

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

ОДЕСЬКА НАЦІОНАЛЬНА АКАДЕМІЯ ХАРЧОВИХ ТЕХНОЛОГІЙ

**ІНСТИТУТ КОМП'ЮТЕРНИХ СИСТЕМ І ТЕХНОЛОГІЙ
«ІНДУСТРІЯ 4.0» ІМ. П.Н. ПЛАТОНОВА**

**ХІІ МІЖНАРОДНА
НАУКОВО-ПРАКТИЧНА
КОНФЕРЕНЦІЯ**

**ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ І
АВТОМАТИЗАЦІЯ – 2019**

**INFORMATION TECHNOLOGIES AND
AUTOMATION – 2019**

Збірник доповідей

Частина I

Одеса,
17-18 жовтня 2019

Секція 1

Наукові напрямки:

**Комп'ютерні
телекомунікаційні мережі та
технології**

**Математичне моделювання
та інформаційні технології**

**Список
скорочень організацій, представники яких взяли участь у конференції**

Таблиця 1

Скорочення	Повна назва організації	Місто	Країна
BNTU	Belarusian National Technical University	Minsk	Belarus
CAFU	CRIAME of Armed Forces of Ukraine	Kyiv	Ukraine
DMTSAU	Dmutro Motorny Tavria State Agrotechnological University	Melitopol	Україна
DNU	Vasyl' Stus Donetsk National University	Вінниця	Україна
EKSTU	East Kazakhstan State Technical University D. Serikbayev	Ust-Kamenogorsk	Kazakhstan
IAEI SB RAS	Institute of Automation and Electrometry of the Siberian Branch of the Russian Academy of Sciences	Novosibirsk	Russia
IRTC IT&S NAS AND MES	International Research and Training Center for Information Technologies and Systems of the National Academy of Sciences (NAS) of Ukraine and Ministry of Education and Science (MES) of Ukraine	Kyiv	Ukraine
KGES	Kharkiv general education school	Kharkov	Україна
LPNUU	Lviv Polytechnic National University	Lviv	Ukraine
NTU "КхPI"	National Technical University "Kharkiv Polytechnic Institute"	Kharkov	Україна
NTU «KPI»	National Technical University "Igor Sikorsky Kyiv Polytechnic Institute"	Kyiv	Ukraine
NU «ОМА»	Національний університет «Одеська морська академія»	Одеса	Україна
NULESU	National University of Life and Environmental Sciences of Ukraine	Kyiv	Ukraine
NUOS	NATIONAL UNIVERSITY OF SHIPBUILDIN NAMED BY ADM. MAKAROV	Nikolaev	Ukraine
ONAFТ	Odessa National Academy of Food Technologies	Odessa	Ukraine
ONU	Odessa I.I.Mechnikov National University	Odessa	Ukraine
SSU	Sukhumi State University	Sukhumi	Georgia
VNTU	Vinnitsia National Technical University	Vinnitsia	Ukraine
БНТУ	Белорусский национальный технический университет	Минск	Белоруссия
ВНТУ	Вінницький національний технічний університет	Вінниця	Україна
ДВНЗ «КНУ»	Державний вищий навчальний заклад «Криворізький національний університет»	Кривий Ріг	Україна
ДонНТУ	Донецький національний технічний університет	Покровськ	Україна
ІК НАН України	Інститут кібернетики імені В.М. Глушкова НАН України	Київ	Україна
НТУ «ХПІ»	Национальный технический университет "Харьковский политехнический институт"	Харків	Україна
НТУУ "КПІ"	Національний технічний університет «Київський політехнічний інститут» імені Ігоря Сікорського"	Київ	Україна
НУ «ЛПІ»	Національний університет «Львівська політехніка»	Львів	Україна
ОДАТРЯ	Одеська державна академія технічного регулювання та якості	Одеса	Україна

Продовження таблиці 1

Скорочення	Повна назва організації	Місто	Країна
ОНАЗ	Одеська національна Академія зв'язку ім. О.С. Попова	Одеса	Україна
ОНАПТ	Одесская национальная академия пищевых технологий	Одесса	Украина
ОНАХТ	Одеська національна академія піщевих технологій	Одеса	Україна
ОНПУ	Одеський національний політехнічний університет	Одеса	Україна
ОНУ	Одеський національний університет імені І. І. Мечникова	Одеса	Україна
ОТК ОНАХТ	Одеський технічний коледж Одеської національної академії харчових технологій	Одеса	Україна
ПНПУ	Південноукраїнський національний педагогічний університет ім. К.Д. Ушинського	Одеса	Україна
ХНУРЕ	Харківський національний університет радіоелектроніки	Харків	Україна
ХРТК	Харківський радіотехнічний технікум	Харків	Україна
ЦНДІ ОВТ ЗС України	Центральний науково-дослідний інститут озброєння та військової техніки Збройних Сил України	Київ	Україна
ЮНПУ	Южноукраинский национальный педагогический университет им. К.Д.Ушинского	Одесса	Украина

ЗМІСТ

ROMANYUK S.O., ROMANYUK O.N., PAVLOV S.V., PYVOVAR M.A. USAGE OF 3D IMAGES FOR GENETIC DISEASES DIAGNOSIS (VNTU, Ukraine).	7
KUPRIYANOV A.B., XU SHANSHAN. CONVOLUTIONAL NEURAL NETWORK AND LIDAR IMAGES IN FOREST INVENTORY (BNTU, Belarus)	9
СЕМЕНЮК В.О. МАТЕМАТИЧНІ МОДЕЛІ ПРОГНОЗУВАННЯ РЕЗУЛЬТАТІВ ФУТБОЛЬНИХ МАТЧІВ (ВНТУ, Україна)	10
KERESELIDZE N.G. MATHEMATICAL AND COMPUTER MODELS OF INFORMATION WARFARE (SSU, Georgia)	13
КОМЛЕВА Н.О., НЕКНТ Н.І. WEB SERVICE FOR AUTOMATED BUILDING OF THE SEMANTIC CORE OF A SITE (ONPU, Ukraine)	16
КУЛЬЧИЦЬКИЙ О.С., ЛАДИГІНА О.А. ОСОБЛИВОСТІ НАДІЙНОСТІ ТА ЗАХИСТУ ІНФОРМАЦІЇ В КОМП'ЮТЕРНИХ СИСТЕМАХ І МЕРЕЖАХ (ЦНТУ, Україна)	19
ШВЕЦЬ В.Т. ІНФОРМАЦІЙНА ЕНТРОПІЯ І СВОБОДА ВИБОРУ (ОНАХТ, Україна)	22
VYATKIN S.I., ROMANYUK A.N., NECHYPORUK M.L. A NUMERICAL METHOD FOR ANIMATING THREE-DIMENSIONAL OBJECTS (VNTU, Ukraine, IAEI SB RAS, Russia)	26
ЧАПЛІНСЬКИЙ Ю.П., СУББОТІНА О.В. ВИКОРИСТАННЯ ОНТОЛОГО-КЕРОВАНОЇ ТЕХНОЛОГІЇ СИСТЕМОЇ ОПТИМІЗАЦІЇ В СИСТЕМІ УПРАВЛІННЯ БЕПЕЧНІСТЮ ПРОДУКТІВ ХАРЧУВАННЯ (ІК НАН України)	29
FAINZILBERG L.S. INTELLECTUAL INFORMATION TECHNOLOGIES ON SMARTPHONE (IRTC IT&S NAS AND MES, Ukraine)	31
ВОЛОШИНА В.А., ЖУКОВ С.О. БІОМЕТРИЧНА ІДЕНТИФІКАЦІЯ КОРИСТУВАЧІВ ІНФОРМАЦІЙНО-КОМП'ЮТЕРНИХ СИСТЕМ (ВНТУ, Україна)	34
НАЗАРОВА І.А. МОДЕЛЮВАННЯ ПАРАЛЕЛЬНИХ ПРОЦЕСІВ ПРИ РОЗВ'ЯЗАННІ БАГАТОВИМІРНИХ ЖОРСТКИХ ЗАДАЧ КОШІ (ДонНТУ, Україна)	36
СИРЕНКО А.І. АНАЛІЗ ПРОИЗВОДИТЕЛЬНОСТІ ВІРТУАЛЬНИХ МАШИН В СИСТЕМЕ ВІРТУАЛІЗАЦІЇ CITRIX XENSERVEN (ОНАХТ, Україна)	38
ПУЙДЕНКО В.О. СИНТЕЗ МОДУЛЯ ДОСТОВІРНОСТІ/LRU КЕШ-ПАМ'ЯТІ ТА АСОЦІАТИВНОГО КЕШ – БУФЕРУ СТОРІНКОВОГО ПЕРЕТВОРЕННЯ ПРОЦЕСОРНОГО ЯДРА АРХІТЕКТУРИ IA-32 (ХРТК, Україна)	39
LEVINSKYI M.V., LEVINSKYI V.M. AUTOMATIC CONTROL SYSTEMS STEADY STATE PROCESSES ANALYSIS IMPLEMENTATIONS IN MATLAB (NU «ОМА», ОНАФТ, Україна)	42
МОРОЗОВ Д.О., ЗІНОВАТНА С.Л. АВТОМАТИЗАЦІЯ РОЗРАХУНКУ ЗАЛИШКІВ ТОВАРІВ З УРАХУВАННЯМ ПЕРЕТВОРЕННЯ ОСНОВНОГО ПРОДУКТУ У НОВИЙ ВИД ПРОДУКТУ (ОНПУ, Україна)	43
МАЗУРОК Т.Л. НЕЧІТКА МОДЕЛЬ ІНТЕГРОВАНОГО НАВЧАННЯ (ПНПУ, Україна)	46
КРИВЧЕНКО Ю.В., КРИВЧЕНКО А.А. КОМП'ЮТЕРНА РЕАЛІЗАЦІЯ АТРАКТОРНИХ СИСТЕМ У БАГАТОВИМІРНИХ ФАЗОВИХ ПРОСТОРАХ (ОНАХТ, ОТК ОНАХТ, Україна)	49
КОЗАК І.Р. КОМП'ЮТЕРИЗОВАНА СИСТЕМА ЗБОРУ БІОМЕДИЧНИХ ПОКАЗНИКІВ ЛЮДИНИ (ВНТУ, Україна)	51
НАЙДЬОНОВ О.Ю., ЗІНОВАТНА С.Л. АЛГОРИТМ КОНТРОЛЮ ОПЛАТИ З УРАХУВАННЯМ ФІКСОВАНОГО ПАКЕТУ СЕРВІСІВ (ОНПУ, Україна)	53
ГУСЯТИН В.М., ЛЕБЕДЕВ В.О. АРХІТЕКТУРА НАПІВПАРАЛЕЛЬНОЇ ГЛИБОКОЇ НЕЙРОННОЇ МЕРЕЖІ (ХНУРЕ, Україна)	55
КОТЛИК С.В., СОКОЛОВА О.П., КОРНІЄНКО Ю.К. ОГЛЯД ЗАСТОСОВУВАННЯ ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ ДЛЯ 3D МОДЕЛЮВАННЯ (ОНАХТ, Україна) ...	58
OTNOSHENNYI I.O. DESIGNING THE SOFTWARE SYSTEM FOR RECOGNITION OF A HANDWRITTEN TEXT USING A NEURAL NETWORK (ONPU, Ukraine)	61
СЛУШНА Н.В. ПЕРСПЕКТИВИ РОЗВИТКУ І ВИКОРИСТАННЯ СИСТЕМ ООБД (ОНАХТ, Україна)	64
КОМЛЕВА Н.О., SHYDER M.O. OUTSOURCING PLANNING PROGRAM OF	65

DESIGNING THE SOFTWARE SYSTEM FOR RECOGNITION OF A HANDWRITTEN TEXT USING
A NEURAL NETWORK

THE WORK CONSIDERED THE PRINCIPLES OF WORK OF THE METHODS OF MACHINE RECOGNITION OF HANDWRITTEN SYMBOLS. ONLINE AND OFFLINE RECOGNITION FEATURES ARE ANALYZED. BASING ON THIS, THE DESIGN OF THE SOFTWARE SYSTEM FOR THE OFFLINE RECOGNITION OF ENGLISH LANGUAGE SYMBOLS IS PERFORMED. TRAINING AND CLASSIFICATION SUBSYSTEMS FORMALIZATION USING THE APPROPRIATE DIAGRAMS.

Introduction. Digitization of handwritten text is a problem that appeared several years ago and remains relevant. The handwriting of different people varies greatly, so it is difficult to create a program that can recognize any of the existing handwriting. In addition, many people write very illegibly, which is why part of the letters merges and becomes incomprehensible in software processing. At the moment, the achieved accuracy of handwriting recognition is lower than for printed text. To date, there is no software that can recognize handwritten text with a 90-100% probability.

The aim of work. The aim of the work is the analysis and formalization of methods that provide automatic recognition of handwritten text offline with high probability.

Research methods.

Handwriting recognition can occur offline and online. The offline mode provides for working with a static image of the text, which can be obtained by one of the following images: 1) is entered by the user in the software application itself using the graphical input cursor; 2) read from a graphic file; 3) obtained by taking photos of paper media on which there is an image. Online mode provides for text recognition, which is carried out in parallel with text input. Online recognition is used in interactive systems, while offline recognition is used to recognize text, bank checks, recipient addresses on mail, signature confirmation. In offline mode, there is no way to track the character-drawing process itself, so this task is more difficult than online recognition.

Consider the following situations that arise when working with handwritten text: 1) the text is written in a manner as close as possible to the printed text; 2) the text does not look like printed.

In the first case, it is possible to use standard utility programs for recognizing scanned text. A good example of such programs is ABBYY FineReader Online. ABBYY FineReader has been supplying various utilities for working with scanned text for over 10 years. The first programs did not work very well, but modern algorithms make it possible to recognize 95-100% of scanned text in a familiar program language. The utility works with the most popular languages of the planet.

In the second case, you can use programs that involve entering handwriting using a mouse, tablet, or moving your finger across the screen, for example, MyScript Stylus. The program recognizes the text by the technology used in the Personal Digital Assistant, and can be used where it is not possible to use a standard keyboard or is difficult to use – for example, if the computer is used as a terminal for input/output of information, such as a payment terminal. MyScript Stylus can be assigned to a specific program, and all recognized text will be transmitted to it, as if the text was entered in a standard way. MyScript Stylus supports 26 languages, however, it is chargeable, trial version is valid for 30 days. It is clear that the development of a free native application that allows you to recognize handwritten text offline, would be extremely useful.

The scope of handwriting recognition systems is very wide: 1) text identification; 2) recognition of electronic signatures; 3) search for given graphic elements; 4) adjustment of elements; 5) analysis of the psychological profile by the nature of the writing of handwritten elements, etc. Consider the main methods to implement this functionality.

The standard process for offline recognition of handwritten texts is carried out in accordance with the following scheme: 1) image preprocessing and highlighting areas of interest; 2) segmentation and normalization of texts of areas of interest; 3) recognition of segmented texts by one or another method.

Many tasks of recognition of graphic objects in images can be reduced to recognition of figures - this is a special case of pattern recognition. Existing methods for representing figures can be classified as follows: these are methods based on the contour and methods based on the domain, spatial domain, and transformation domain; information-preserving and information-non-preserving methods. Depending on the

image processing method, approaches to the selection and presentation of figures are divided into one-dimensional function, polygonal approximation, spatial interrelation feature, moments, scale-space methods, shape transform domains [1]. However, the solution of such problems is not the subject of research in this article.

Graphic images of symbols at the output of the scanner have the form of shapes (forms), which are matrices of points that can be edited element by element. Consider the requirements that the image of handwritten letters must satisfy: 1) the letters are darker relative to the background; 2) there are no other graphic elements on the image except for the recognizable signature; 3) the letters should have approximately the same size and orientation, and should also be written in a row.

Formally, the task of recognizing handwritten characters can be formulated as follows. It is required to find the minimum discrepancy between the standard for each symbol and the current representation of the image, presented as a set of features. According to the standard of the symbol, having minimum mismatch with the current image, the recognized image of the symbol should be indexed. For recognition of "doubtful" shapes, data on the result of recognition of neighboring elements in the text is used. In the simplest cases, words are the context.

For the analysis and recognition of handwritten characters, whether it be ASCII characters or characters from other code tables, two processes are required. The first process is to teach the system the features of each of the characters that you want to recognize. The second process is to use information about the set of symbols available in the system and compare the determination of whether it is possible to define a new symbol as a specific element from a given set, or whether it does not belong to it at all. A quantitative criterion for the successful completion of this stage is the probability value with which the new symbol is recognized. At both of these stages, it is advisable to use a recurrent neural network. This is a type of neural network where links between elements form a directed sequence. Thanks to this, it becomes possible to process a series of events in time or sequential spatial chains. Unlike multi-layer perceptrons, recurrent networks can use their internal memory to process sequences of arbitrary length. Therefore, RNN networks are applicable in such tasks where something integral is divided into parts, including handwriting recognition.

The process of training the system for subsequent recognition of handwritten characters includes: 1) a training sample for each character received from a particular person or group of people depending on the task being solved; 2) selection of the correct sets of characteristic features of the image; 3) the formation of global parameters that provide information about the general case affecting the image structure; 4) the formation of local parameters, providing general information about the shape of the symbol according to different criteria; 5) neural networks receive at the input sets of normalized input data that are located in arrays. These arrays are usually called input vectors. The networks are then trained to produce the correct output on specific input data sequences.

The handwriting character recognition process includes the following steps: 1) registering a new character; 2) image processing; 3) the allocation of image features (structural features, characteristic features, a mixed version); 4) image verification; 5) identification of the recognized character.

To increase productivity, neural networks, which include many layers and neurons in each layer with initial weights, must be correctly designed.

The most commonly used algorithm for training multilayer direct propagation neural networks is the back propagation algorithm. That is why such a neural network is often called a back-propagation network. The network with the back propagation of errors is trained in a finite number of standards, i.e. pairs of patterns that consist of source input value sets and desired output value sets.

As signs describing the shape of the curved lines with which the characters are represented, Bezier curves can be used. Bezier curves are a particular type of third-order curves that require fewer parameters (eight instead of eleven) for their description. The basis for constructing Bezier curves is the use of two tangents drawn to the extreme points of a line segment. The curvature (shape) of the line is affected by the slope and the length of the tangent line, the values of which can be controlled interactively by dragging their end points. Thus, the tangents act as virtual levers, allowing you to control the shape of the curve. Bezier curves are of particular importance for both vector and bitmap graphics. The appearance of Bezier curves caused a real revolution in three-dimensional graphics. Due to the simplicity of the task and manipulation, Bezier curves are widely used in computer graphics for modeling smooth lines [2].

Currently, Bezier curves are present in any modern graphics package. Also, most computer fonts consist of Bezier curves. By segments of such a curve, an arbitrarily complex contour can be approximated. In this case, it will consist of a set of Bezier curves. The flexibility in constructing and editing Bezier curves is largely determined by the characteristics of the nodal points.

Results and discussion. Using the recognition method using neural networks is distinguished by higher efficiency and productivity, however, it requires either a large number of examples during training, or the creation of special structures of the neural network that take into account the specifics of these tasks.

Data for the research are taken from the letters of the Latin alphabet, for each of which 8 to 12 characters are highlighted. Character values are quantitative values measured on a continuous scale. For each character there are examples of inscriptions made by 15 people.

Before making the classification, the algorithm is trained on the training data set - the training sample. Each row of such a selection contains: in fields designated as input – a set of input parameters; at the output – the class designation corresponding to this set. The list of classes is set by the training data set during the training of the neural network and cannot be changed / revised during the classification process.

Technically, training consists in finding weights – the coefficients of connections between neurons. In the learning process, the neural network is able to identify complex relationships between input and output parameters, as well as perform generalization. This means that in the case of successful training, the network will be able to return the correct result based on data that were not in the training sample, as well as incomplete and/or “noisy”, partially distorted data, which are certainly present in the handwritten text.

At the software design stage, concept class diagrams were created. In Fig. 1 is the diagram for the learning subsystem. Since some operations for training classifiers were quite long in time, it was advisable to use multithreaded algorithms. This is why it is advisable to place the parallel process manager on the conceptual class diagram. In Fig. 2 is the diagram for the classification subsystem. Both diagrams were then detailed to the program class diagram, after which programming was carried out. The software system is currently in the testing phase.

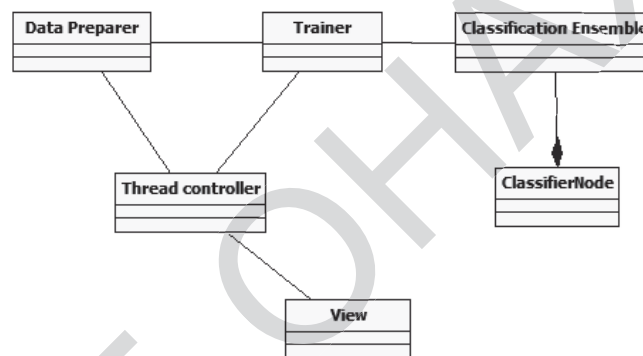


Figure 1 – Diagram of conceptual classes of the learning subsystem

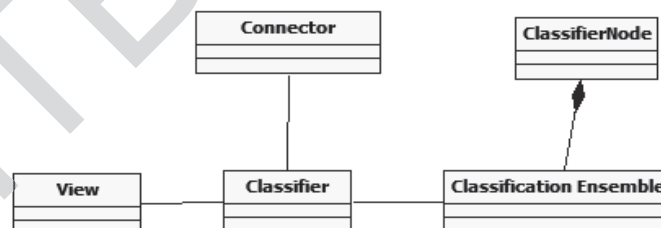


Figure 2 – Diagram of conceptual classes of the classification subsystem

Conclusion. The paper analyzes the methods of handwriting recognition. The problems associated with recognition, as well as the requirements for the original image of the symbol are considered. The design of a handwritten English-language text recognition system based on a recurrent neural network has been designed. System architecture details and programming have been carried out. It is planned to use such a system as an instrument of analysis of the psychological profile by the nature of the writing of handwritten elements

REFERENCES

- [1] D. Zhang, G. Lu “Review of shape representation and description techniques”, *Pattern Recognition*, V. 37, p. 1–19, 2004.
- [2] Y. Peng-Yeng “Pattern recognition techniques, technology and applications”, *Croatia: In-Tech*, 626 p., 2008.

ХІІ МІЖНАРОДНА НАУКОВО-ПРАКТИЧНА КОНФЕРЕНЦІЯ**ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ І АВТОМАТИЗАЦІЯ – 2019****INFORMATION TECHNOLOGIES AND AUTOMATION – 2019**

*ОДЕСА
17– 18 ЖОВТНЯ, 2019*

Збірник включає доповіді учасників ХІІ Міжнародної науково-практичної конференції «Інформаційні технології і автоматизація – 2019»

Редакційна колегія: Котлик С.В., Хобін В.А., Плотніков В.М.

Комп'ютерний набір і верстка: Соколова О.П.

Відповідальний за випуск: Котлик С.В.