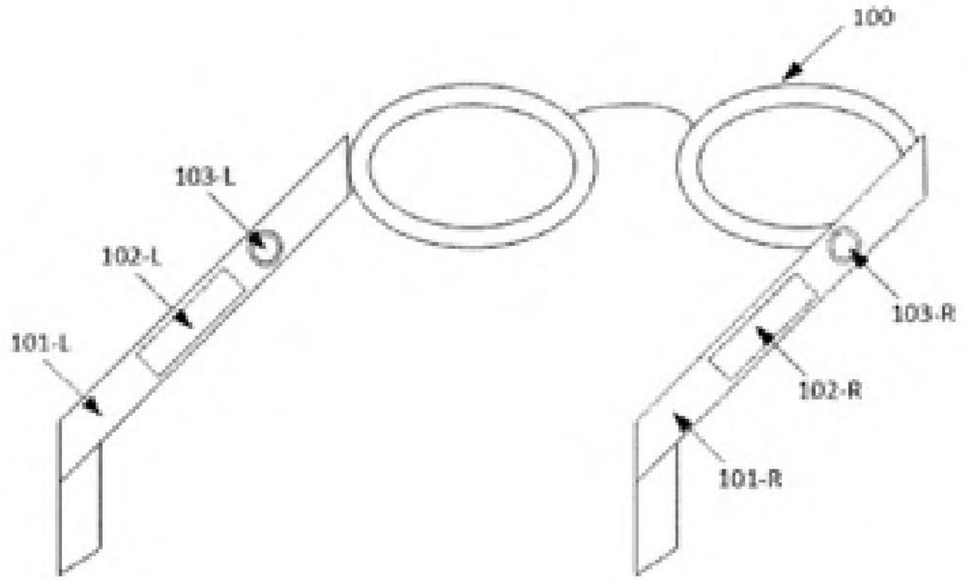
4

Design and Development of an EOG-based System to Control Electric Wheelchair for People Suffering from Quadriplegia or Quadriparesis

ANALYSIS OF KNOWN TECHNICAL SOLUTIONS FOR BUILDING VIEW CONTROL SYSTEMS ACCORDING TO THE RESULTS OF THE PERFORMED PATENT SEARCH



US005360971A «Apparatus and method for eye tracking interface», 1994 ÿÿÿÿ



US9955895B2 «Wearable head-mounted, glass style computing devices with EOG acquisition and analysis for human-computer interfaces», 2014 ÿÿÿÿ

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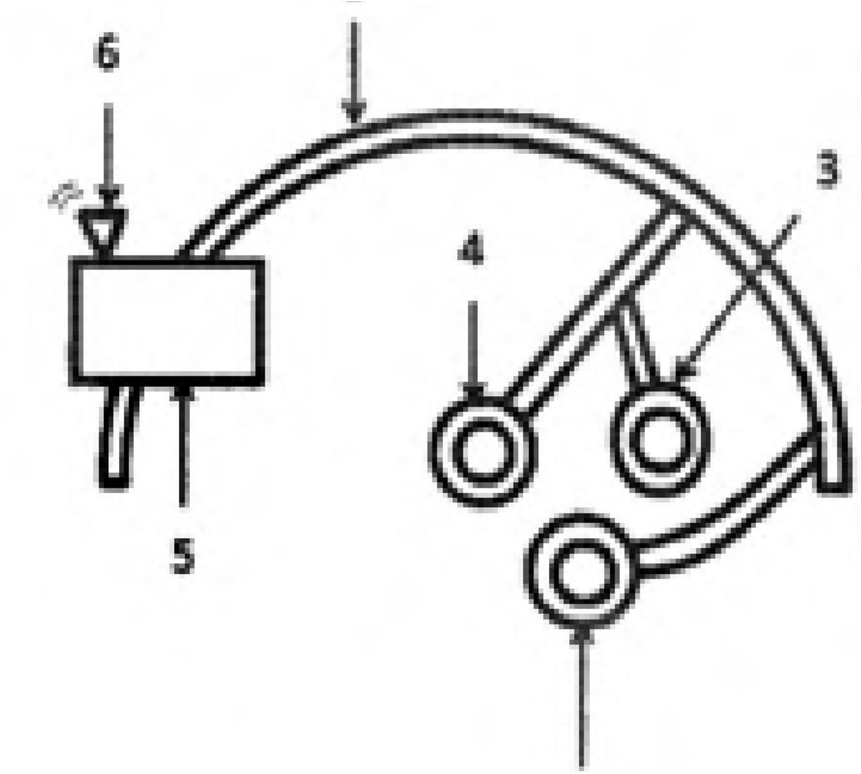
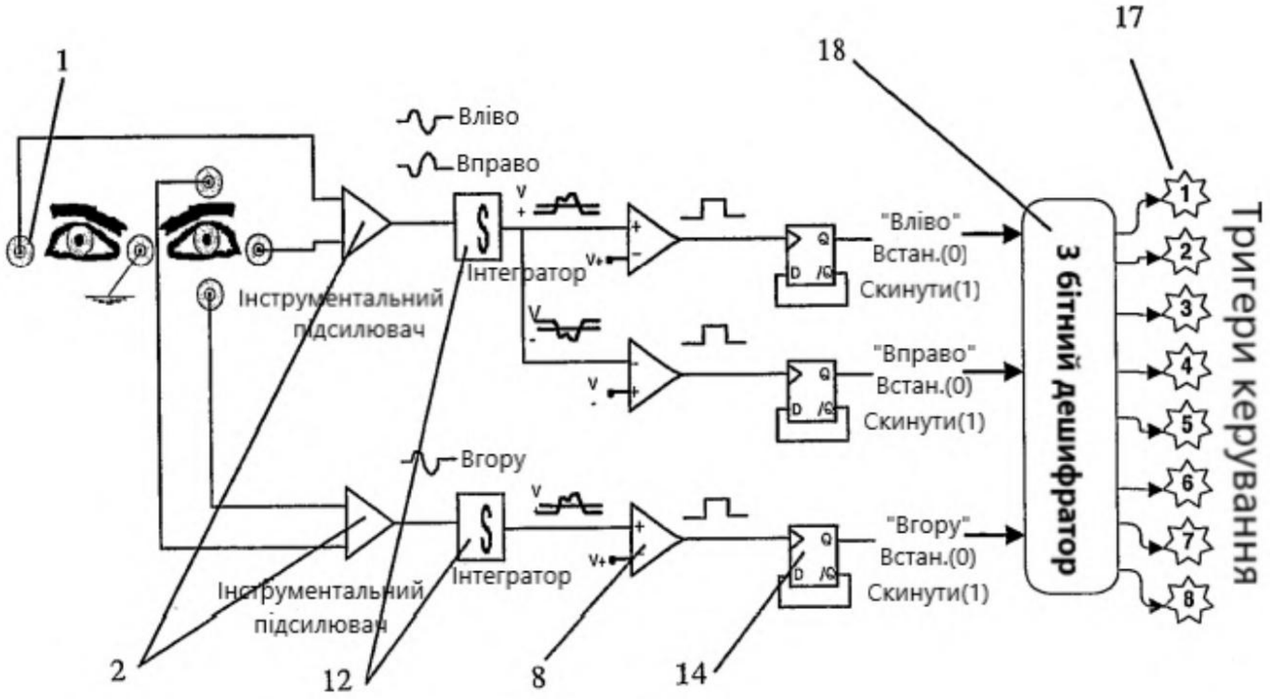


WO2022015132A1 «System for the remote control of objects, machines or equipment by eog signals», 2022 ÿÿÿÿÿ



WO2004021157A1 «Method and apparatus for generating control signals using electro oculographic potentials», 2002

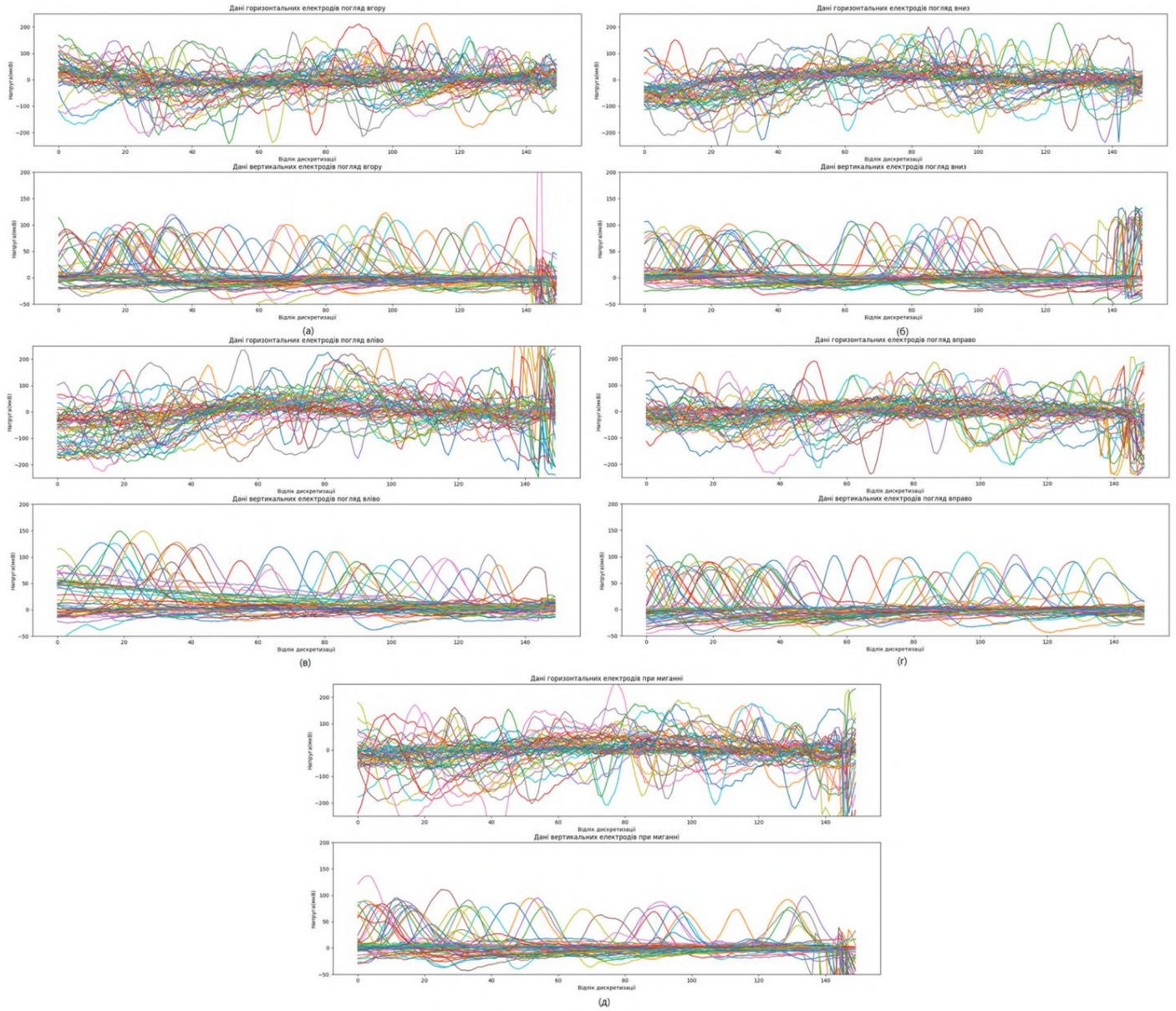
CLASSIFICATION PROBLEM

ASSESSMENT OF RELIABILITY

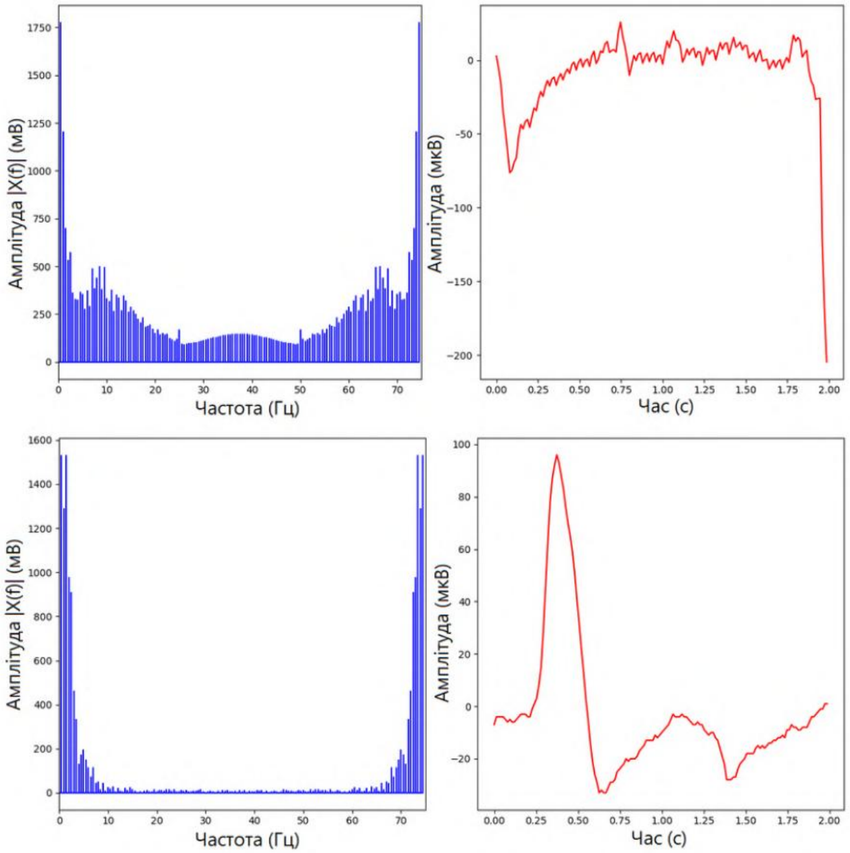
		Передбачені класи			
		1	**2**	**…**	**k**
Фактичні класи	**1**	n_{11}	n_{12}	…	n_{1k}
	2	n_{21}	n_{22}		n_{2k}
	…	…	…	…	…
	k	n_{k1}	n_{k2}	…	n_{kk}

$$A = \frac{n_{11} + n_{22} + \ldots + n_{kk}}{n_{11} + n_{12} + \ldots + n_{k1} + n_{21} + n_{22} + \ldots n_{k2} + \ldots + n_{1k} + n_{2k} + \ldots + n_{kk}}$$

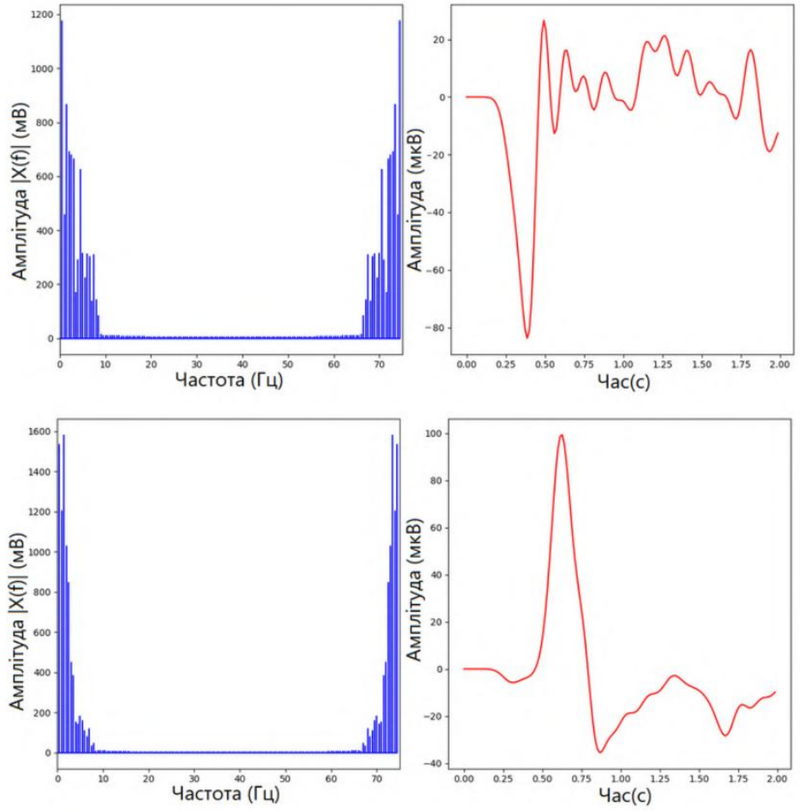
TEST DATA



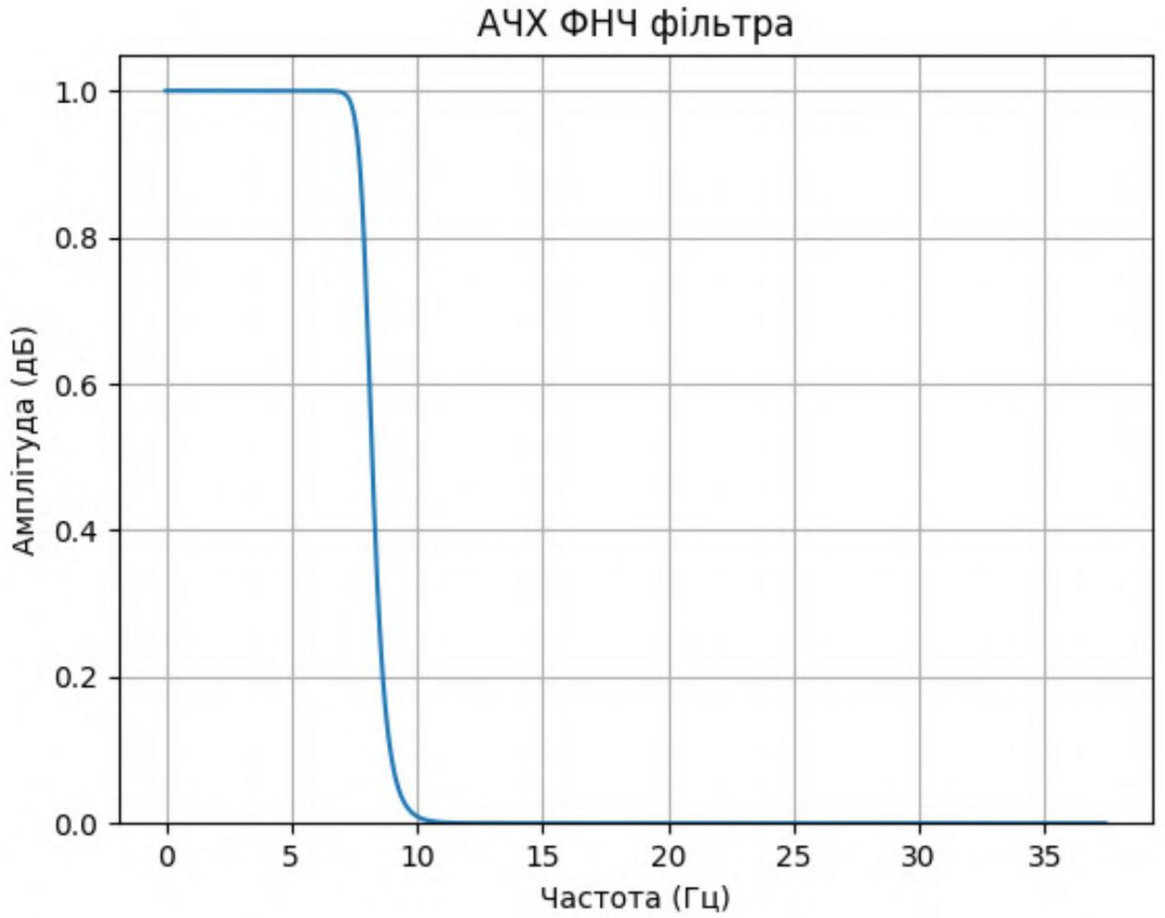
PROCESSING OF TEST SIGNALS



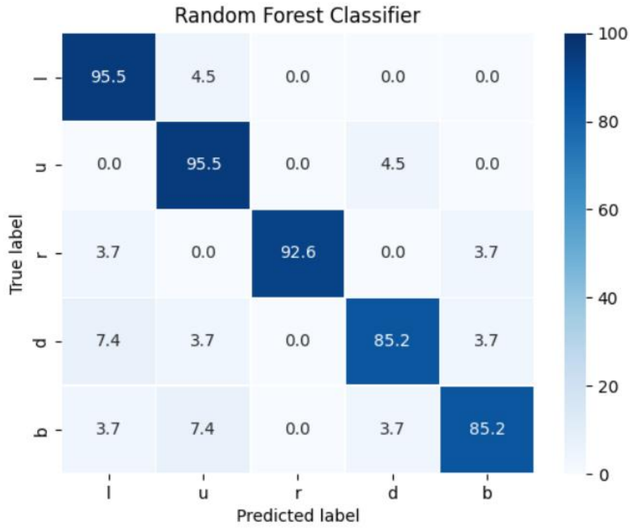
Butterward's FNL of order 4

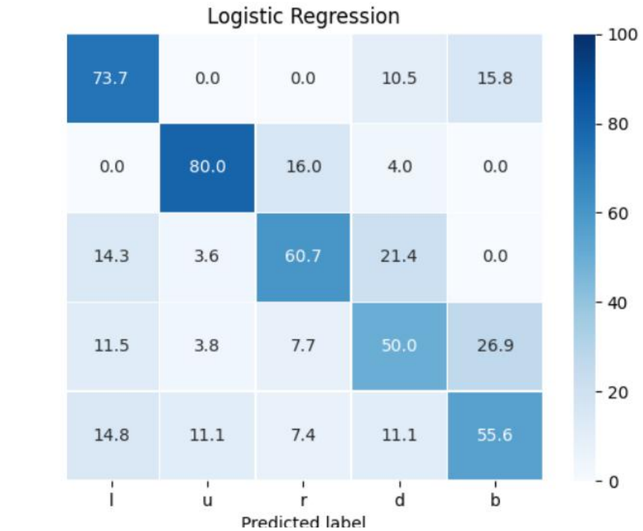


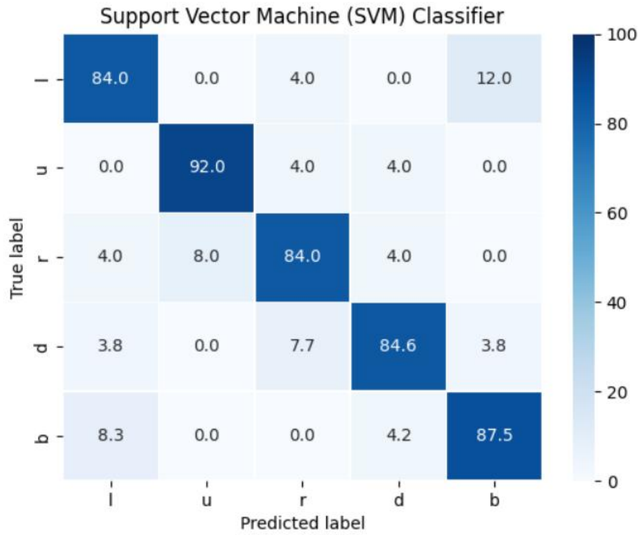
Frequency response of the applied filter

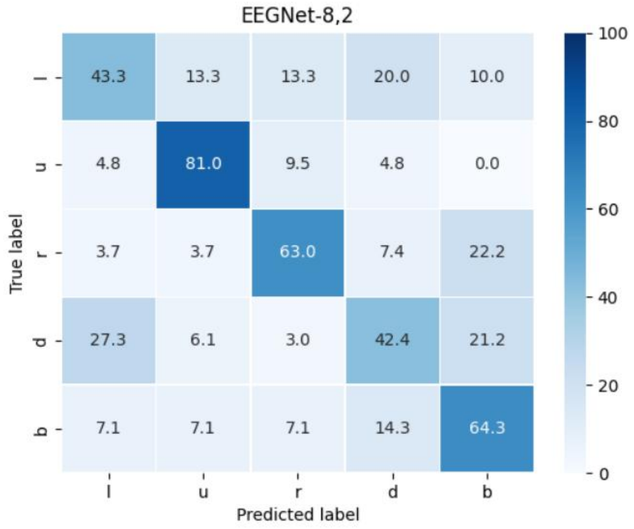


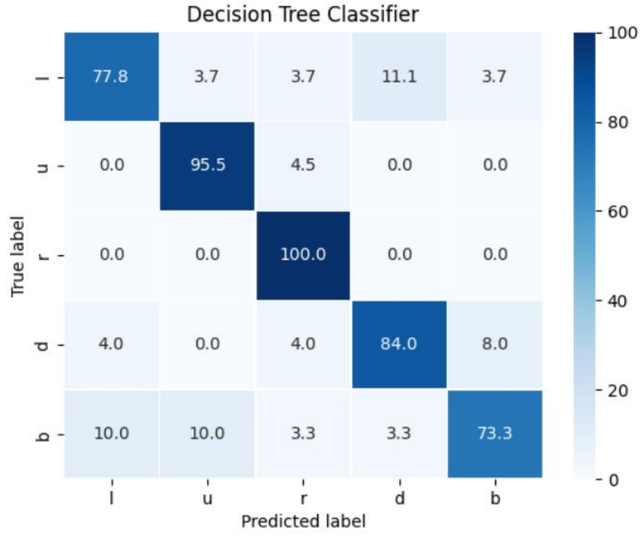
MATRICES OF ERRORS OF CLASSIFICATION METHODS

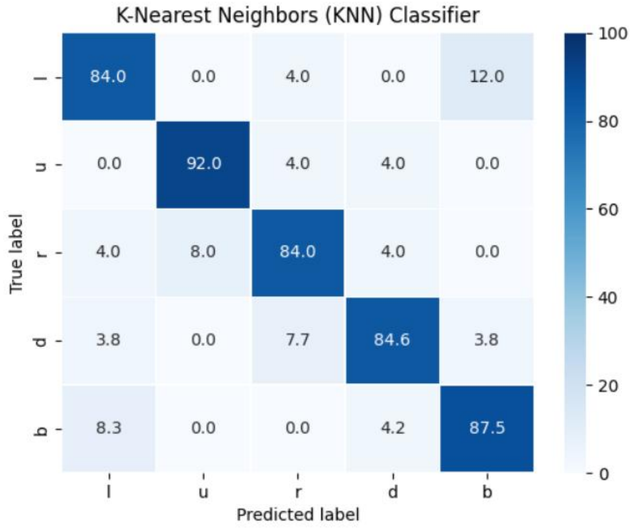












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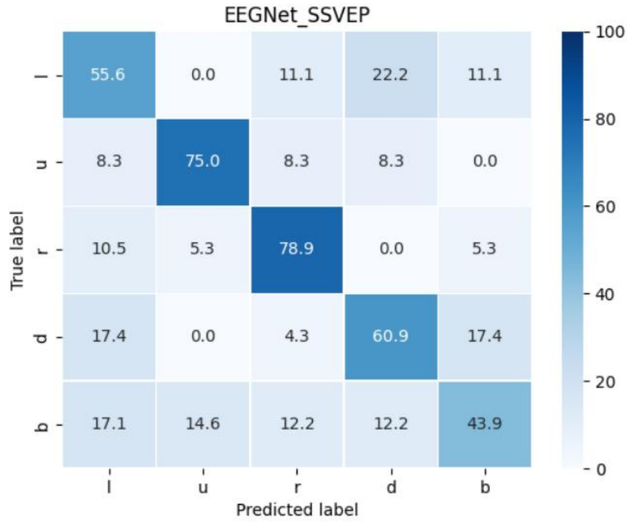
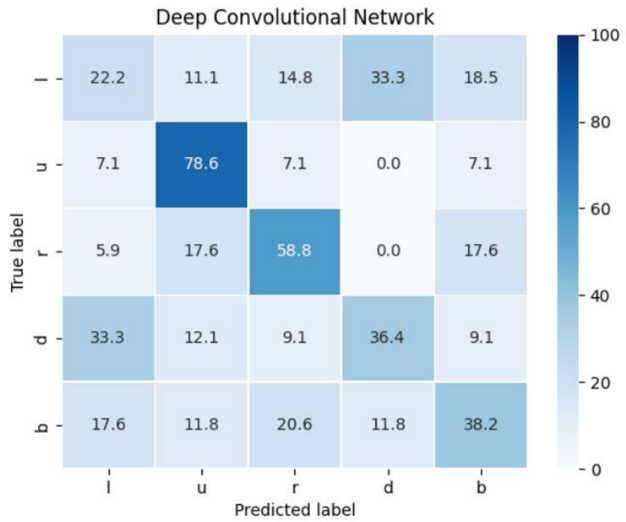
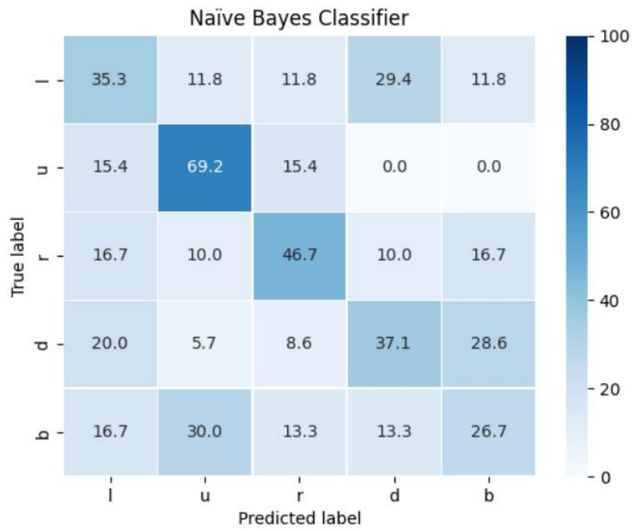
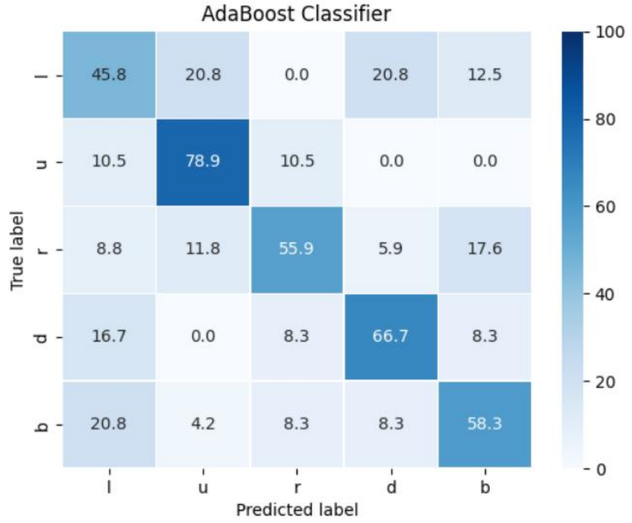
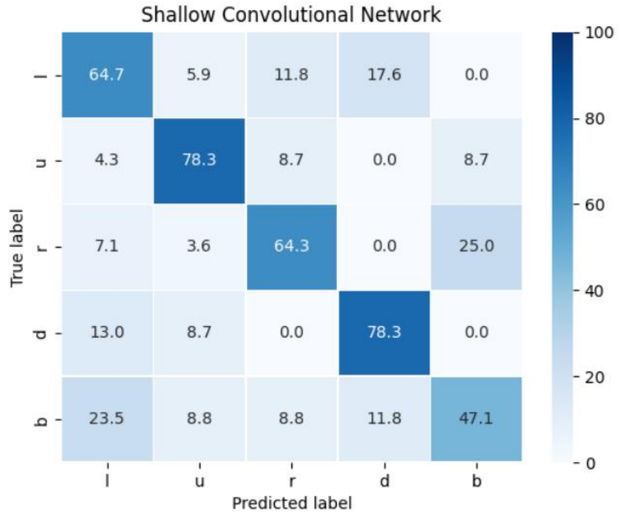
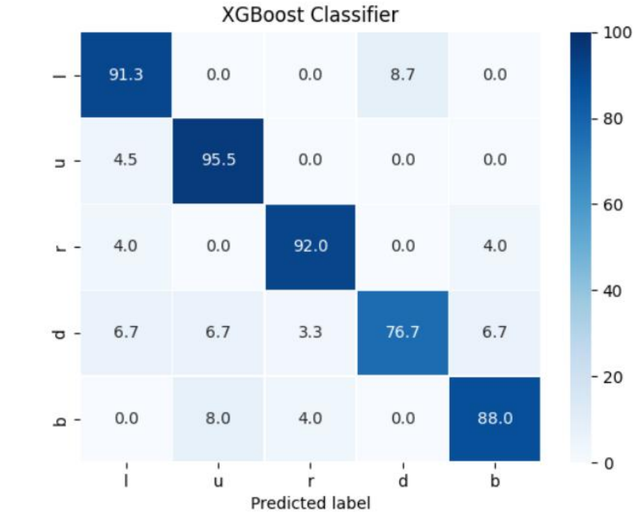




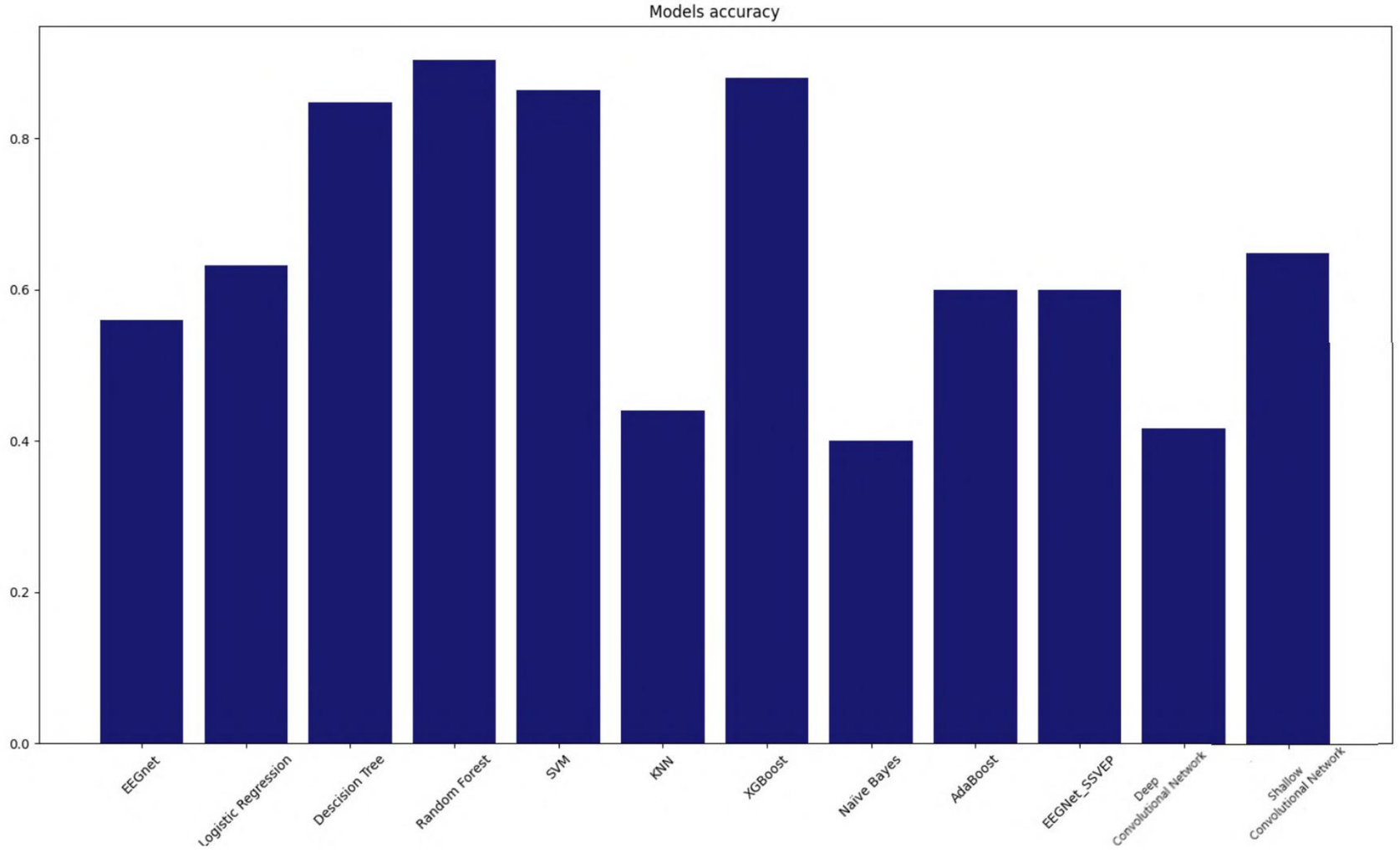




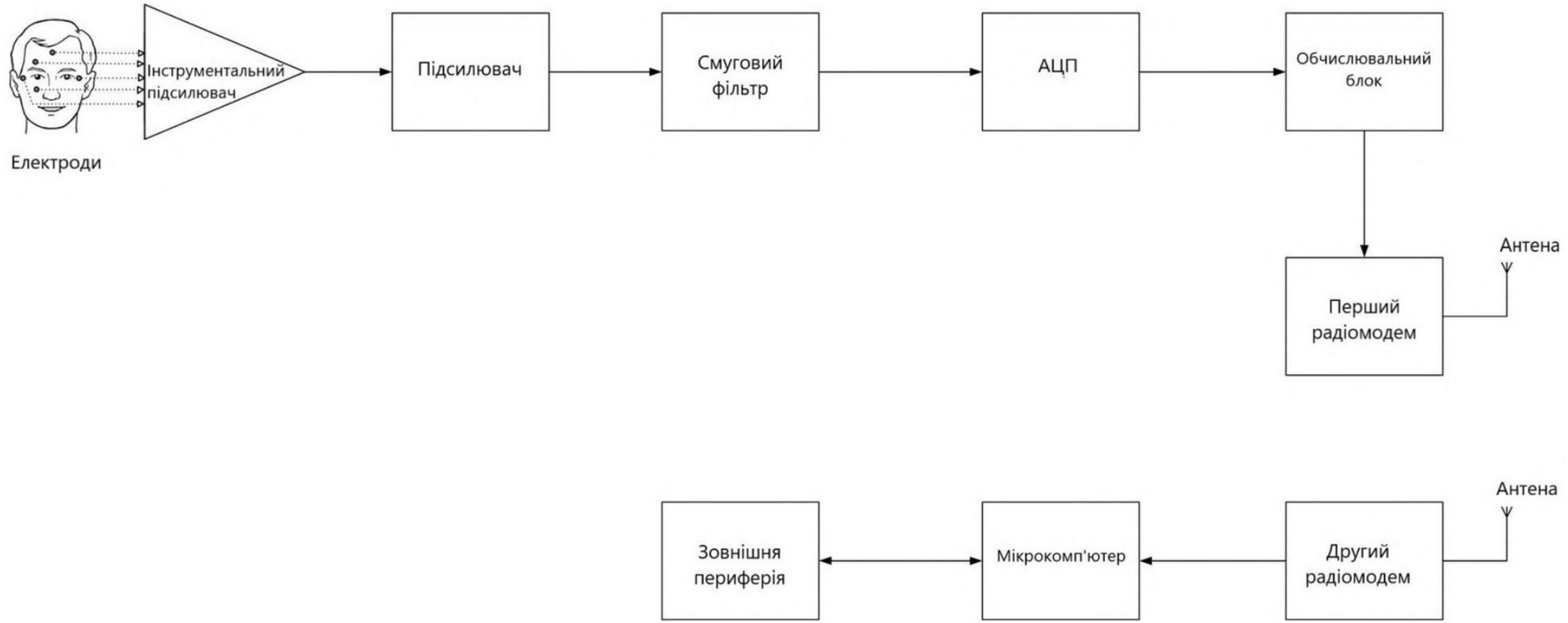




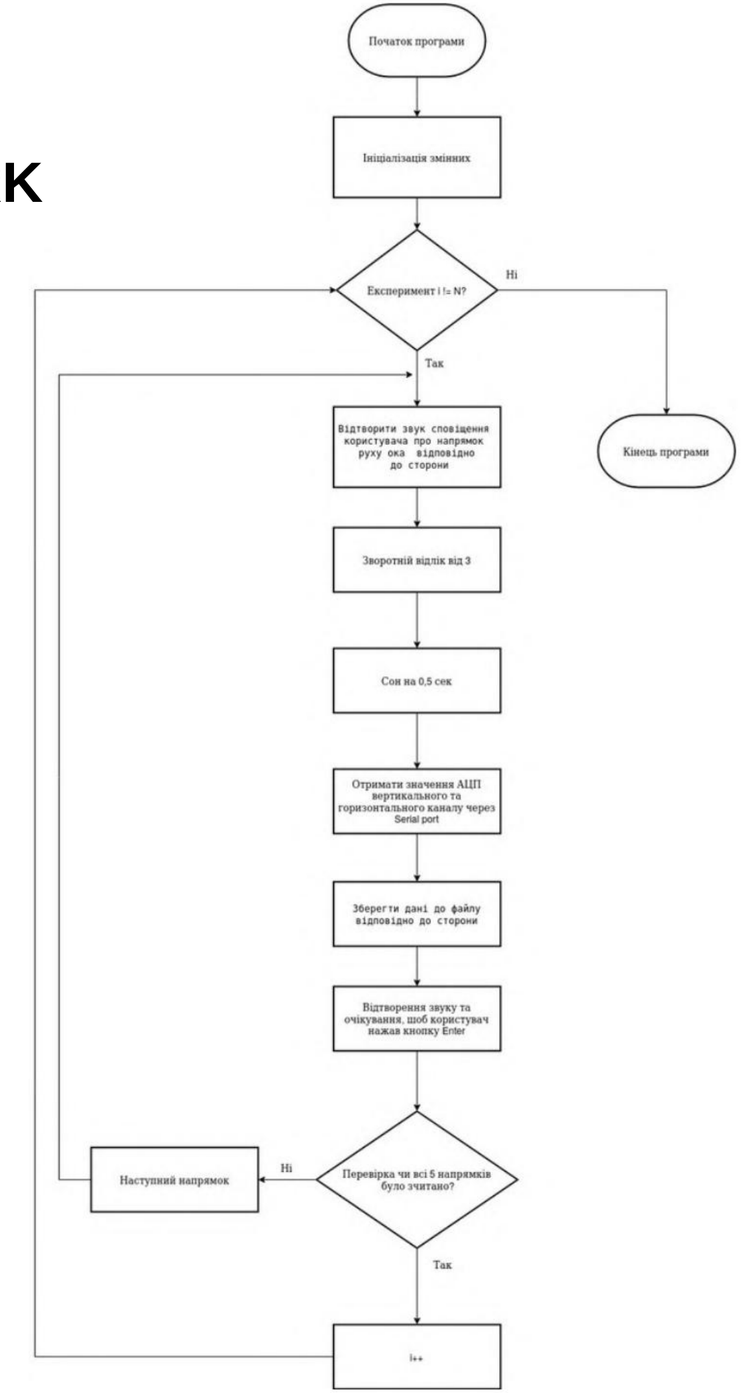
HISTOGRAM OF RELIABILITY OF CLASSIFICATION METHODS

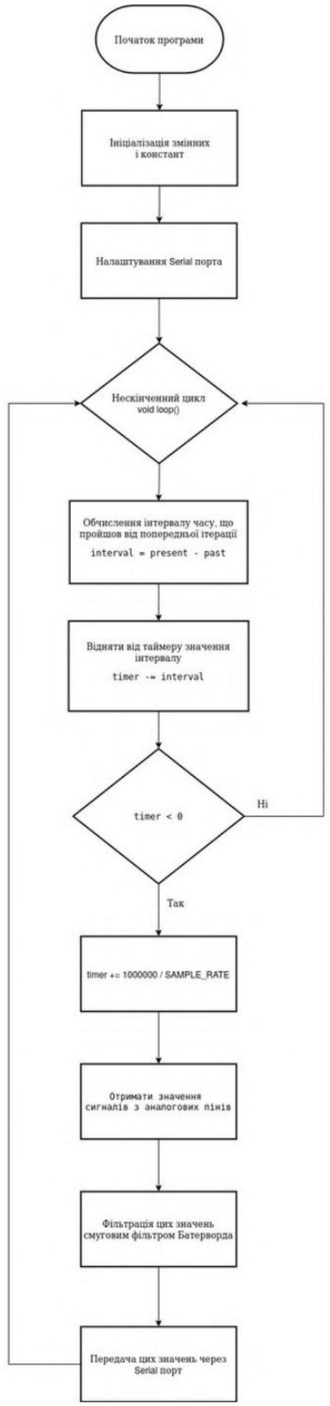


STRUCTURAL AND FUNCTIONAL ORGANIZATION OF THE SYSTEM

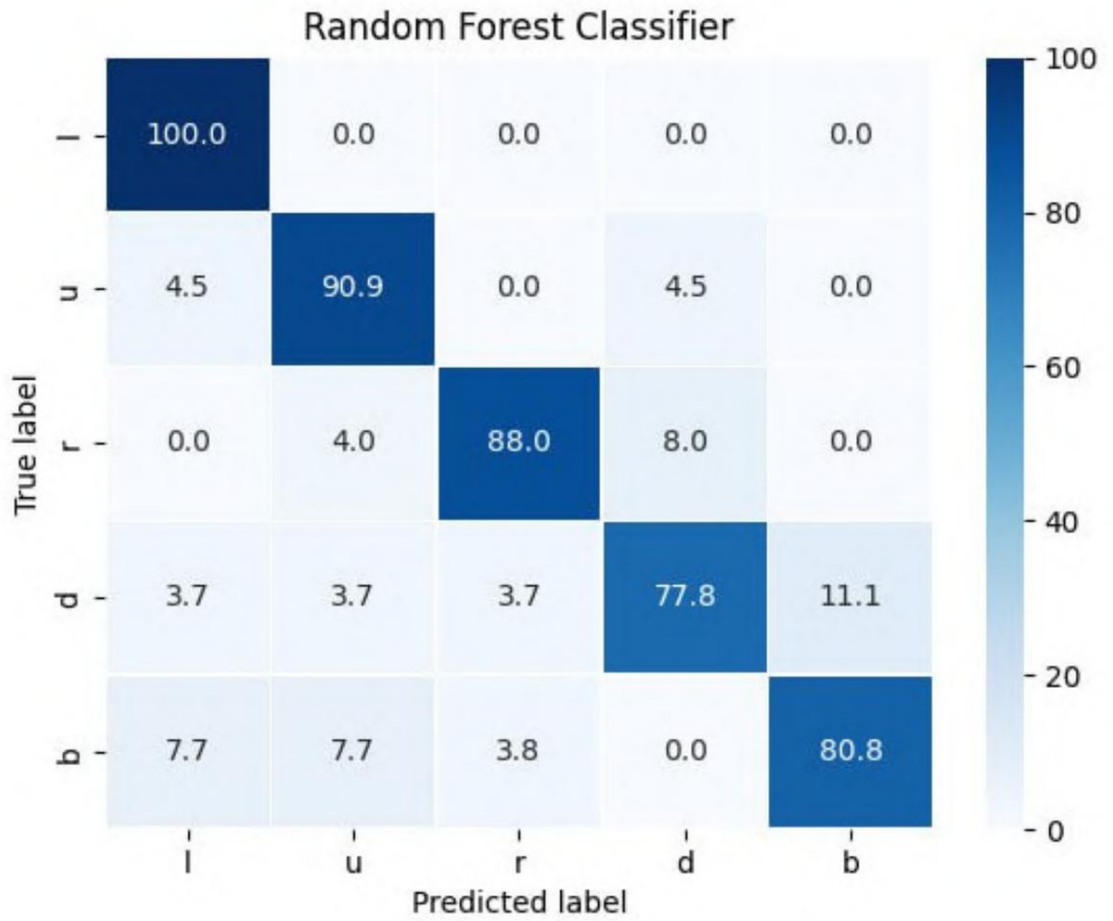


BLOCK DIAGRAM OF REGISTER AND MICROCONTROLLER WORK ALGORITHMS





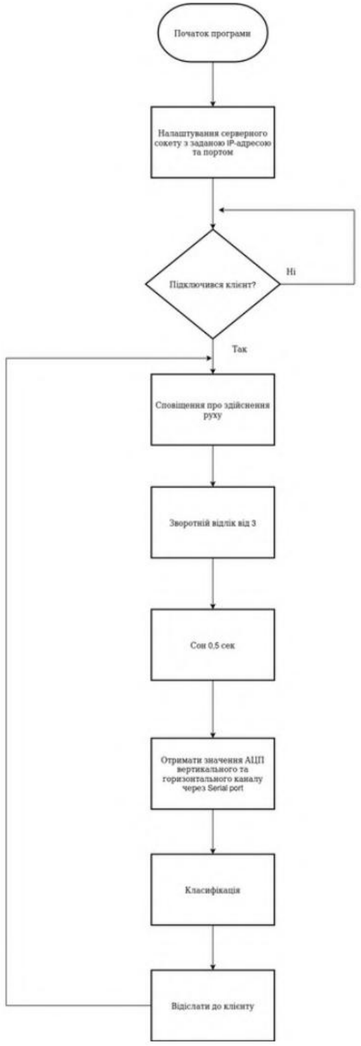
ERROR MATRIX OF REAL DATA

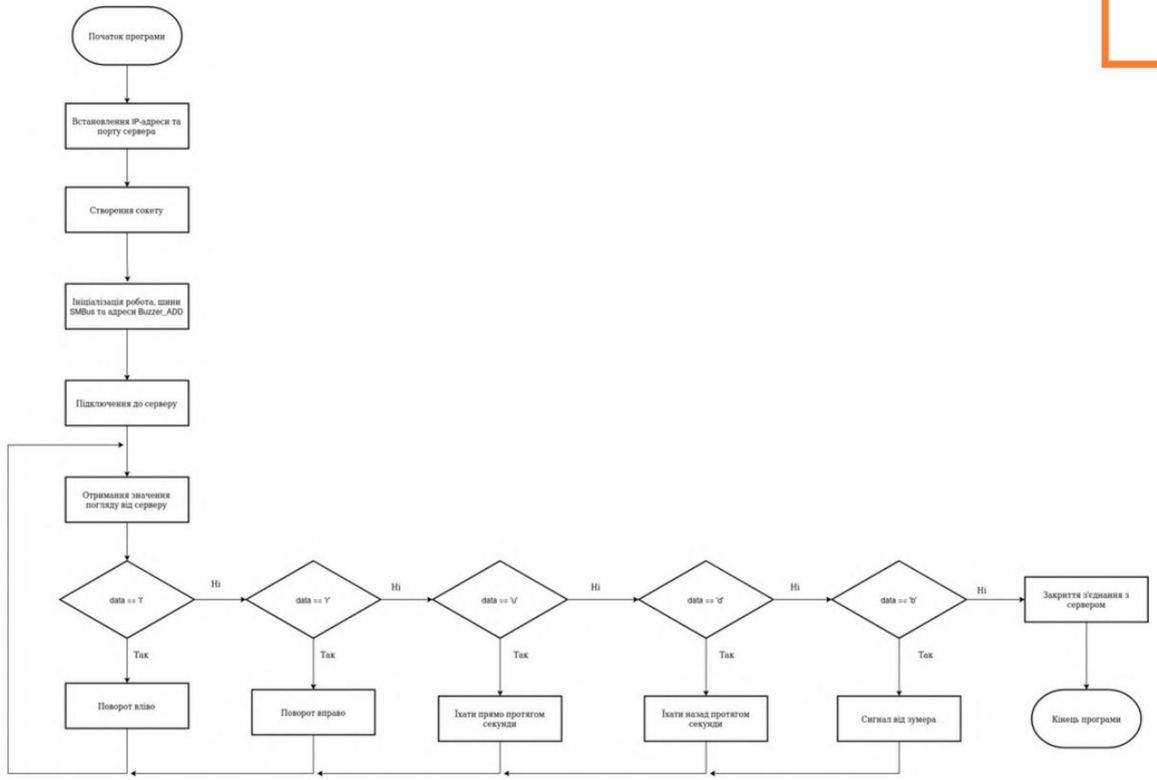


BLOCK DIAGRAM OF SERVER AND CLIENT WORK ALGORITHMS FOR ROBOT CONTROL

ROS

Mini Jetbot





BLOCK DIAGRAM OF SERVER AND CLIENT WORKING ALGORITHMS FOR CURSOR CONTROL

VIDEO DEMONSTRATION

A P R O B A T I O N

The results of dissertation research were tested at the International Multidisciplinary Scientific Internet Conference "The World of Scientific Research. Issue 18", Ternopil (Ukraine) - Perevorsk (Poland), April 20-21, 2023.

www.economy-confer.com.ua

СЕРТИФІКАТ

цей Сертифікат засвідчує, що

Коцюбайло Антон Васильович

взяв(ла) участь у роботі Міжнародної мультидисциплінарної наукової інтернет-конференції «Світ наукових досліджень. Випуск 18» з публікацією на тему: «СИСТЕМА КЕРУВАННЯ ПОГЛЯДОМ НА ОСНОВІ МЕТОДУ ЕЛЕКТРООКУЛОГРАМИ»

Форма участі: дистанційна, тривалість конференції 18 годин 0,6 ECTS credits

Конференція проведена за сприянням та участю Громадської організації "Наукова спільнота» та Wyższej Szkoły Społeczno-Gospodarcza w Przeworsku (Польща)

ECONOMY

Голова Оргкомітету

м.Тернопіль (Україна) - м.Переворськ (Польща), 20-21 квітня 2023 року

PUBLICATIONS