Практичне застосування сервісу полягає у використанні сервісу читачами для знаходження наступної книги для читання або складенні списку книг на основі власних вподобань, а також у можливості застосування сервісу в середніх навчальних закладах та закладах вищої освіти.

Перспективами подальших досліджень і розробок може бути створення мобільного додатку до веб-сервісу для розширення способів доступу користувачів до сервісу, реалізація ще одного алгоритму інтелектуального пошуку – алгоритму нечіткого пошуку, реалізація інтелектуального пошуку на основі аналізу змісту (повного тексту) творів для ще більш точної рекомендації схожих книг.

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Intelligent image pre-processing technology for handwriting recognition by photo

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Інтелектуальна технологія попередньої обробки зображень для розпізнавання рукописного тексту по фотографії

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Анотація

У цих тезах було розглянуто проблематику предметної області, аналіз можливих алгоритмів, які використовуються для поставлених задач попередньої обробки зображень, основні підходи та складнощі при розпізнаванні рукописного тексту з зображень. Після аналізу інформації було сформовано план на дослідження та виведено методологію проведення експериментів, які в результаті мають привести до створення інтелектуальної технології попередньої обробки зображень для розпізнавання рукописного тексту з зображень, котра має значно підвищити точність виявлення та розпізнавання рукописів.

Handwriting is the basis for the transmission of language through signs, which is the beginning of knowledge transfer for generations to come. Many books (manuscripts) have been written by hand since that time, which seem to be of great value and retain unique, centuries-old knowledge. The theme is the research of existing methods of pre-processing of images for recognition of the handwritten text on a photo and development of own intellectual technology by improvement and combination of existing methods.

Classical algorithms for recognizing printed text, such as Hamming Metrics [1], for example, do not work effectively because the writing of different people is very different, making it impossible to use such standardized methods. Also, the problem becomes much more complicated because the spelling of the letters is highly dependent on the neighbouring letters. But many neural networks were developed to resolve this problem and most of them use some pre-processing algorithms for better handwriting recognition, but how to understand which algorithm works better in specific circumstances of handwriting recognition is still the question. This work is supposed to answer the question, which image pre-processing algorithms and their combinations works best for such a task.

The aim of the work is to study the methods of image processing related to text recognition, their improvement, combination and creation of intelligent technology for handwriting recognition by photo.

Even in the modern world there is still a lot of information that exists only in handwriting, although, given the development of information technology, to analyze, store and transmit information is much more convenient in electronic form. And for this it is necessary to have reliable mechanisms for converting handwritten text on paper into an electronic version.

In the course of the research it will be possible to find out which methods of image pre-processing are best for recognizing handwritten text, how to get rid of the shortcomings of existing methods that work for recognizing printed text by adapting them to manuscripts.

When performing the work following tasks will need to be performed:
− Review and comparative analysis of existing methods of pre-processing images with text.
− Identify methods that are best suited for pre-processing images with handwritten text, identify methods to improve the visibility of the text, divide the photo into individual words and recognition.
− Identify ways to solve problems existing in existing methods.
− Design and develop a system for analysis and verification of the implementation of the found methods of image pre-processing for handwriting recognition.
− Test the developed system with the selected methods and their combinations, analyze the results of experiments and choose the most optimal mechanisms.

The practical value of the work is that the developed system and the set of methods used in it will help to convert manuscripts into electronic form much easier and more reliable, which in turn will simplify the analysis of large amounts of manuscript data, search and storage.

To determine the effectiveness of algorithms and their combinations, it is necessary to derive a methodology for their evaluation. The following methodology will be used for this study:
− For the initial result, a convolutional neural network will be trained without using preliminary image processing. IAM Handwritten Database [2] will be used as a dataset. The final result of the accuracy of the determination will be recorded as the base accuracy.
− The basic algorithms for preliminary image processing will be highlighted.
− Combinations of these algorithms that make sense will be defined.
− A neural network with the same parameters as in the base one will be retrained using preprocessing algorithms and their combinations
− An analysis of the obtained data will be carried out and the optimal algorithm or their combination for handwriting recognition will be determined.

Designing an algorithm.

Looking at the problem of handwriting recognition extensively, it becomes clear that the process is basically divided into two stages. The first part of the handwriting recognition process is the segmentation of the text, sometimes by letters, sometimes by words (the option of segmentation by sentence is almost impossible, since it is almost impossible to even estimate the sample size required for learning such a neural network).

First, consider the most common letter segmentation approach. This approach works great for printed text (although most often there would be enough just mathematical / genetic algorithms) [3], but has a number of disadvantages to handwriting [4]:

1.　　　The segmentation process is quite problematic, the letters can merge into one (fig. 1).

2.　　　Some letters cannot be recognized without the analysis of neighbouring letters.

Figure. 1. Example of merged letters.

These disadvantages make it impossible to go beyond a certain threshold of recognition accuracy, since even a huge training data set will not help with the problems above.

Considering the word segmentation option, it is immediately clear that word division is much easier, but recognition requires a much larger data set for learning. As the amount of images of handwriting have become much bigger than they were a few years ago, and the need to analyze them is becoming more acute, it is quite easy to find data for training the neural network and it will become easier in the future. Word segmentation is the most critical pre-processing step for any handwritten document recognition/retrieval system [5].

The algorithm was chosen for this algorithm "Scale Space Technique for Word Segmentation" [6], which has accuracy about 99% of words in images, although sometimes the algorithm considers combinations of words as one word, but given that the next step is to define the word by artificial neural network, this fact can be considered acceptable. Such accuracy allows choosing this algorithm without additional alternatives research. So, further work will be mostly focused on separated images processing.

Designing a neural network model.

After dividing the image into separate words, they must be submitted to the input of the neural network. Given that all of these images have different sizes, they need to be normalized. Defining a normalization option is an important step in designing a neural network model because image size greatly affects the number of parameters that need to be considered in a neural network model.

Word images are usually shaped like an elongated rectangle, which is why it was decided to use image normalization to a size of 128x32 pixels. The image should also be normalized by colour, sharpness, etc., but this will be the purpose of the further work.

An artificial neural network with 5 convolution layers was selected for word recognition from the images, which was caused by the sufficiently large image size and the high number of possible classes for classification. As an activation function, a ReLU (Rectified Linear Unit) [7] between all wrapping layers was used. Also, max-pooling layers were used between all convolutional layers [8].

Inspired by the fact that when reading the handwriting, a person defines words not only by the word itself, but also by the words nearby, it was decided not to use a normal fully-connected perceptron as the last layer, but 2 layers of recurrent fully-connected perceptron.

In the course of the research the theoretical part of the subject area, the analysis of possible algorithms used for the tasks of image pre-processing, the main approaches and difficulties in recognizing handwritten text from images were considered, neural network model have been created for the further research using chosen methodology. After analyzing the information, research tasks were formed, which should eventually lead to the creation of intelligent image pre-processing technology for handwriting recognition from images, which should significantly improve the accuracy of detection and recognition of manuscripts.

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